Investigating the Affective Core of Subjective Wellbeing: the Circular Way

by

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Submitted in fulfilment of the requirements for the degree of

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1 The suffix to the title of this thesis “the Circular Way” is an original phrase appropriated by Michael B. Gurtman (1997) in his chapter entitled: Studying personality traits: the circular way. In R. Plutchik & H.R. Conte (Eds.), Circumplex models of personality and emotions (pp.183-210). Washington, D.C.: American Psychological Association. Professor Gurtman informs me the phrase pays homage to the work of Jack Block, who used the California Q-set and other novel methods to study personality “the long way”. Professor Gurtman’s chapter relied on the Q-set method to illustrate circumplex methods, and so he thought his title was appropriate, and, of course clever. I agree!
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EXECUTIVE SUMMARY

While there is general agreement that subjective wellbeing (SWB) comprises both cognitive and affective components, a growing body of research (Blore, Stokes, Mellor, Firth, & Cummins, 2011; Davern, Cummins, & Stokes, 2007; Lai & Cummins, 2013; Tomyn & Cummins, 2011) suggests that SWB is mostly affective in nature. Moreover, with the recent claim that set-points for SWB have been demonstrated (Cummins, Li, Wooden, & Stokes, 2014), the precise nature of this affect becomes a central concern for researchers in this area. This thesis investigates the nature of the affective component of SWB, called Homeostatically Protected Mood (HPMood), and determines HPMood’s degree of association with SWB, and its major correlates, on the circumplex.

HPMood is a core affective construct

SWB Homeostasis theory (Cummins, 2010, 2012; Cummins, Lau, & Davern, 2012) links Russell and Barrett’s (1999) original definition of mood, as a prolonged state of core affect, to Cummins’ description of the affective core of SWB, he calls Homeostatically Protected Mood (HPMood). HPMood is a form of core affect, described by Russell (2003), as a “neurophysiological state consciously accessible as the simplest, non-reflective feelings evident in moods and emotions” (p.148). In accordance with the circumplex model of affect, it is proposed that, in any given moment, core affect is experienced as some combination of the two independent and bipolar dimensions of Hedonic Valence (pleasure vs. displeasure) and Arousal (activated energy vs. deactivated energy). To validate the nature of HPMood as a state of core affect requires a structural model to capture its specific blend of Hedonic Valence and Arousal.

Measuring the affective ‘core’ of SWB

Traditionally, researchers working within the theory of SWB Homeostasis (Blore et al., 2011; Davern et al., 2007), use linear multiple regression analysis to validate the HPMood construct. By simultaneously regressing multiple independent affect measures onto the single-item dependent measure of SWB (i.e., General Life Satisfaction (GLS)), these studies examine which affects significantly and uniquely
predict scores on GLS. The rationale for this approach is that the abstract and personal nature of the GLS question, “How satisfied are you with your life as a whole?” captures the essence, or affective ‘core’ of SWB. Thus, responses to this single-item measure will be dominated by HPMood (Cummins, 2010).

However, a major flaw in these research designs is the use of a linear model to verify a theoretically non-linear state of core affect underlying responses to SWB. This approach also reveals that, inconsistent with the idea that HPMood has a constant structure, the unique affects predicting GLS, change with different samples (see Blore et al., 2011; Davern et al., 2007). Therefore, the determination of a valid representation of HPMood from a composite set of unique affects becomes uncertain.

This uncertainty translates into a major source of unreliability when researchers (e.g. Davern et al., 2007; Lai & Cummins, 2013; Tomyn & Cummins, 2011) do not rely on this validation procedure, and simply assume that HPMood is best operationalised as happy, content, excited/alert. This has the effect of imposing the structure of HPMood before it has been determined. This is problematic particularly when research is driven by the theoretical assumption that HPMood is the determining force responsible for the stability in SWB (Cummins et al., 2014), and that HPMood drives the relationship between SWB and major correlates of SWB such as self-esteem, perceived control, optimism, and extraversion (Blore et al., 2011; Davern et al., 2007; Tomyn & Cummins, 2011).

The main aim of this thesis is to address these limitations by providing a more valid description of the affective nature of HPMood, and its degree of association with SWB and major correlates of SWB, using a circumplex analysis.

Verifying HPMood on the circumplex

This entire investigation was conducted across four studies, and involved participants who responded to Surveys 21 ($n = 790$) and 24 ($n = 569$) of the Australian Unity Wellbeing Index Longitudinal Project, over the years 2011-2012.

The first study utilised the Circular Stochastic Process Model with a Fourier Series (CSPMF), commonly known as CIRCUM (Browne, 1992), to test the circumplexity of the affective data. The findings confirmed a structure of core affect
from 23 single-item measures of feelings about life in general. However, the results also revealed a relative absence of high activation. This was largely attributed to the number of affects sampled and the use of a response format eliciting judgements about life in general.

The second study repeated the first, but this time a new structure of core affect was validated from 11 composite measures (3 items per scale) of momentary feeling states. While the analysis again failed to capture highly activated unpleasant states, it did reveal the presence of purely activated states and highly activated pleasant states. This was largely attributed to the response format eliciting momentary states of affect.

Two additional studies utilised a procedure known as the Cosine Wave Method (Yik, 2009; Yik, Russell, & Steiger, 2011), to investigate the psychological nature of HPMood, and its magnitude of association with SWB and its major correlates, on the circumplex. The findings verified that, the specific type of core affect infusing the content of SWB and related variables of self-esteem, optimism, and facets of extraversion (positive affect, sociability, activity), is pleasant and mildly activated. The results also revealed that, SWB is more affective in nature compared to the other included variables. However, HPMood’s character varied depending on the design of the core affective model. Establishing a life in general circumplex and locating HPMood with SWB described HPMood as pleasant core affect. Establishing a momentary circumplex and locating HPMood with SWB revealed a mildly activated and pleasant core state of affect. HPMood’s magnitude of association with SWB also varied between moderate to strong depending on the design of the core affective model.

Overall, this character of HPMood is largely consistent with predictions based on Homeostasis theory. However, the findings do not conclusively support previous evidence that HPMood dominates the content of these responses. One major implication of the findings is that cross-sectional research designs may not reliably capture HPMood’s nature as a prolonged state of core affect.

In summary, these four studies together provide an empirical definition of HPMood with research methodology that can best describe its specific blend of
Hedonic Valence and Arousal. The specific blend infusing the content of SWB, self-esteem, optimism, and facets of extraversion is always pleasant, and mildly activated. This is the most valid understanding of HPMood yet produced.
CHAPTER 1:
INTRODUCTION

1.1 THE HISTORY OF AFFECT

Scientific progress within psychology is highly dependent on understanding affect. Yet it is only over the past 30 years that researchers in psychology have been eager to explore affective processes. This delay was due, in part, to the dominant view held by 19th century scholars, which continued to hold sway up to the early decades of the 20th century, that human psychological faculties or domains should be studied in isolation from one another (Hilgard, 1980). Consequently, the psychological domains of cognition, affect, conation, and personality came to be seen as distinct and unrelated. Such partialling-out of psychological domains into separate investigative silos not only prevented consideration of their reciprocal nature, but also led to the neglect of some domains and the privileging of others. Arguably, affect has been the least understood and the last of all psychological domains to be systematically explored (Forgas, 2008).

The reluctance to explore affective processes can be traced back to Plato (Plato., 576 b-588 a; 602 c-605 c/1974) who regarded emotions or ‘the passions’ as dangerous, always threatening the wellbeing of individuals and society. Indeed, Plato believed the path to obtaining a ‘happy’ or ‘blessed life’ was via a systematic pursuit of rational inquiry. This idea, that rationality represents a true state of the world, and that affective processes are dark, unruly forces threatening psychic equilibrium, has been a recurring theme in theories concerning human nature throughout the ages (Cottingham, 1998).

One of the most influential early theories to conceptualise the affective domain in terms of an invasive force is Sigmund Freud’s Psychoanalytic Theory, in particular, his notion of ‘the unconscious’ (Freud, 1915/1957). Freud’s, depiction of affect as an immoral and unjust perpetrator of cognitive or rational processes, combined with the time in which his theories were flourishing, proved to be powerful antecedents for mystifying and retarding our understanding of affect over the past century. With this in mind, the following section will review in more detail Freud’s ideas regarding affect, along with some of the most influential theorists from the late
nineteenth and early twentieth centuries, before elaborating on the major theories of the present day. The aim of this historical review is to elucidate the paradigms the theories represented and the power of certain paradigms to shape our current understanding of affect.

1.1.1. Early Affect Theories

*Sigmund Freud (1856-1939)*

The term ‘unconscious’ had multiple meanings for Freud. However, he mainly used the term as an adjective to highlight a common property found among the components of ‘the unconscious’; used here as a noun to make sense of what Freud believed to be the most extensive and important component of the mind (Elder, 1994). Most interestingly, Freud used the term in an active, or dynamic sense, to explain the causal role that affect played in determining an individual’s thoughts, symptoms, and actions (Power & Brewin, 1991).

Freud’s early theorising about affect was modelled on an influential law in 19th century science, the Law of Thermodynamics, guided by the ‘Principal of Constancy’ (Power & Brewin, 1991). Freud adopted principles and laws from the natural sciences to provide a known conceptual analogue to describe unknown, or unconscious mechanisms underlying behaviour. He used these adopted laws to demonstrate that unconscious systems of a psychological nature operated in the same way as physical systems (Chalmers, 2007).

For instance, Freud conceptualised affect as energy, which existed in a ‘free flowing’ form. This energy possessed all the characteristics of quantity ($Q$) thus $Q$ was capable of increasing, diminishing, displacing, and discharging (Freud, 1895/1950). For example, incoming energy, as stressors from the environment, produced excitation, or increased energy, which needed to be discharged by the nervous system in order to return to a ‘free state’. If psychic equilibrium was not maintained, or if certain threshold values were exceeded, a traumatic memory formed, and ‘repression’ occurred. This resulted in the manifestation of an illness, which Freud termed ‘a neurosis’ (Freud, 1916-1917/2001).
Freud’s energy model of affect, conceptualised as a mechanism for maintaining psychic equilibrium is equated with the term ‘homeostasis’ (Freud, 1895/1950). Historically, homeostasis is most commonly applied to conceptualising the body’s physical regulation of internal body temperature. Freud’s ideas are an example of an early psychological theory that applies homeostasis to the maintenance of psychic equilibrium, in other words, levels of personal wellbeing. Indeed, the term ‘homeostasis’ (Cannon, 1939) is currently utilised to describe the basic mechanism underpinning Subjective Wellbeing (SWB) management (Cummins, 1998, 2010; Cummins, Gullone, & Lau, 2002). Homeostasis and its application to the theory of SWB Homeostasis will be reviewed in detail in section 1.2.

At present it is sufficient to say that both Freud and Cummins assign affect terms with hedonic tone to their mechanistic models to make psychological sense of a physiological concept. According to Cummins (2010), the single most important thing about SWB is that it is positive, and what sets this positivity, or hedonic tone in place, is the combined experience of happiness, contentment, and alertness. Hedonic tone, or pleasure conceptualised as the only thing which has a positive value in itself (i.e. the only original good) has been documented in philosophising throughout the ages (Tatarkiewicz, 1976). Indeed, many psychological theories from the 18th century to the present time reduce discussion of the affective domain to aspects of pleasure and displeasure (see Hilgard, 1980 for a review).

Freud’s theorising about affect also emphasised the hedonic aspect of pleasure and displeasure in so far as the affective domain was said to be governed by the ‘Pleasure Principle’ (Frosh, 2003). However, Freud’s interpretation of hedonic pleasure was constrained to emotional expressions of sexuality and aggression. Furthermore, Freud’s theorising emphasised the activation and valence dimensions of affect, an emphasis particularly evident in current affect theories (e.g. Feldman Barrett & Bliss-Moreau, 2009; Larsen & Diener, 1992; Russell, 1980, 2003, 2009; Yik, Russell, & Feldman Barrett, 1999).

In summary, Freud’s main argument is that the essence of humanity is the dynamic unconscious, in other words, the affective domain. More importantly, inferring that the ‘dynamic unconscious’ behaves in accordance with the laws of
nature provides a natural link to a causal explanation for affect in Freud’s theory. This was crucial for Freud because striving to demonstrate causality in psychological theories provided determinists, such as Freud, with the confidence to assert that their theories would be free from contradiction (Freud, 1895/1950). However, at the time when Freud’s ideas were flourishing, the scientific community ignored his claim that affect could be the essence of human nature. This was largely due to the non-systematic methods he employed to measure affective processes. Therefore, it was deemed that Freud’s theories about the affective domain were best suited to the consulting room rather than being the stuff of science (Frosh, 2003).

William James (1842-1910)

Freud recognised his psychoanalytic theory was foreign to the psychology of the affect at the time. A time where the James-Lange theory of emotion held sway. Originally proposed by William James in 1884, and extended by physiologist Carl Lange in 1885, these scholars argued that emotions are essentially ‘readout’ of internal body states (Yovell, 2000). In fact, James believed there were no special brain-centres for affective processes. His sensational theory of the mind postulated that all affective processes are consciously experienced via bodily changes. Therefore, sensational, associational, and motor elements were all the brain need contain (James, 1890/1950a).

Specifically, James reasoned that humans’ sense, or perceive, or may even imagine an object, which ‘excites’ the nervous system. The arousal produced by a perceived object produces a reflex effect in the form of bodily changes, or ‘physiological reverberations’ (i.e. muscular contractions or dilation, glandular secretions, and the like). Our feeling of those reverberations as they occur is emotion. Whereas Freud connected physiological symptoms to psychological trauma, James believed physiological symptoms were felt emotions.

This idea that emotions are feelings of reflexive acts and therefore sensational processes was an important postulate of the James-Lange theory. It provided a worthy measure for affective processes, in that understood physiological processes caused emotions. Hence, James relied on known facts of a physical and structural nature to de-mystify the affective domain. More importantly, however, connecting affective processes to consciously felt reflexive acts, as opposed to Freud’s
unconscious forces, provided an overt measure for affective processes. In this way, the James-Lange theory of emotion protected psychology’s main claim to its legitimacy as a science; a claim that called for a systematic approach to the gathering of data (Öhman, 2005).

This same idea, that emotions are feelings of reflexive acts, served as the basis for a further postulate. James contended that by consciously attending to these reflexive acts, one can detect the various ‘emotional moods’ that depict that sense of personality we unfailingly carry with us (James, 1890/1950a, p.451). Implicit in this proposition is the assumption that emotions, as reflexive acts, are subjectively experienced, and that mood characterises personality.

James does not distinguish between mood as a trait, and emotion as a momentary state (Huelsman, Nemanick, & Munz, 1998) except to say that emotions as reflexive acts are less practical sensational processes. According to James, sensational processes are practical if they contribute to evolutionary fitness. Emotions as reflexive acts do not serve this purpose because emotional reactions usually terminate in the perceiver’s own body (James, 1890/1950a). Impulsive acts, on the other hand, which James connected to instincts, enter into more practical relations with an exciting object thus serve to contribute to evolutionary fitness. Whilst James does not explicitly define personality, he uses the terms instinct and trait interchangeably, and describes instincts as the faculty of acting without foresight of the ends (James, 1890/1950b).

If, as James states, that ‘emotional moods’ depict our sense of personality, and that our sense of personality is always with us, then James’ conceptualisation of the instincts, related to his concept of emotional mood, signifies an early conceptualisation of the modern terms trait mood (Huelsman et al., 1998) and core affect (Russell, 2003). For James, these core affective instincts define personality. However, whilst James does distinguish between instincts and emotions in terms of their utility, and by stating that instincts support emotions (James, 1890/1950b, p.412), it is difficult to discern from James’ theorising whether instincts as core affect drive emotions and define personality.
This difficulty stems from taxonomy in his theory, which is essentially based on physiological terminology (i.e. instincts are impulses; emotions are reflexes). Yet when conceptual clarification is required, affect terms are used. For example, James distinguishes between various emotions based on the magnitude of perceived bodily sensations, with the strongest sensations signalling emotions that everyone recognises (i.e. fear, rage, love, grief). These are what James termed the ‘coarser emotions’ (James, 1890/1950a). Indeed, the strongest bodily sensations are pleasure and displeasure, or pain. However, these same affect terms are applied to the labelling of instincts, sensational processes in James’ theory that are purported to be stable and distinct from the more transitory sensations he calls emotion.

This inconsistency in his use of terminology is a result of James’ view that a taxonomy of emotion based on lay concepts fails to provide affect theories with deductive or generative principles (James, 1890/1950a). Moreover, labelling emotions via language systems in order to objectify affective experience is a redundant exercise given that emotions are tied to reflexive acts. He believed that reflexes are variable, both in terms of their constitution, and the objects that invoke them. Reflexes are, therefore, a valid explanation for the infinite number of possible emotions people experience, and the variability found between individuals in their experience of them.

In sum, the relative lack of consideration for the human faculty of affect in the James-Lange theory of emotion is driven by the belief that affective processes are tied to physiological impulses and reflexes. When we attend to these reverberations we sense via our emotional moods, the essence of our personality. Whether this sense of personality can be linked to trait mood or core affect is uncertain due to his disregard for taxonomy of affect.

Charles Darwin (1809-1882)

Unlike James, Darwin was most noted for his meticulous recording and construction of nomological networks to describe all manner of life on earth. His paradigmatic beliefs about the origin of species influenced a score of disciplines, from population genetics, to evolutionary biology, to biotechnology, to the study of ecosystems and the science of emotions (Rothwell, 2011). In relation to the latter, Darwin shared with James, materialistic assumptions regarding the origins of
emotional expression in man and lower animals (Darwin, 1872/1934). Yet whereas the James-Lange theory of emotion asserted that physiological actions and affective processes are essentially the same material substance, the Darwinian science of emotions, through affording affect a causal role in the theory, could not exemplify such materialistic epistemology at that time.

The later discovery of the role of endocrine glands and their chemical messengers, hormones, would have provided Darwin with a material basis for the psychological processes he theorised about. According to Darwin, there are chemical processes (yet to be found) that represent our innermost moods, and are responsible for all physiological manifestations associated with mammalian emotional expression (Darwin, 1872/1934). Moreover, Darwin’s main thesis in relation to the affective domain was that emotional expression is largely an innate capacity that is similarly produced and interpreted cross-culturally (Snyder, Kaufman, Harrison, & Maruff, 2010).

The psychological processes specifically associated with human emotional expression are discussed by Darwin in his book *The Expression of the Emotions in Man and Animals* (1872/1934). He argues they can be partitioned into the domains of cognition (rational thoughts and ideas), conation (volition), and what Darwin terms ‘our state of mind’, which he defined as emotions (i.e. feelings) and sensations (i.e. impulses generated from our corporeal framework). All of these psychological domains act upon expression. The term ‘expression’ is used by Darwin to describe the physiological manifestations (i.e. glandular secretions; muscle dilations and contractions; gesticulations) that represent the language of the body. Hence, psychological processes activate mutual action and reaction between physico-chemical phenomena.

However, when it comes to explaining how emotional expression is ultimately determined, Darwin assigns each psychological domain a function. Overseeing all psychological processes is an inherited core affective state (i.e. ‘our state of mind’). This underlying emotional state is afforded most influence over expressive behaviour because it determines involuntary physiological actions, and this type of emotional expression cannot be influenced by cognition and conation. Rather, these lower order domains serve to habituate expressive behaviour via
repeated associations between core affective processes and physiological actions. This occurs through learning and imitation thus, habituation of emotional expression via cognitive and conative processes determines voluntary expression in man (Darwin, 1872/1934). This functional explanation served to support Darwin’s main idea that emotional expression evolved as an adaptive and communicative function that reflects a shared evolutionary history with mammalian animals and our humanoid ancestors (Hess & Thibault, 2009).

Given that Darwin could not provide a physico-chemical basis for affective processes in his science of emotions, he turned to the known physical concept of energy, and its activating function to conceptualise affect. Darwin goes on to construct taxonomy for core emotions based on our language system, with affect terms depicting the degree of activation. Hence, the *Hedonic Valence* (pleasure vs. displeasure) and *Arousal* (activated energy vs. deactivated energy) dimensions of affect are emphasised in Darwin’s affect theory. For example, activating emotions such as ‘*joy*’, ‘*happy*’, ‘*rage*’, and ‘*anger*’ lead to energetic expression. De-activating emotions such as ‘*pain*’, ‘*grief*’, and ‘*fear*’ are termed ‘depressing’ because these habitually exhaust rather than energise expression. Finally, there are other emotions such as ‘*affection*’, which Darwin believed, lead to no activation of any kind, and as a result, do not manifest in expression (Darwin, 1872/1934).

The claim that ‘*affection*’ is voluntarily non-expressive alludes to conservative sociocultural beliefs and practices representative of Victorian England. More interestingly, it elucidates the quality of Darwin’s own interpersonal relationships. Darwin is described as a kind, inquiring, open-minded man (Darwin, 1872/1934; Rothwell, 2011). However, the death of his mother at eight years of age combined with his estranged relationship with his father, whose depressive nature turned to sarcasm and bullying after the loss of his wife, no doubt, contributed to Darwin’s struggle to make sense of an affectionless world (Bowlby, 1990), and to his theorising about affect. Therefore, Darwin’s science of emotions reflects knowledge founded on semiformal observations. Nonetheless, it was his power of observation and analytic mind that lead Darwin to challenge the popular notion that emotional expression in man was distinct from such expression in lower animals. As a result,
Darwin conducted what has been described as the first-ever single-blind experiment to challenge this notion (Hess & Thibault, 2009).

Darwin asked between 20 and 30 persons ‘of all kinds’ to judge emotions from a series of photographic plates. The 60 photographic plates were borrowed from a colleague, French physician and physiologist Guillane-Benjamin-Amand Duchenne, who had demonstrated using galvanic electrical stimulation to facial muscles, that certain muscles were responsible for separate individual emotions (Snyder et al., 2010). Darwin chose 11 of these photographs to investigate whether, via shared agreement among subjects’ judgements, a much-reduced set of core emotions could be identified. His validation criteria required near unanimous agreement among subjects (i.e. when all or nearly all agree). Hence, photographs not meeting criteria were deemed not truly expressive of the emotion.

Darwin found general agreement among subjects regarding some of the photographs but little agreement on others. However, when Darwin compared subjects’ levels of agreement with his own judgements of the photographs, he found his level of agreement was higher than his subjects. Darwin turned to methodology for an explanation and discovered that in his case, he had first been shown a photograph and then told what the emotion represented. His subjects, on the other hand, were shown the photographs without a word of explanation. Therefore, Darwin concluded from his experiment that suggestion was a factor in reading emotional states from facial expressions (Woodworth & Schlosberg, 1954).

To further support his theory of evolution, Darwin conducted a survey by sending letters to colleagues living and working in different parts of the world. He asked them to describe the emotional expressions they observed when interacting with indigenous cultures to determine whether these core emotions could be considered stable exemplars of universal emotional expression across cultures and species. He concluded from the survey that expressions were indeed universal (Hess & Thibault, 2009).

In performing this work, Darwin was the first to use human judgement studies for the assessment of the meaning of human emotions from facial expressions. Experimental psychologists employed this same methodology in the
early twentieth century (Boring & Titchener, 1923; Buzby, 1924; Fernberger, 1928). In fact, such methods are currently utilised by neuropsychologists investigating novel therapeutic treatments for schizophrenia and autism spectrum disorders (Snyder et al., 2010). However, whether emotions are universally recognised from facial expressions is debated by critics (Goodard, 1991; Lutz, 1982; Russell, 1991, 1994, 1995; Wierzbicka, 1994) who argue that, emotions are not only culture specific but also emotion terms are rooted in the semantics of the English language. Indeed, the concept of 'emotion' is not found in all language systems.

In summary, Sigmund Freud, William James, and Charles Darwin discuss emotional expression as being a product of the interaction between such lower order processes as cognition and conation, and higher order affective processes. Higher order affective processes oversee all psychological processes, and are described in terms of Hedonic Valence (pleasure vs. displeasure) and Arousal (activated energy vs. deactivated energy). This ‘core’ state of affect is thought to be inherited and not influenced by lower order domains. Therefore, this affective state of mind is stable and trait-like, and a determining force responsible for human thoughts and actions. Moreover, a distinction is made between core affect, which is adaptive, and emotions and feelings. These are more transitory affective states borne out of the perceiver via language systems, and are thus, largely subjective and highly variable. Finally, all three scholars suggest physico chemical processes are involved in the expression and maintenance of wellbeing. The need to maintain affect or psychic equilibrium within certain thresholds is connected to homeostasis. A further suggestion is that physiological reactions (i.e., muscular contractions or dilation, glandular secretions) are overt observations of core affective processes preparing the body for action.

1.1.2. Affect in the 20th Century

As this historical review moves into the twentieth century, it becomes apparent that experimental psychologists, who focused on a taxonomic study of affect, dominated research in the earlier decades. Their fundamental aim was to unite common sense with empirical inquiry. A common-sense notion is that the human face, as a most vital and visible structure of the body, is an obvious place to seek patterning in emotions. For experimental psychologists at this time, the face became
an empirical measure of the complex pattern of neural, muscular, and glandular changes that constitute affect.

However, in these early decades, the research evidence base was grossly limited by a lack of quantitative measures to analyse affective processes from facial expressions. Research methods, whilst considered ‘experimental’, continued to rely on somewhat qualitative methods of analyses (i.e. participants’ judgements of abstracted facial expressions) (Boring & Titchener, 1923; Buzby, 1924; Gates, 1923). This free-choice method of naming expressions introduced the problem of synonyms into research design, in that the experimenter must decide which among the following are correct judgements for an emotion term. For instance, *rage* could be judged as *rage, anger, wrath, indignation, resentment* etc. (Woodworth & Schlosberg, 1954). In addition, the primary measurement tools were photographs or drawings of facial expressions, which are presented to participants for judgement. These consisted of a series of actors’ posed interpretations of how each emotion *ought* to be expressed. Thus, a double chance for disagreement exists (Woodworth & Schlosberg).

Furthermore, Darwin’s earlier assertion that ‘suggestion’ was a factor in reading emotional states from facial expressions is supported and built into these early experimental study designs. The aim was to improve consistency in judging emotional states in others from the perception of an abstracted facial expression. This was particularly sought for ambiguous facial expressions such as ‘*dismay*’, where agreement was seldom achieved. The suggestion method provided participants with a list of suggested terms for facial expressions (Buzby, 1924; Fernberger, 1928), or they were given a context (i.e. a stimulus situation) to better convey the posed emotion (Fernberger). However, any increased agreement obtained between pose and judgement via suggestion, merely demonstrates subjects’ ability to learn how to read emotional expression as a result of prior conditioning. This does not demonstrate that facial expressions convey hardwired affective processes. Nevertheless, the consistent finding that some facial expressions are harder to judge, and others produce consistent agreement lead to subsequent investigations into the relationships between various expressions. Leading the way in this regard was the functional psychologist, Robert Woodworth.
Robert Woodworth (1869-1962)

Robert Woodworth believed an important element in the study of affect from facial expressions is finding the correct term for the expression. Given that experimental methods at the time relied on the accuracy of judgements, the human faculty of language provided a myriad of possible terms and hence increased probability of error in naming. Woodworth believed the methodological problem of establishing criteria for correctness from synonyms needed to be resolved in order to yield communicable results (Schlosberg, 1941). Thus, Woodworth developed a scale of facial expressions to examine the relationships between emotion terms. He reasoned, that if he arranged facial expressions along a continuum, he could examine divergence in judgements. Moreover, with a linear scale for affective processes, it would be possible to obtain a numerical measure of just how far apart people’s judgements of emotional expressions are from one another (Schlosberg).

Woodworth constructed his scale with data provided by (Feleky, 1922). After careful examination of this distribution of 100 subjects’ judgements of 86 female poses, Woodworth obtained a scale with six steps: (I) Love, Happiness, Mirth; (II) Surprise; (III) Fear, Suffering; (IV) Anger, Determination; (V) Disgust; (VI) Contempt. He created a seventh step or category labelled ‘Scattering’ for poses that did not appear to fit the scale. He used the scale on Feleky’s data to investigate the efficacy of his chosen emotion terms to resolve the difficulty concerning a ‘criteria for correctness from synonyms’, and found they performed satisfactorily. For instance, terms such as ‘fear’ might have represented a neighbouring step (surprise or anger) but rarely represented steps further away (love or disgust).

He then used his scale to quantitatively examine this divergence in judgement and found a correlation of .92, which suggested far greater accuracy in judging facial expressions than the aforementioned research that relied on free-choice or suggestion methods (Boring & Titchener, 1923; Buzby, 1924; Fernberger, 1928; Frois-Wittman, 1930). In these earlier studies, the most successful judgements (i.e. agreeing closely with the actor’s intentions according to qualitative assessment) were obtained, on average, only 35 percent of the time. Woodworth went on to test the consistency of his scale with other data sets and found similar results (Woodworth & Schlosberg, 1954).
Harold Schlosberg (1904–1964)

Harold Schlosberg agreed that Woodworth’s linear scale was the first step towards quantifying judgements of different facial expressions. However he pointed out that Woodworth had tested his linear scale on existing data sets, where data collection methods were variously qualitative. According to Schlosberg, problems arise in converting qualitative indices of distance (i.e. divergence in judgements) into scale units. He explains, “[It is] like the man who measures a distance as three strides and half the length of my foot and then tries to convert it to inches” (Woodworth & Schlosberg, 1954, p.124). Hence, Schlosberg used the scale to collect quantitative data on 45 students, using the Frois-Wittmann photographic series of 72 male poses (Frois-Wittmann, 1930).

Schlosberg utilised three identical sets, totalling 216 photographs, shuffled into one deck. Each participant had the task of sorting them into seven bins, arranged in a row, and labelled (from left to right) with the names of the six categories in their assumed order: (I) Love, Happiness, Mirth; (II) Surprise; (III) Fear, Suffering; (IV) Anger, Determination; (V) Disgust; (VI) Contempt. They could also use the ‘Scattering’ bin for those expressions that did not belong (Woodworth & Schlosberg, 1954). Although this procedure involves categorisation, the aim was to quantify participants’ divergence in judging a set of ‘core’ emotions from facial expressions. As such, Schlosberg was expecting to replicate the earlier work of Woodworth by finding a linear relationship between these affective exemplars. Thus, a photograph with the highest mode for step one (Love, Happiness, Mirth) should have its next highest frequency in step two, then step three, and so on, with no entries in step six.

Instead of this expected result, Schlosberg found a scale that constituted a circle, or recurrent series. That is, entries in step one were as apt to spread into step six as to step two. His discovered scale not only demonstrated circularity, it also behaved as a continuous rather than a categorical measure. This was evident after calculating means and average deviations according to assumptions of circularity rather than linearity. That is, an expression which was evenly split into steps six and one was assigned a mean of 6.5, rather than of 3.5, which would have put it on the opposite side of the circle (Schlosberg, 1952). To calculate meaningful averages of expressions, in order to demonstrate circularity, means and average deviations utilise
the mode rather than the mean. Working both ways around the circle, values were temporarily assigned to each scale step. For example, step 1 was given a value of 0; steps 2 and 3 received values of +1 and +2 respectively; working backward, steps 6 and 5 received values -1 and -2 respectively, and step 4 was given a value of +3 or -3 depending on the form of the distribution. Schlosberg developed a simple formula (see Schlosberg, 1941, p.502) based on these values to determine the position of the expression in relation to the mode in circular space.

These values formed the average responses of participants’ judgements, which were then arranged in order in a table so as to provide a graphical display of the distribution of pictures. The modes (step 1.00 through step 6.00) were displayed across the top of the table. A marker in the centre of a horizontal line illustrated each picture’s mean position in relation to the mode, the length of which signalled the degree of deviation from the mean. Evidently, the means progressed at a fairly constant rate diagonally across the table. Schlosberg believed this clearly suggested a scale, not six discrete categories, where pictures would be seen to cluster in one mode and not another.

Yet Schlosberg found it difficult to ascertain whether this recurrent scale represented a true interval measure due to the variability in mean scale positions (i.e. average deviations between scale steps). These varied from .34 to .71 of one scale step (Schlosberg, 1941). Schlosberg could not determine whether this variability was a function of the scale or the pictures. For instance, bin five (V) *Disgust*, had only 6 photographs whereas bin three (III) *Fear, Suffering* had 17. Schlosberg tentatively inferred the variability was a function of the scale, in that the unequal distribution of photographs was the result of the composite naming of some of the steps.

Replication studies were undertaken with other photographic series, to eliminate the possibility that the aforementioned results were an artifact of Frois-Wittmann’s methodology. Whilst findings were mixed, Schlosberg highlighted the results of Kanner (1931) and M.L. Brown (1943 in an unpublished Honours thesis) to support the reliability and validity of the circular scale. More importantly, however, Schlosberg posited a further idea that would enhance scientific understanding regarding the structure of affect; to conceptualise affect as a dimensional structure as opposed to a basic category structure.
Schlosberg reasoned that, in order to achieve circularity in scale measurement, there must be more than one underlying dimension explaining the variance shared among facial expressions. The tendency for pictures to collect in steps (I) Love, Happiness, Mirth, (III) Fear, Suffering, and (IV) Anger, Determination, may not be due to the composite naming of these steps but instead indicate the presence of a major dimension depicting Pleasantness-Unpleasantness (P-U). Moreover, while the tendency for pictures to collect in the remaining steps is comparatively less, there must be something that keeps these categories from fusing with the P-U dimension, or with each other (i.e. step II with step IV). Based on the expression terms of these remaining steps (II) Surprise, (V) Disgust, and (VI) Contempt, this second dimension was labelled Attention-Rejection (A-R) (Schlosberg, 1941). The importance of these dimensions for understanding how the circular scale is constructed from judgements of facial expressions is emphasised by the shape of the surface illustrated in Figure 1 below. Schlosberg theorised ‘circumplical’ space is elliptical rather than circular, and is the result of a greater collection of pictures depicting the P-U axis.

Figure 1: Facial expression model of emotion proposed by Schlosberg (1952, p.232).

The six scale steps to obtain facial expression positions in circumplical space divide the elliptical surface, measured in degrees. The positioning of step 1 at the top
of the circle is arbitrary. Dividing 360 by the six scale steps assigns step 1 with the lowest value in degrees of 60° with scale steps and positions in degrees increasing clockwise around the circle.

To test the proposition of dimensionality, Schlosberg developed a nine-point rating scale. The aim was to predict the circular ordering of facial expressions from participants’ ratings of Pleasantness-Unpleasantness (P-U) and Attention-Rejection (A-R). The procedure involved combining, by averaging, all participants’ scores to give a single pair of values for each facial expression. Expressions were then plotted on graph paper using P-U values on the ordinate and A-R values on the abscissa. The scatterplot was mounted on a protractor with the centre of the circle representing the mid-point (5-5) of the axes (Schlosberg, 1952). As shown in Figure 1, the P-U axis is oriented at 60° and 240° degrees and corresponds to recurrent scale positions of (I) Love, Happiness, Mirth and (IV) Anger, Determination. A thread was then stretched from the intersection of the axes across the plotted facial expression point, and its position read off in degrees.

Across four separate experiments (see Schlosberg, 1952 for a review), participants had no trouble rating facial expressions on the P-U axis (i.e. “The man felt pleasantness or unpleasantness”). However, without the provision of photographic anchors depicting the A-R axis, participants struggled to rate facial expressions on this minor dimension. After providing anchors on the A-R dimension and comparing across multiple photographic series, Schlosberg calculated an average error in prediction that ranged from .33 to .54. In other words, participants made errors in predicting core emotions from ratings on the P-U and A-R scale that, on average, varied by half a scale step. Schlosberg reasoned that in a six-step circular scale, the maximum error is three steps therefore average error would be one and one-half steps. Thus, he concluded that reasonably good predictions of core emotions could be made from ratings on the P-U and A-R dimensions (Schlosberg). This is of course assuming that distances between scale steps are found to be equal. This purely subjective assumption remained quantitatively untestable for the time being.

Schlosberg’s later theorising about the nature and measurement of the affective domain focused on the unresolved issue of ambiguity in interpreting emotions from facial expressions, or in measurement terms, that seventh category in
Woodworth’s scale, the ‘Scattering’ bin depicting expressions that did not belong. The need to account for these less distinctive terms, along with earlier conceptualisations of affect as activation energy, lead to the notion of a third dimension, \textit{Level of Activation}, to account for all affective behaviour (Schlosberg, 1954).

Schlosberg analogised his three dimensional theory of affect to the colour wheel, which illustrates the relationship between colours (i.e. primary, secondary, and tertiary colours) and their degree of visual intensity. As shown in Figure 2, the P-U and A-R bipolar dimensions are said to represent the colour surface of the blue-yellow and red-green axes, and \textit{Level of Activation}, or in lay terms – \textit{tension}, corresponds to visual intensity. Here, the figure places affective states with respect to their maximum level of activation. The top surface is sloped to show that anger and fear can reach higher levels of activation than can contempt (Schlosberg, 1954).

\begin{figure}
\centering
\includegraphics[width=\textwidth]{schlosberg-figure2.png}
\caption{Three dimensions of emotion proposed by Schlosberg (1954, p.87).}
\end{figure}

To test the model, ratings were again obtained on the Frois-Wittmann (1930) photographic series. The rating scale measured \textit{Level of Activation} ranging from \textit{sleep}, defined as near zero level of activation, to \textit{tension}, defined as a high level of activation (Schlosberg, 1954).
The same aforementioned procedural approach for predicting facial expressions from P-U and A-R ratings was adopted in order to locate facial expressions in circumplicial space. In addition, ratings of Level of Activation, ranging from sleep to tension, were obtained on the same pictures. The results supported Schlosberg’s model of three dimensions of emotion in that unpleasant facial expressions tended to show high levels of activation and were located around the circumference of the ellipse. Expressions such as *Mirth* were located closer to where the axes intersect and showed an intermediate level of activation while *Contempt*, which Schlosberg stated combines a distinct element of unpleasantness with rejection, showed a low level of activation. For those expressions that achieved the same P-U and A-R values, for example, *Grief*, *Pain*, and *Suffering*, this third dimension differentiated expressions in terms of their level of activation with *Grief* receiving ratings considerably below the other two expressions (Schlosberg, 1954). Hence, the structural model of affect proposed by Schlosberg was an elliptical model of pleasantness-unpleasantness and attention-rejection with intensity described by level of activation. This was the beginning of modeling affect structure according to the circumplex.

### 1.1.3. Circumplex Structure

The word circumplex designates a circular order or patterning among certain types of phenomena. The concept has been applied across disciplines where research is focused on analysing systems in regards to component structure. The detection of circumplex structure as it relates to systems of social competitiveness in the market place is one real-world example. For instance, ethnographic research (see Peterson & White, 1981 for a review) has identified circumplex structure by examining how individual competitiveness is socially patterned. In this work, the conditions necessary to produce circumplex structure occur when a conventional institutional system is successfully de-stabilised by different kinds of competitors with ‘unconventional’ ideas; ‘unconventional’ stands to mean ideas, which are usually tied to creativity and innovation. ‘New’ ideas de-stabilise ‘conventional’ ideas and institutions and subsequently force all different kinds of competitors into a free-market economy. This flooding of the market place with too many competitors has the surprising effect of curbing not promoting competition. Consequently,
competitors of different kinds feel a shared, or common fate with those around them. This in turn, facilitates the sharing of information, ideas, and emotional support. Hence, social ordering around competitive interaction of this kind is designated circular because there are no clear criteria of achievement and no agreed ranking of members. The circle may have one or more regions of greater interaction but there are no formal rules regarding ranking of members (Kadushin, 1976; Peterson & White).

Component structure analysis: an order-factors approach

This real-world example of circumplex structure is also observed amongst the ordering of certain kinds of psychological variables within the discipline of psychometrics. Here circumplex structure forms part of a double-ordered system of components first proposed by Guttman (1954a) and outlined in his Radex theory. Radex theory represents a particular approach to factor analysis known as the ‘order-factors’ approach. The word ‘Radex’ is designated to indicate a “radial expansion of complexity” (Guttman, p.260) from the previous and dominant common-factors approach to factor analysis (Thurstone, 1947). Guttman’s Radex theory and ‘Law of Circularity’ formalises circumplex rules observed in the aforementioned ethnographic research, and psychometrically extends Schlosberg’s (1954) earlier discovery of circularity in scale measurement.

As in the aforementioned ethnographic studies, Guttman observed that certain sets of interrelated variables that vary in kind yet remain constant in terms of their degree of complexity, display a circular ordering among themselves, or structural interdependence (Guttman, 1957). This inequality pattern is psychometrically demonstrated among different kinds of mental abilities tests in Table 1 below. Correlation coefficients decrease at first as one moves diagonally away from the main diagonal and then increase. As such, there is no hierarchical display from highest to lowest, or no rank order in degree of interrelatedness (Guttman, 1954a).
Table 1:
*Intercorrelations reproduced from Guttman (1954a) among tests of six different kinds of abilities for Chicago schoolchildren (N = 710)*.

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<td>2. Incomplete Words</td>
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<td>3. Multiplication</td>
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<td>.388</td>
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<td>4. Dot Patterns</td>
<td>.213</td>
<td>.313</td>
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<td>5. ABC</td>
<td>.254</td>
<td>.208</td>
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<td>6. Directions</td>
<td>.442</td>
<td>.330</td>
<td>.328</td>
<td>.247</td>
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It has also been observed that when interrelated variables of the same kind vary in terms of their degree of complexity then correlation coefficients will display rank order, or simplex structure (Guttman, 1954b). As demonstrated in Table 2 below, simplex structure displays a linear ordering such that variables that are adjacent in this ordering have the highest correlation and correlations decrease as the separation between variables in the ordering increases (Browne, 1992).

Table 2:
*Intercorrelations reproduced from Guttman (1954a) of nine verbal abilities tests for Chicago eighth-grade school children (N = 437)*.

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<td>1. Letter Grouping</td>
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<td>2. Letter Series</td>
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<td>3. Pedigrees</td>
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<td>4. Sentences</td>
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<td>.555</td>
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<td>5. Vocabulary</td>
<td>.381</td>
<td>.468</td>
<td>.525</td>
<td>.829</td>
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<td>6. Completion</td>
<td>.396</td>
<td>.446</td>
<td>.523</td>
<td>.768</td>
<td>.775</td>
<td>-</td>
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<td>7. Suffixes</td>
<td>.303</td>
<td>.305</td>
<td>.319</td>
<td>.407</td>
<td>.482</td>
<td>.433</td>
<td>-</td>
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<td>8. First Letters</td>
<td>.398</td>
<td>.391</td>
<td>.355</td>
<td>.419</td>
<td>.472</td>
<td>.428</td>
<td>.557</td>
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<td>9. Four Letter Words</td>
<td>.381</td>
<td>.367</td>
<td>.323</td>
<td>.356</td>
<td>.415</td>
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In the previous ethnographic analysis of systems of social competitiveness in the market place, Peterson and White (1981) also observed simplex structure and provide a real-world description of this type of social patterning outlining the following common elements:

- “All simplexes are composed of a small set of peers (variables) who know each other personally.

- Simplex members (variables) assess and rank each other’s ability while acclaiming their collective excellence relative to all non-members.

- Simplex members seek to control the relevant people in the task environment by shaping the flow of information both about how the job can best be done, and also about the ability of persons inside and outside the simplex to satisfactorily perform the work.

- Simplex structures are surprisingly stable, powerful, and long-lasting although, simplexes remain invisible to most observers. What are ordinarily seen are individual acts of ranking, favours, and contacts, while the collective nexus we call the simplex goes unobserved” (p.18-19).

Returning to Radex theory and the psychometric literature, simplex and circumplex correlation structures are described as inequality patterns. This means their formation is order dependent, and so arbitrary re-ordering of the variables will destroy their structure (Browne, 1992). Moreover, within a circumplex structure, various simplex structures can be found, and this is what defines Guttman’s (1954a) double-ordered system known as the Radex. According to Guttman, an analysis of component structure must involve distinguishing between distinct systems of components for such an analysis to be meaningful. That is, we must know what total structure is being referred to and how to sample this ‘super universe’, and Guttman suggests clear guidelines for distinguishing between distinct systems of components.

At the most peripheral level, a system exists of semantic components to define the ‘universe’ of psychological content under observation. Indeed, there is cross-disciplinary acceptance (Wierzbicka, 1986) that it is the language system of the interpreter along with an inextricable link to the specifics of the local culture that ultimately determines what is communicable. What is commonly overlooked however, is that empirical interpretations concerning the structure of interrelated data are largely based on Western, individualist cultural norms, embedded in an English
language system. Therefore, defining the ‘universe’ of psychological content under observation from semantic categories, indigenous to whoever has the power to seek agreement on the subject, does not necessarily provide the facts of nature.

The ‘universe’ of affective content provides an excellent example of diversity in semantic component structure. For instance, in English, up to 2,000 semantic terms have been identified that define the affective domain (Wallace & Carson, 1973). Whilst not all of these terms are in common use, the number of words in most people’s working vocabulary to define affective experience is well over 100 (Russell, 1991; Wierzbicka, 1994). In contrast, in Ifalukian, a language of the oceanic people of Micronesia, 58 terms have been identified (Lutz, 1982), and only seven words define the affective domain in the Chapang language of Malaysia (Howell, 1981). Arguably, those privileged with the power to empirically interpret and inform must be mindful not to impose a universal ‘etic’ (Berry, 1989; Pike, 1967) when semantically defining the ‘universe’ of psychological content.

Nonetheless, once a system of semantic components is identified, Guttman (1954a) then suggests that an analysis of elementary component structure is a necessary requirement for establishing hypotheses for why observed data are statistically interrelated the way they are. Most important is to systematically establish order-factors (i.e. simplex and circumplex components), a necessary requirement for subsequent deduction of principal component structure. Only when there is an established systematic theory for interrelatedness is one in a position to enquire into the principal components of the system. An analysis of principal components provides a secondary frame of reference, which may be useful, however this is neither a necessary nor a sufficient level of inquiry. Guttman argued radex theory within the paradigm of elementary components theory, and the order-factors approach, opens a clear path to better predictions with less tests for component structure analyses. What he means by this involves a brief review of common-factors theory from Guttman’s perspective to demonstrate how the common-factors approach inspired radex theory.

Component structure analysis: a multiple common-factors approach

Early theory building concerning the common-factors approach was based on two key observations. First, when observing correlations among various achievement
tests conducted in Western cultures (i.e. tests in history, geography, arithmetic, and vocabulary), intercorrelations among tests were never negative. Instead, they always displayed positive or zero correlations among themselves. Second, certain batteries of tests formed a hierarchy, in that the tests seemed to be arranged in rank order, such that the correlations between two tests decreased the farther down the hierarchy they were. Indeed, these key observations underpin the order-factors approach.

However, the mathematical theory developed to explain such a hierarchy failed to solve with repeated hypothesis testing on observed data. Hence, empirical investigations of hierarchical or order-factors ceased and attention turned to theories proposing multiple common-factors. According to Guttman (1954a, p.265), this is where factor analysis lost its predictive power. He states, if one exhaustively extracts common factors from a finite number of ($n$) tests, one is bound to end up with some set of ($m$) common-factors to explain the observed intercorrelations. Moreover, it will not do to justify this approach with the concept of parsimony (e.g. $m$ should be small compared to $n$).

Hence, Guttman’s main argument is that psychologists in the mid 20th Century, using the common-factors approach, did not persist with early and meritorious observations now key to his radial expansion (radex) theory. Such persistence would have revealed that order-factors are empirically observed for only certain sets of test variables; one of those sets involves the psychological domain of affect. The following section will focus on the structure of self-reported affect according to circumplex theory.

1.1.4. The Circumplex Model of Affect

*James Russell (1947)*

In 1980, the psychological constructionist James Russell revived the circumplex as a descriptive tool for representing self-reported affect through the geometry of a circle. His structural model of affect is termed the ‘affective circumplex’ (Russell, 1980; Russell & Barrett, 1999) to indicate that categories of mood and emotion are simultaneously similar or dissimilar from one another on two more primitive psychological dimensions. These dimensions are *Hedonic Valence* and *Arousal*, the same basic dimensions identified in all theories under review. It is
also interesting to observe that the early claim by Darwin (1872/1934), that an inherited ‘core’ state of affect oversees all psychological processes, is consistent with contemporary constructionist theories.

A contemporary constructionist description of core affect is as a “neurophysiological state consciously accessible as the simplest, [primitive] non-reflective feelings evident in moods and emotions” (Russell, 2003, p.148). A feeling that is primitive implies one that cannot be reduced to anything simpler at a psychological level (Feldman Barrett, 2009; Yik et al., 2011). To assist in interpretation, Russell analogises core affect to felt body temperature, in that it is always there, it can be noted at will, extremes are very salient, and it exists without using words to describe or attribute its cause.

As with Schlosberg’s (1952) model of affect, which was constructed from facial expressions, Russell’s (1980; Yik et al., 1999) affective circumplex constructed from self-reported feelings is also depicted within a Cartesian space. This is because Hedonic Valence and Arousal are statistically independent (unrelated), and the theoretical affective space created by these dimensions is bipolar. Hence, Hedonic Valence ranges from pleasant states at one end of the dimensional continuum to unpleasant states at the other end, and perceived Arousal ranges from high activity and attention to low activity and sleepiness. Each unipolar part of each bipolar dimension is located 90° away from one another in circular space (Yik et al., 2011; Yik, Russell, Ahn, Fernandez Dols, & Suzuki, 2002). Only this kind of structure can depict the subjective experience of core affect as a single feeling, based on a blend of Hedonic Valence and Arousal at a given moment in time.

Empirically, psychological constructionists like Russell use emotion categories (e.g. happy, content, joyful) as guideposts for describing the primitive irreducible qualities of various states of core affect. For instance, the subjective experience of contentment can capture a state of core affect that is simultaneously positive and slightly deactivated. Capturing contentment, as a state of core affect, is most clearly represented in psychometric studies of self-reported experiences of everyday feelings, and is assessed by asking how one is feeling “right now, in the current moment” (Russell & Barrett, 1999). According to Russell (2003), when people report how they are feeling, in a given moment without knowing why, they
are accessing a state of core affect. Hence, at an individual level, this pleasant and slightly deactivated (contented) state of core affect is experienced as ‘free-floating’ (i.e., not attached to an object either real or imagined), and existing within the person.

When people are asked to report their feelings over extended time periods, as assessed by asking, “**how one generally felt**” (during a moderate time period), core affect becomes mood (Russell & Barrett, 1999). Russell and Barrett originally defined mood as a prolonged experience of core affect. In this sense, the distinction between ‘free-floating’ core affect, which can fluctuate from moment to moment, and ‘free-floating’ mood, which is a prolonged experience of core affect, becomes an empirical issue. However, Russell (2003, p. 147) asserts, mood is a ‘fuzzy’ concept because it is not possible to determine if a mood is stable or long lasting. This claim represents a valid, first line of inquiry, and an interested researcher will strive to discover such properties through rigorous research design particularly if a theory seeks to reduce the scope of discussion to primitive elements. It is argued that the mood concept, to Russell, is ‘fuzzy’ because he has already found a way to speak at an elemental level. This is through the construct of core affect, and hence mood is a subsidiary term to him.

**Mood is secondary to core affect?**

Evidence for this claim is found in Russell’s (2003) prescribed conceptual framework of the affective domain. Russell’s highest purpose is to limit the status of everyday words to offer a parsimonious conceptual framework for discussing and measuring affective experience. As a result, language terminology used in his theorising is partitioned into three levels of understanding:

1. Technical concepts. These concepts refer to core affect and related terms that describe the various functions of this primitive psychological element. According to Russell, these are the terms that must be refined using scientific analysis and evidence.

2. Folk concepts. These refer to emotion categories (‘fear’, ‘anger’ ‘joy’), and these must be discovered in everyday word usage.
3. Secondary concepts. These refer to the terms moods, emotional episodes and emotional meta-experiences, and these concepts ‘bridge the gap’ in understanding between technical/scientific terms and folk/lay terms.

According to Russell, mood is second to core affect. Mood is empirically ‘fuzzy’ and is therefore not worthy of scientific analysis in Russell’s work. However, it seems likely that the ‘fuzziness’ surrounding mood for constructionists’ actually represents a lack of interest to empirically understand the mood concept. Evidence for this claim begins at the conceptual level where constructionists’ provide contradictory definitions of the mood concept as follows:

1. *Simple mood* as defined by Russell (2003) refers to constructionists’ original definition of mood as a prolonged ‘free-floating’ experience of core affect (Russell & Barrett, 1999). How a simple mood comes to be experienced is due to a ‘free-floating’ prolonged form of core affect that is not attached to a percept. This follows the definition of mood by Ruckmick (1936) who suggested that moods are long lasting, and have no attachment to cognitive elements that may suggest a target for whom or what the mood is directed. It also follows Zajonc’s (1980) claim that because moods arise without awareness of the inducing event, they are not accompanied by cognitive elements of knowing and appraisal that typically induce action tendencies (i.e., behaviour). Additionally, Morris’ (1989) understanding of moods as diffuse, global, and pervasive supports Nowlis and Nowlis’ (1956) understanding of mood as a trait characteristic that is a source of information about the current functioning nature of the self. Hence, Russell’s definition of simple mood represents a general consensus in the literature. Moreover, if mood is simply a prolonged experience of core affect, then mood cannot be excluded from scientific analysis and evidence.

2. *Mood with a ‘quasi-object’*: This refers to Russell’s (2003, p.147) second definition of mood. While he does not clarify what a ‘quasi-object’ means, more recently, Russell and colleagues (see Yik et al., 2011, p.705) have suggested that moods come and then go, whereas core affect is always there. Thus, an ‘anxious’ mood, for example, is assigned the qualities of core affect (i.e., unpleasant arousal), thoughts (i.e., worry), behaviour (i.e., vigilance), and
motives (i.e., to avoid risk). Herein lies a contradiction in Russell’s theorising. At one time, moods represented a prolonged experience of core affect with no real insight from the perceiver as to where or whom the mood is directed. At another time, moods are perceived transitory states, of which core affect is a part of, but not all that is involved in their expression. Indeed, this recent definition of mood is closer to constructionists’ definitions of emotion.

When it comes to defining emotion, constructionists have not altered their collective view. James (1890/1950a) asserted that emotions are transitory affective states borne out of the perceiver via language systems. In sympathy, Russell (2003, 2009; Russell & Barrett, 1999) asserts, emotion categories are folk terms used to reflect upon an ‘emotional episode’. Such an episode is initiated by a rapid change in core affect when core affective qualities are attributed to a percept in terms of its pleasant-unpleasant and activating-deactivating character. Hence, when core affect becomes attached to a percept, and changes rapidly, it drives the detection of physiological and expressive changes (facial, vocal and autonomic changes), cognition (appraisal, attribution), and behaviour (instrumental action), culminating in an ‘emotional meta-experience’ (Russell, 2003).

The suggestion by Russell (2003, 2009) that emotion categories depict reflections about ‘emotional meta-experiences’ is considered a contemporary synthesis of (a) James’ (1890/1950a) early insight that emotions involve ‘self’ perceptions of autonomic processes’ with (b) Russell’s theorising about the types of processes involved. The main idea regarding processes is that the different weightings or contributions these processes make towards final expression of an emotional episode accounts for why an emotion like ‘fear’, for instance, can manifest in various ways (Russell, 2009). Therefore, based on Russell’s most recent theorising about the affective domain, moods and emotions play a subsidiary role when it comes to scientific analysis and evidence, and at best, moods can be considered attenuated forms of emotions. As a result, ascribing processes of physiological changes, cognition, motivation, and behaviour to the expression of both moods and emotions implies, core affect is a part of but not all there is to moods and emotions (Yik et al., 2011).
Lisa Feldman Barrett (1963)

Another constructionist, Lisa Feldman Barrett within the context of her Conceptual Act Model (Feldman Barrett, 2009), reduces the scope of discussion to the level of physico-chemical elements to account for all mental life. This includes the affective domain. Feldman Barrett’s theorising centres on a natural function of the brain. This is to continuously and unintentionally categorise and monitor sensory stimuli in broad adaptive terms. By reducing her scope of discussion to the sensory level, she infers, as James (1890/1950a) did before her, that bodily sensations that are variously experienced, are what distinguishes an instance of ‘fear’ (i.e., an emotion) from an instance of ‘appraisal’ (i.e., cognition), and so on. According to Feldman Barrett, sensational information comes from three sources:

1. Sensations from the outside world (i.e., external stimuli). Here the brain draws on the exteroceptive sensory array of light, vibrations, and chemicals and so on, as a source of information.

2. Sensations from inside the body (i.e., internal stimuli). Here she refers to the internal milieu, a concept first introduced by physiologist C. Bernard (1813-1878). The internal milieu describes the many variables contained in the blood and fluids surrounding the cells that are regulated for constancy by control mechanisms, predominantly found in the limbic system. The limbic system houses a number of subsystems (i.e., hippocampal formation, amygdala, hypothalamus, olfactory regions, entorhinal area) that extend upwards toward the neocortex and downwards towards the brain stem, and these primitive systems are vital for adaptation. The general function of the limbic system is to process visceral information, particularly those deep affective processes associated with the emotional state of the organism (Lledo, 2002, p. 491). W. B. Cannon (1871-1945) coined the term homeostasis to merge the concept of this biological need for constancy (i.e., the internal milieu) with a basic principle of modern physiology involving the theory of feedback systems, or systems of self-regulation. Hence, homeostasis refers to the production of stability in dynamic systems of the body by negative feedback control (Cannon, 1939). The function of homeostasis is to detect deviations in the
normal functioning of vital systems, and to engage control mechanisms to return any ‘trouble spots’ to their initial steady state.

According to Feldman Barrett (2009), in sensing the internal milieu, the brain seeks information about the homeostatic state of the body from the hypothalamus. The hypothalamus is considered the ‘master’ control mechanism of the limbic system because it plays a central role in regulating the autonomic nervous system and neuroendocrine secretions. These are the ‘regulated’ variables that would otherwise have a wide scope for variation. This basic need for internal constancy by self-regulation or negative feedback control is essential for the survival of the organism.

3. Memory. Here the brain draws on sensory neurons to re-activate or re-inhibit prior experiences as a source of information.

Together, these three sources of sensory stimuli are variably categorised by the brain, and hence, categorisation provides meaning for sensory stimulation. More than that, the variable nature of the categorisation process means cognition, perception, and emotion stem from various combinations, or weightings of these three sensational sources. In this sense, emotions, perceptions, and cognitions are contents of mental life, not processes, and so are essentially comprised of the same stuff. It is only with the acquisition of language, which comes later in development, that category labels (i.e., words) provide the ‘glue’ to hold categories together and allow for the distinction among categories (Feldman Barrett, 2009).

Categorising emotional life

When it comes to categorising sensations that distinguish emotional life, categorisation involves the interaction of three basic elements: (1) a human conceptual system which resides in memory, to draw on what is already known about emotions; (2) controlled attention, which represents the available capacity of the individual to build categories and manage the process of categorisation, and (3) core affect, which according to Feldman Barrett (2009, p.1294) is a mammalian system that represents physical states that are experienced as pleasant or unpleasant with some degree of arousal. Feldman Barrett elaborates further by suggesting that core affect, as an experienced state of some combination of Hedonic Valence and Arousal, is synthesised through the integration of sensory information from outside the body,
with internal homeostatic and sensory information from inside the body (e.g. hormonal changes, immune responses).

Such sensory integration forms a basic affective code, or state of core affect, which can be experienced as either a foreground or background feature of consciousness, depending on where attention is directed. When core affect becomes consciously directed towards an object, and changes rapidly as a result of some obvious external event, controlled attention combined with memory about the emotion, shape the subjective and conscious categorisation of one’s emotional experience (Feldman Barrett, Mesquita, Ochsner, & Gross, 2007). Much earlier, James (1890/1950a) called this ‘self-perception’, and Russell (2003, 2009) calls this an ‘emotional meta-experience’, where cognition (appraisal, attribution), behaviour (instrumental action), and the detection of physiological and expressive changes (facial, vocal and autonomic changes) allow for reflection about an ‘emotional episode’.

There is no doubt that constructionist theories regarding the component structure of affect are highly comprehensive. In Russell’s (2003) affect theory, the degree of conceptual complexity reflects his desire to unite various theories of emotion into one overarching conceptual framework. It is not the purpose of this current discussion to review these various theories (see Russell, 2003 for a more detailed discussion). However, they are alluded to in Russell’s prescription of the processes involved in an ‘emotional meta-experience’, cited in the previous paragraph. The important point in the current discussion is the claim by Russell that, it is possible to describe the conceptual complexity of emotional life in a parsimonious way through the scientific/technical concept of core affect. Hence the testing of Russell’s theory involves modeling the structure of core affect with a circumplex analysis to show how core affect ‘integrates’, or accounts for most of what is common about these various perspectives. Using a circumplex model of core affect to integrate various affect theories will be discussed in more detail in section 1.3.3 to follow.

In Feldman Barrett’s theory, conceptual complexity reflects more traditional constructionists’ views (e.g. James, 1890/1950a) that look to the sensory level for describing emotional life. Her contemporary update advances these views to
incorporate core affect, and to suggest the basic materials that allow for its synthesis are the same materials that allow for the synthesis of all mental matter. In this sense, core affect is a part of all mental life, not just emotional life (Feldman Barrett et al., 2007).

In summary, both Russell and Feldman Barrett (1999; Feldman Barrett, 2006, 2009; Russell, 2003, 2009) regard emotion categories as tools to communicate a change in core affect when core affect becomes attached to a percept. They also consider core affect in ‘free-floating’ form as psychologically primitive. This means that when core affect is not attached to a percept, its representation in physical states as the ‘simplest feeling’ is psychologically irreducible. A further implication is that when people report how they are feeling, in a given moment without knowing why, this reported state of core affect represents a trait property of conscious experience. Based on these premises, it would appear that core affect is an individual difference variable. Thus, comprehensive theories, which incorporate core affect, must account for its degree of stability between individuals, across situations, and over time.

Core affect: an individual difference variable

When it comes to discussing the stability of core affect, Russell (2009) concedes this is not fully understood. He prefers to conceptualise change in core affect as ‘fluid’ meaning, one cannot pinpoint the beginning or end of the change. He also states this fundamental element varies greatly over time within each individual. Therefore, neither duration nor degree of stability can be established from this understanding. Feldman-Barrett (2009), however, does account for stability and individual differences in core affect by unpacking the structure of core affect itself (Feldman-Barrett, 2006, p.39; see also Feldman, 1995b; Feldman Barrett, 2004; Feldman Barrett & Bliss-Moreau, 2009). She proposes that the Hedonic Valence dimension is the invariant ‘core’ of core affect. This stable part of core affect stems from the process of valuation. Valuation is a simple form of meaning analysis in which something is judged relevant or important to wellbeing. To account for individual differences in core affect, Feldman Barrett makes the further claim that, Hedonic Valence as an invariant property of core affect, varies depending on whether (or not) individuals’ focus on the valenced aspect of affective experience. It is this
variation in focal preference, or what she terms, ‘emotional granularity’, that accounts for individual differences in core affect.

To test her theory of individual differences in core affect, Feldman Barrett (2004; see also Feldman Barrett & Bliss-Moreau, 2009; Feldman, 1995b) adopts a within-subjects research design with two main objectives. The first is to empirically determine whether Hedonic Valence and Arousal are indeed properties contained in self-reported feelings, or whether they are properties of the words used to describe affect. The second is to investigate individual differences in core affect (i.e., emotional granularity) from self-reported affective experience. These objectives are based on Feldman Barrett’s (2004, p. 272) rationale that in order to consider that Hedonic Valence and Arousal are properties of self-reported moods and emotions, individual differences in the extent to which people weigh (focus on) valence and arousal in their definitions of emotion words should not be highly related to the extent to which they weigh valence and arousal when reporting their feelings. This lack of relatedness would suggest that self-reports reflect the actual experience of emotions and thus, provide a proxy for observing individual variation in emotional granularity.

Her methodology to test these propositions requires the establishment of two kinds of structural models. The first model is called a semantic circumplex and is derived from a correlation matrix based on a sorting task where participants’ rate the similarity of pairs of emotion words. The sorting of word pairs for the purpose of judging similarities (or differences) is designed to capture participants’ cognitive representations of the language of affect (Russell, 1980). The second model is called a self-report circumplex, and is derived from a $P$-correlation matrix. A $P$-correlation matrix comprises self-report ratings of affective experiences, of a single individual, across an observation period. Experience-sampling methods are used to obtain these data. Each participant is provided with palm-top computers and prompted (3 times per day over 60 consecutive days) to rate, on a Likert scale, how closely a set of affect descriptors describes his or her momentary feelings.

To quantify how much a person emphasises valence and arousal in reporting his or her affective experience, each person’s $P$-correlation matrix is correlated with a valence-based and arousal-based semantic similarity matrix that contains the same
word set (see Feldman Barrett, 1995a, 2004 for a detailed discussion on the methodology employed). Her results indicate that, first, semantic circumplexes are depicted in Cartesian space as perfect circles. This suggests that when judging the similarity of emotion-related word pairs, people give equal weight to the valence and arousal properties contained in the words as depicted in Figure 3 below. Feldman Barrett finds, semantic circumplexes to be highly replicable both within and across subjects’ designs.

*Figure 3:* A hypothetical semantic circumplex representation of data based on similarity judgements of emotion-related word pairs.

Additional findings (Feldman Barrett, 1995b, 2004; Feldman Barrett & Bliss-Moreau, 2009) indicate that when reporting momentary feelings, individuals tend to focus more on one of these properties, and hence self-report circumplexes are depicted in Cartesian space as ellipses. Figure 4a depicts a hypothetical individual who is more arousal-focused whereas the individual depicted in Figure 4b is more valenced-focused.

*Figure 4a:* Arousal-focused individual  
*Figure 4b:* Valenced-focused individual
According to Feldman Barrett, these individuals are low in emotional granularity as they use discrete category labels to convey their feelings in more global terms. For instance, in the case of the valence-focused individual in Figure 4b, feelings of the same valence (i.e., happy, enthusiastic, calm, elated) are reported as ‘pleasant’ and indicate that when the person reported feeling happy, they also reported feeling elated and calm. This demonstration of focal preference, or high valence-focus, accounts for individual differences in core affect because it reveals the person cannot give equal weight to valence and arousal and hence, report about their feelings with more precision (i.e., “I felt happy, not elated”).

To address the question of whether valence-focus and arousal-focus are properties of self-reported feelings, and not words, Feldman Barrett’s (2004) findings reveal, there is no association between the valenced properties of emotion words and the contents of momentary feelings. This implies hedonic valence is indeed a property of the actual experience of emotions. However, a significant association is found between the arousal properties of the words and the contents of momentary feelings. This means that individuals who focused more on the arousal properties of emotional language, as opposed to those who focused less, also focused their reported experiences on felt activation.

While Feldman Barrett’s (2004; Feldman Barrett & Bliss-Moreau, 2009) research design demonstrates individual differences in core affect, her findings also reveal that, the majority of participants’ observed in her studies (n = 700) are more valenced-focused. This implies that, in general, people report about their feelings in terms of “feeling good/bad” and find it difficult to incorporate perceived arousal into their responses. Taken together, people are generally low in emotional granularity.

An alternative viewpoint is that high valence-focused representations of the structure of self-reported affect are dominated by hedonic valence (i.e., the invariant ‘core’ of core affect) (Feldman Barrett, 2006), with the presence of mild arousal. This suggests that self-report circumplexes could depict core affect regulated for constancy. Hence the prototypical shape of self-report circumplexes depicted as an ellipse, illustrates the extent to which people rely on a basic steady state of affect for reporting felt experiences, under normal conditions. This line of reasoning
incorporates the main concept of stability associated with the term homeostasis (Cannon, 1939). It also acknowledges claims by theorists under review of the role of homeostatic processes in the formation of core affect (Feldman Barrett, 2009) as well as the need for the production of ‘psychic equilibrium to maintain wellbeing within normal limits (Freud, 1895/1950).

Moreover, a structure dominated by hedonic valence with the presence of mild arousal describes the kind of affect discussed by researchers who seek to understand the ease (or effort) with which particular mental contents come to mind (Schwarz & Clore, 1983; Slovic, Finucane, Peters, and MacGregor, 2002a, 2002b; Zajonc, 1980). In specific relation to the self-report process Slovic et al. suggest that, people rely on an affect heuristic to guide information processing and judgements. Heuristics are mental short cuts people unconsciously employ to avoid effortful information processing.

Feldman Barrett (2004) describes the mental effort involved in reporting momentary moods and emotions. She claims, self-reports require introspection to assess a momentary feeling state, working memory to hold the felt state in mind whilst deciding the extent to which a sample of adjectives (despondent, sluggish, outraged, serene etc.) describes the feeling state, and decision-making about which point on a Likert scale most likely represents the level of intensity or frequency of the experience. Slovic et al. (2002) argue, in place of such deliberate and analytical assessments, people use affect (i.e., hedonic valence), or mood (Zajonc, 1980) as information when registering responses. They do this automatically and effortlessly. Self-reports are therefore guided by a kind of affect that is invariant and a natural property of conscious experience. It is this type of core affect that may be represented in the prototypical shape of self-report circumplexes.

In summary, suggesting an invariant kind of core affect, which is dominated by hedonic valence with the presence of mild arousal, supports an empirical demonstration of the types of circumplexes commonly produced in the literature. This understanding of core affect considers the property of stability, which is the main concept associated with the term homeostasis (Cannon, 1939). The role of homeostasis in the formation of core affect and the maintenance of personal wellbeing has been alluded to in certain theoretical perspectives in this review (e.g.
Furthermore, proposing that core affect is stable unites the concept of homeostasis, and its production of stability in dynamic systems, with the basic tenet of Subjective Wellbeing Homeostasis theory (Cummins, 2010, 2013 in press; Cummins et al., 2014) in regards to the demonstration of set-points for subjective wellbeing.

An invariant kind of core affect under homeostatic influence in relation to SWB

The kind of core affect represented in Subjective Wellbeing Homeostasis theory (Cummins, 2010, 2012) describes a form of enduring, positive/pleasant and mildly activated mood that is defended by homeostatic processes, and is coined Homeostatically Protected Mood (HPMood). Cummins conceptualises HPMood as having the following characteristics:

- By linking the nature of HPMood to Russell and Barrett’s (1999) original definition of mood as a prolonged state of core affect, HPMood is proposed to be biologically based and hard-wired for each individual. However, this kind of core affect is pleasant and mildly activated and adaptive, in the sense that it provides the background activation energy, or motivation for behaviour (Cummins, 2012).

- HPMood is proposed as the basic steady mood-state that homeostatic mechanisms seek to defend. It approximates each individual’s set-point for subjective wellbeing because SWB is found to be highly saturated with affect in linear models (Blore et al., 2011; Davern et al., 2007; Lai & Cummins, 2013; Tomyn & Cummins, 2011). It is further proposed that on a 0 (dissatisfied) to 100 (satisfied) point rating scale, HPMood is set, on average, at a level of 80 points.

- Cummins (2010, 2012), like Darwin (1872/1934) before him, suggests that HPMood, as the ‘core’ of affect, pervades conscious experience and so, is perceived in all higher process including personality and memory. It is also perceived in cognition but, most strongly in the rather abstract perceptions of the self. It is these self-perceptions that elicit a chronic strength of positivity that approximates the set-point HPMood (Cummins, 2012).
In summary, this conceptualisation of an invariant kind of core of affect explicitly defines an individual difference variable in HPMoody that is psychologically irreducible and functions as the most primitive conception of the self (i.e., abstract self perceptions). As will be demonstrated in section 1.2, the theory of Subjective Wellbeing Homeostasis aims to broaden understanding about the affective core of subjective wellbeing through the property of stability. The unique contribution of this PhD thesis is to validate HPMoody, as a specific type of core affect, on the circumplex.

1.2. MORE ON HOMEOSTASIS: MANAGING STABILITY IN DYNAMIC SYSTEMS

As previously discussed in section 1.1.4, it is now understood that all vital variables of the body need to be regulated for constancy (Lledo, 2002). Regulation requires homeostatic management systems to maintain such variables within a narrow range of values. It is important to note that regulating variables do not constrain vital variables to some fixed parameter but instead ensure their operation meets internal and external environmental challenges (Cannon, 1939). This means that vital variables may be actively changed within limits by homeostatic mechanisms so that the organism is ready to meet demands that are placed upon it.

As an example, Cannon (1939) describes how biological homeostatic mechanisms (regulating variables) will actively increase blood glucose levels (vital variables) in ‘anticipation’ of acute ‘emotional excitement’. The mechanisms involved include adrenalin, glucocorticoids, and cytokines, and their anticipatory function to maintain stability through change has recently been described as the physiological production of an allostatic state (McEwen & Wingfield, 2010). Whilst the mediating effects of homeostatic mechanisms are adaptive in the short term, their prolonged involvement in raising baseline levels of vital variables in response to chronic environmental challenges leads to wear-and-tear, or what McEwen and Stellar (1993) term allostatic load. The implication for the wellbeing of the organism is an increased risk of pathology, or allostatic overload.

In the psychobiological literature, allostatic overload in relation to mood affect is psychologically defined in the form of chronic ‘depressive illness’ (McEwen, 2003). The biological homeostatic mechanisms to signal this kind of
illbeing include prolonged elevated levels of cortisol, growth hormone, glucose, insulin resistance, and blood platelet reactivity. Such prolonged elevation indicates a system malfunction due to ‘overwork’ in raising baseline levels of vital variables in response to internal and external environmental challenges. Furthermore, an identified sequence of pathological changes in chronic ‘depressive illness’ resulting from allostatic overload is linked to bone mineral loss, abdominal obesity, and an increased risk of cardiovascular disease and type-2 diabetes (McEwen). Therefore, it comes as no surprise that a major focus of this literature is to identify potential sources of challenge in order to intervene early and prevent chronic health problems.

More recent studies conducted in this literature (e.g. Fava, Guidi, Semprini, Tomba & Sonino, 2010; Offidani & Ruini, 2012), however, acknowledge a need to move beyond reductionist accounts of distress and illbeing when developing health policy to target chronic health disease prevention and intervention. Whilst insight is gained by approaching the molecular mechanisms of affective experience, there are ethical implications when study designs attempt to model a causal path for molecular malfunction in living humans. As a result, designs are largely correlational (see Chen, Miller, Lachman, Gruenewald, & Seeman, 2012; Roepke, Mausbach, Patterson, Von Kanel, Ancoli-Israel, Harmell et al., 2010; Schultz, Mentz, Lachance, Johnson, Gaines, & Israel, 2012). Therefore, it is not possible to draw causal links between major sources of challenge and allostatic overload (e.g. chronic ‘depressive illness’), sequences of change (e.g. cardiovascular disease), or to determine whether an additional, unmeasured source of challenge is influencing the relationships found.

In the light of this, Offidani and Ruini (2012) introduce a wider conceptual framework for evaluating allostatic overload in a clinical setting. Evaluative criteria are based on the clinimetric approach (Feinstein, 1987). The term clinimetrics refers to a sensibility surrounding clinical assessment and diagnosis that is expressed through incorporating many different indices to target an outcome measure. The clinimetric approach applied to targeting allostatic overload incorporates ‘hard data’ collected with conventional laboratory methods and ‘soft data’ collected with self-report rating scales and clinically administered inventories. Hard data are observed biological indicators obtained exclusively with technologic procedures. According to proponents of the clinimetric approach (e.g. Feinstein), these are the ‘true’ indicators
of pathology. Soft data are clinical assessments of psychiatric and psychosomatic symptoms, subjective appraisals of stress and coping, and subjective evaluations of distress and illbeing (Offidani & Ruini). Whilst the clinimetric approach considers a comprehensive range of indicators, the partitioning of data into ‘hard’ and ‘soft’ categories exposes epistemologies surrounding objective and subjective indicators of illbeing. Implicit in this practice is a preference for the former.

Nevertheless, within this wider conceptual framework for identifying allostatic overload, internal and external challenges associated with weakened ability of biological homeostatic mechanisms to manage stability in dynamic systems have been hypothesised. These include complex interactions among predisposed vulnerabilities to cope with challenge (i.e., genes and hormones as a source of challenge) (Beauchaine, Neuhaus, Zalewski, Crowell, & Potapova, 2011), adverse growth and development (i.e., early trauma, neglect, and poverty) (Chen et al., 2012; Beauchaine et al.; Schultz et al., 2012), lifestyle factors (i.e., poor sleep quality, excessive caffeine and alcohol consumption, and nicotine use (McEwen 2003; Offidani & Ruini, 2012), and life events (i.e., full-time caregiving, the death of a family member, constant work pressure) (Offidani & Ruini; Roepke et al., 2010; Schultz et al.).

Additional interactions between primary (objective) sources of challenge and secondary (subjective), psychological sources of challenge associated with allostatic overload have also been hypothesised. For example, Roepke et al. (2010) examined the moderating effects of perceived mastery (Personal Mastery Scale) (Pearlin & Schooler, 1978), depressive symptoms (Centre for Epidemiologic Studies Depression Scale: CESD-10) (Andresen, Malmgren, Carter, & Patrick, 1994), and perceived burden of care (Role Overload Scale) (Pearlin, Mullan, Semple, & Skaff, 1990), on allostatic load, in full-time caregivers of Alzheimer’s sufferers, after controlling for age, gender, history of nicotine use, antihypertensive drug use, and cholesterol-lowering drug use.

The results indicated a significant interaction between perceived mastery and increased allostatic load in Alzheimer’s caregivers. However, the relationship was only significant when mastery was high. In other words, Alzheimer’s caregivers with high levels of perceived mastery had higher, not lower allostatic load, compared to
non-caregivers with high mastery. This finding was unexpected as high mastery was predicted to act as a protective resource for allostatic load. Drawing on other inconsistent findings to explain their results (e.g. DeGood, 1975; Houston, 1972; Seeman, 1991), Roepke et al. (2010) suggest that high mastery could elicit an unrealistic sense of perceived control over future personal circumstances. This may be unhelpful in the context of caring for someone with Alzheimer’s, which is recognised as a disease with an uncontrollable course. Whilst this seems plausible, this study highlights an inconsistent research evidence base invested in linking objective and subjective indicators to molecular mechanisms of the body.

In sum, the psychobiological literature views the need to provide a comprehensive conceptual framework for understanding pathology, or allostatic overload. This brief review of a rapidly growing literature shows that such a framework is being used to understand both objective and subjective indicators of illbeing. As such, research is focused on identifying internal and external sources of challenge that contribute to the malfunction of homeostatic systems in the body, and the manifestation of psychopathology and disease. The literature in this review has focused discussion of allostatic overload on mood affect, and as such, adds to a wide body of existing knowledge that is focused on the psychopathological end of the wellbeing continuum.

In the quality of life literature, and the theory of Subjective Wellbeing Homeostasis (Cummins, 1998, 2000, 2010; Cummins et al., 2012), a psychological definition of allostatic overload in relation to mood affect is also defined as chronic ‘depressive illness’. However, instead of focusing on psychopathology and illbeing, SWB homeostasis theory offers a shift in understanding towards identifying the processes involved in managing wellbeing. In this sense, policy developers are informed about the types of internal and external psychological resources that build resilience for maintaining the presence of subjective wellbeing and the absence of chronic disordered mood or depression.

Subjective wellbeing homeostasis theory adheres to the performance requirements of homeostatic systems. In doing so, the theory concentrates on the processes of SWB management in regards to identifying psychological homeostatic mechanisms that build resilience in a dynamic system to protect those rather abstract
perceptions of the self (our SWB). It is this subjective sense of wellbeing that elicits a chronic strength of positivity and approximates the set-point HPMood. In this sense, HPMood is the affective core of SWB and vital variable under homeostatic control. Its regulation within a narrow set-point range maintains an absence of illbeing in the form of chronic depression (Cummins, 2010, 2012). The following section 1.2.1 elaborates on the major tenets of SWB Homeostasis regarding the nature of HPMood, as a core affective construct and vital variable that requires regulating for constancy. Section 1.2.2 reviews studies conducted within the context of homeostasis theory to examine current methodologies employed in the operationalization of HPMood. Finally, in section 1.2.3, limitations in current research designs to impede empirical validation of this key construct are discussed.

1.2.1 HPMood is a Core Affective Construct and Vital Variable Under Homeostatic Control

The previous description of HPMood as a pleasant and mildly activated ‘core’ state of affect that is always present and providing a sense of subjective wellbeing, suggests this psychological variable is vital for the survival of the organism. Indeed, the idea that HPMood is under homeostatic control is based on the intuitive assumption that, in evolutionary terms, the human organism benefits from the maintenance of a predictable positive self-disposition (Cummins & Nistico, 2002). Thus HPMood provides the activation energy or motivation for normal living and avoiding the debilitating motivational consequences of depression (Cummins, 2010).

The homeostatic management of this vital variable is discussed by Cummins (2013 in press), in ecological terms, as an open-managed system (Holling, 1973) contained by a boundary of defence. The boundary itself is understood to comprise the mechanisms (regulating variables) for managing stability in a dynamic psychological system of SWB. The system is “open” because the boundary is permeable, allowing constant interaction between HPMood, its regulating variables, and external sources of influence. This implies that structurally, the relationships among these different parts of the system are interdependent. As a result, the relation between any two variables in the system will depend on the current values of these variables, as well as on the current values of other variables in the system.
Homeostatic mechanisms

Homeostatic mechanisms work in concert to build adaptive capacity for the SWB management system. Adaptive capacity reflects the learning behaviour of a dynamic human system (such as SWB) in response to challenge. Carpenter and Gunderson (2001) consider adaptive capacity as a component of resilience, a characteristic that makes quality of life viable. Homeostatic mechanisms for managing SWB stability are partitioned into external and internal regulating variables. The external regulators refer to objective indicators of SWB. These are the traditional measures of life quality because they focus on the circumstances of living that can be simultaneously observed by a number of people (Cummins et al., 2012). Comprehensive analyses of the types of objective indicators measured in the Australian population over the past 13 years and their influence on life quality are available from a series of reports found at the Australian Centre on Quality of Life http://www.deakin.edu.au/research/acqol/auwbi/survey-reports/.

These data have been gathered from approximately 62,000 respondents, who participated in the Australian Unity Wellbeing Index Project, which commenced in 2001. To date, surveys conducted several times a year have produced 30 snapshot snapshots to indicate what makes Australians’ happy. These various aspects of objective life quality are measured in quantities or frequencies and can include, for example, getting enough sleep, the number of friends (or pets) a person has, the degree of disability a person has and whether that person is responsible for their own care. While each analysed variable has the capacity to either support or challenge SWB, two aspects of life quality namely, earning enough money and sharing an intimate relationship with another person have been identified for their capacity to consistently protect SWB. This allows these ‘fundamental’ objective indicators to be conceptualised as external homeostatic buffers of the SWB management system (Cummins, 2010, 2013 in press; Cummins et al., 2012).
External buffers

Earning enough money and sharing a supportive intimate relationship with another person strengthens the boundary of defence for maintaining SWB. Put another way, wealth and relationships provide protective resources for building resilience in this dynamic system. Resilience, in this context, refers to the ability of the system to adapt easily to challenge or change in set-point levels of SWB (Cummins, 2013). A detailed discussion of set-points in relation to SWB stability will be discussed later in this section. The successful operation of wealth and relationships to act as external homeostatic buffers, against challenge and change, therefore results in the maintenance of the affective ‘core’ of SWB (HPMood) and a chronic sense of positivity.

Wealth

The most valuable property of money is its flexibility to assist homeostasis (Cummins, 2000) through the purchase of resources. Wealthy people use money to minimize perceived unwanted challenges in daily life. This resource is obviously diminished for poor people with the implication that poor people are more exposed to negative life events. Because of this influence, SWB rises with income. This is shown in Figure 5 generated from cumulative data in the Australian Unity Wellbeing Index Project (Cummins, Woerner, Hartley-Clark, Perera, Gibson-Prosser, Collard et al., 2011), which plots the relationship between SWB and gross household income, based on the responses of about 30,000 people. The horizontal bar shows the normative range for sample mean scores.
The * in Figure 5 denote a significant increment in SWB from the previous level of income. As can be seen, there are four such increments covering the four income levels above <$15,000. The final increment is at $101-150K where SWB is higher than it was at $61-100K. To some extent these determinations of significance are a function of the number of respondents. However, the increment from $101-150K to $151-250K of 0.9 points is not large enough to become significant, and the estimates for the two higher groups are difficult to interpret due their relatively low Ns. From these data it is concluded that income loses its ability to reliably raise SWB beyond a household income of $100-150K. In Survey 25, which was the most current sample of participants included in this accumulated data, 18.7% of households had an income of $101-150K and 11.8% of households had an income that exceeded this level (Cummins et al., 2011).

Two observations can be made from the data presented in Figure 5. The first is that, as income rises, fewer people experience levels of SWB below the generic normal range. As can be seen, most people with levels of SWB below this range earn ≤ $30,000. According to Cummins (2010), it is this proportion of income earners who have insufficient money to act as an effective resource to protect SWB. Their lower resilience increases the probability of homeostatic failure. The second observation is that SWB plateaus at around 80 points. This is quite consistent with a recent study (see Cummins et al., 2013), which estimates individual set-points to be normally distributed within a range of 71-90 points. This study will be elaborated later in this section.

The idea that money is a flexible resource, which is used to buffer against negative life events has been tested with the following proposition: “Objectively rich people should subjectively experience more happy events and less sad events in their lives compared to poor people” (Cummins et al., 2012). Participants were asked: “Has something happened to you recently causing you to feel happier or sadder than normal?” The results using cumulative data from the Australian Unity Wellbeing Project (Survey 14) are re-produced in Figure 6 to suggest the following.
Figure 6: Household income vs. happy and sad events.

Approximately 50% of respondents recall that they have recently experienced such an event. In line with predictions, as income increases, the frequency of people reporting sad events decreases, and the frequency for happy events increases up to an income of about $60,000 to $90,000 per year. At this level and beyond, the probability of experiencing both positive and negative events appears to be roughly the same. This is consistent with a ceiling effect for the influence of income on both positive and negative events.

Relationships

The mutual sharing of intimacy and support with another person is a powerful external resource for protecting levels of SWB, and results from the AUWI attest to this power. Figure 7, presents cumulative data from the AUWI (Survey 25) (Cummins et al., 2011).

Figure 7: Household structure and the Personal Wellbeing Index (SWB) (combined surveys).

Figure 7 depicts the SWB of people living in household structures that differ in the kinds of relationships among the inhabitants. The black line represents the
‘threshold for depression risk’ set at a value of 70. This is an approximate value and is derived from research conducted using survey mean scores from different Western populations (see Cummins, 2003), within Western population samples (Cummins, 2010; Cummins et al., 2012), and for an individual over time (Cummins et al., 2013). These various data sources consistently show that people below this level are more prone to experience depression than people who fall within the normative band.

The results shown in Figure 7 show that sole-parents (6.9% of the sample) have a mean score, which lies at this 70-point threshold. Indeed, people living without partners show consistently lower SWB compared to all other household structures. People living without partners, but who live with parents, children, and other adults maintain levels of SWB within the generic range. The seven highest groupings comprise various household structures where respondents live with their partner. Here the power of intimacy and social support in raising levels of SWB either higher than, or within, the normal-range for SWB for sample means is most strongly demonstrated.

It might be expected that the power of the two external buffers to protect SWB is additive, and this is demonstrated in Figure 8 below. The general trend across different household structures is for increased SWB with increased income, but some household structures demonstrate this more markedly than others. These differences appear to be caused by a combination of social support and financial demands.
Figure 8: Household income × household structure: Personal Wellbeing Index (SWB) (combined surveys).

The results shown above make three strong points about the homeostatic management of SWB as follows:

1. Living with a partner in the absence of children offers the best protection for normal SWB for incomes up to about $100K. Above this income level, the groups tend to converge as the buffering effect of income takes over, and negates the effects of different living circumstances.

2. The power of income to affect SWB depends on the strength of demands and other resources. The group with the best resources and least demands are couples alone. Even at an income of <$15K their SWB lies in the normal range, and up to an income of $251-500K their SWB rises by only 5.2 points. This contrasts with the single parents, who have the highest demands. From <$15K to $151-250K their SWB increases by 15.3 points.

3. As further evidence of the positive power of a partner, the SWB of parents living with their child enters the normal range at an income of $31-60K. Sole
parents do not enter the normal range until they reach an income of $61,000 - $100,000.

All of these results indicate that the management of SWB is a function of stressors matched against resources. Income provides one form of resource, and having a partner provides another. If the relative advantage of intimacy and social support provided by another adult exceeds the financial demands required for their maintenance, then their presence will have an overall advantage in terms of SWB management. This is supported by the cited results, and a similar argument can be made in terms of the data on people who live alone. They have a lower level of wellbeing than the people who live only with their partner and their wellbeing does not enter the normal range until their income reaches $101-150.

One implication of these results is that the low SWB of people who live alone is unlikely to reflect some personality deficit, such as low levels of extraversion. Much more likely is that many of these people have not achieved a level of resource, through an income of <$101-150K that enables them to effectively buffer their wellbeing in the absence of a partner.

Internal buffers

When the external buffers are not strong enough to prevent a loss of SWB, a set of internal buffers provide extra resilience for managing stability in the system. Their combined action is to defend HPMood, which in turn, allows the maintenance of the perceived self as positive, leading to ‘self satisfaction’ (Cummins & Nistico, 2002), and feeling satisfied with life as a whole (Diener & Diener, 1995).

Inspired by Taylor and Brown (1998; see also Colvin & Block, 1994), the homeostatic model proposes three cognitive components to comprise ‘self satisfaction’. Each one reflects a positive sense of value and worth as self-esteem (Rosenberg, 1979), a perceived ability to change the environment according to one’s desires as control (Folkman & Moskowitz, 2000), and a sense of optimism for the future (Peterson, 2000). These internal buffers are in constant interaction with momentary experience, and all are strongly related to positive-activated mood (HPMood), which is delivered at the set-point (Cummins, 2013). Their role is to re-frame adverse life events in such a way as to minimise negativity and maximise
advantage to the self. The re-framing devices built into each of the internal buffers can be thought of as abstract beliefs that maintain a perception that life’s needs are about three-quarters fulfilled, and which ensure the “gap” between needs and their fulfilment is maintained within a narrow range (Cummins & Nistico, 2002, p.43). The process of this re-framing discussed by Cummins and Nistico is described as positive cognitive biases (PCBs).

Self-esteem

In relation to self-esteem, people engage in positive cognitive biases (PCBs) of self-enhancement, and self-enhance in different ways to maintain self-consistency (Lecky, 1945). For example, people with high self-esteem tend to over-evaluate their own personal qualities rather than devalue the qualities of others. People with low self-esteem seek positive identities and outcomes indirectly via association to others. There is little evaluation of their own personal qualities but much derogation of others’ qualities (Cummins, Gullone, & Lau, 2002).

PCBs of self-enhancement such as claiming to be ‘more capable than others’ are likely based in the use of social comparisons (Festinger, 1954). When self-esteem is challenged, individuals evaluate themselves against someone close in ability or opinion. For example, people with high self-esteem will re-frame a personal failure by engaging in upward social comparisons. As such, they attribute personal failure to some unavoidable situation because they believe that an upward comparison person would also have failed (Wood, Giordano-Beech, Taylor, Michela, & Gaus, 1994). Those with low self-esteem tend to engage in downward social comparisons by comparing personal failure against someone who is worse off. In this way, failure is re-framed by a belief that the self is not as bad as some other who has experienced more failure (Aspinwall & Taylor, 1993). It is therefore proposed that PCBs of self-enhancement constitute one device for regulating set-points (HPMood) of SWB. PCBs of control represent another similar mechanism.

Control

People in Western cultures predominantly engage in PCBs of primary control, which concern generalised beliefs that life events are under one’s personal control (Cummins & Nistico, 2002). PCBs of primary control such as ‘working hard
to overcome things’ are most likely engaged when the environment is perceived as non-threatening or challenging to the self. At times when the environment is not under the person’s control such as when negative life events must be endured, PCBs of secondary control take over. These biases attribute external sources such as ‘luck’, or ‘the will of God’, to the uncontrollable situation in order to cope with challenge. Whereas PCBs of primary control maintain levels of SWB, PCBs of secondary control buffer against negative feelings associated with adversity to protect SWB from being diminished (Cummins et al., 2002).

PCBs of perceived control are likely based in more fundamental traits pertaining to an individual’s locus of control (Rotter, 1990). Those with an internal locus inherently attribute success to internal, stable and global causes, and failure to external, unstable and specific causes (Abramson & Alloy, 1981). The reverse can be said for those with an external locus of control. The third type of PCB contributing to the maintenance of SWB is that of unrealistic optimism.

**Optimism**

The definition of optimism is framed in terms of a perceived generalised expectancy for pleasurable outcomes in the future (Scheier & Carver, 1985). PCBs of optimism refer to a set of unrealistic, positive beliefs people hold for themselves in the future. For example, most people tend to believe they are less likely, than most others, to experience negative life events in the future. Clearly, this is unrealistic because first, it is not possible that everyone’s future will be ‘sunnier’ than his or her peers (Taylor & Brown, 1988). Second, such an expectation is difficult to discern because the future is yet to arrive (Cummins & Nistico, 2002).

Acting in ways believed to bring positive outcomes to fruition is another example of unrealistic optimism that highlights an expectancy that people can control future desired events and outcomes (Peterson & Seligman, 2004). This biased belief is strongly linked to primary control (Scheier & Carver, 1992), and alludes to interrelatedness among the internal buffers. The additional biased belief that “the present is better than the past” further highlights how people engage in a downward comparison with the past in order to maintain a chronic sense of positivity (Cummins et al., 2002). All this suggests that PCBs are interchangeable devices shared among
the cognitive buffers to build adaptive capacity for maintaining SWB and quality of life.

Consistent with the theoretical propositions of the homeostatic model, self-esteem, perceived control, and optimism demonstrate a high degree of interrelatedness (see Peterson, 2000; Scheier & Carver, 1992; Tiger, 1979 for reviews). Yet all three are discriminable constructs, and discriminable from SWB (Diener & Diener, 1995). They are also positively associated with SWB, and negatively associated with depressive symptoms (see Cummins et al., 2002; Cummins & Nistico, 2002; Carver & Connor-Smith, 2010 for reviews). However, the 14 studies cited in Cummins and Nistico’s review show that whilst all three buffers are indeed positively related to SWB, their magnitude of association with SWB varies considerably. It appears such inconsistency may be sample dependent.

The studies reviewed by Cummins and Nistico (2002, p.44) consistently show that self-esteem is most strongly and positively correlated with SWB, regardless of the kind of population sampled. Weak positive correlations are found between perceived control and SWB, and between optimism and SWB, when samples represent the general population. These correlations increase in magnitude when samples comprise participants who are experiencing negative life events (e.g. spinal injury patients or daughter caregivers). The results of a more recent study with a sample of the general Australian population (see Lai & Cummins, 2013) reveal a similar pattern. Whilst all three buffers share a positive association to SWB, self-esteem is the strongest correlate. In terms of the predictive power of the internal buffers, after controlling for the shared variance attributed to HPMood, self-esteem is the only buffer to contribute unique (independent) variance to the prediction of SWB.

These results have intuitive appeal for theory building as they suggest that when people experience persistent challenge from negative life events, they draw upon the ‘full suite’ of protective resources to buffer against negative feelings associated with adversity in their lives. The stronger magnitude of association found between all three internal buffers and SWB in samples suffering chronic challenges in life (e.g. spinal injury patients), could reflect SWB management system requirements for prolonged elevated levels of these regulating variables. Furthermore, their increased presence, both in duration and strength, would likely
increase the chances of detecting their combined contribution to managing SWB in an empirically measured moment. This line of reasoning, whilst intuitive, is a cautious assumption given the correlational nature of study designs highlighted in Cummins and Nistico’s (2002) review.

On the other hand, a measured moment of the general (normal) population may capture one of two things:

a) The relatively low correlations found among these variables in general population samples may reflect no perceived challenge to levels of SWB from life events. In this case, measurement reflects reduced system requirements of some buffers, and this is evidenced by their reduced magnitude of association with SWB.

b) Alternatively, measurement may capture acute instances of life’s ups-and-downs in these samples. As such, the observed variation in magnitude of association between the buffers and SWB indicates these regulating variables are at various stages in the process of returning to baseline levels.

That self-esteem remains strongly associated and predictive of SWB supports a further contention that self-esteem has a high level of biological determination (Stevens, 1992). The revised homeostatic model (see Cummins, 2010; Cummins et al., 2012) proposes the dominant determinant is HPMood. However, as previously highlighted in the findings of Lai and Cummins (2013), self-esteem continues to contribute additional variance to the prediction of SWB, after controlling for the dominating effect of HPMood. The additional component of self-esteem likely represents motivation towards self-consistency, that is, a striving to maintain unity regarding beliefs about the self (Stevens). This process is clearly the most robust of all the PCBs for its ability to maintain stability for the SWB management system.

Finally, the most important role of PCBs is to maintain a positive sense of wellbeing that is both non-specific and highly personalised. This ensures PCBs remain unfalsifiable properties of the internal buffers. The implication is that if they cannot be easily negated, PCBs will tend to be robust, even in the face of adversity (Cummins & Nistico, 2002). One consequence of this most general sense of positivity is that people feel they are ‘superior’ to others (Headey & Wearing, 1992),
or better than average (Diener, Suh, Lucas, & Smith, 1999). It is these biased beliefs that allow the personal sense of wellbeing to be so defendable against life’s ups-and-downs (Cummins et al., 2012).

However, when the level of challenge to SWB is too strong, homeostatic buffers no longer regulate the set-point (HPMood) within it pre-determined range. When this occurs, the predominant stable positive mood associated with SWB is redirected to the dominating emotions synonymous with the challenge. Challenge to the homeostatic management of SWB may be positive or negative, and thus SWB will move above or below the set-point range of HPMood. When challenge is acute the processes of adaptation and habituation will return the dominant affective experience to HPMood over time. When the challenge is chronic, recovery may not take place resulting in a system failure (Cummins, 2010; Cummins et al., 2012). Cummins’ term for when the system fails is homeostatic defeat, and homeostatic defeat as a result of chronic exposure to negative life events is synonymous with the experience of depression. This idea is commensurate with the term allostatic overload in the psychobiological literature reviewed earlier in relation to ‘chronic disordered mood’.

‘Set-points’ not ‘Baselines’ nor ‘Equilibrium levels’

Subjective Wellbeing Homeostasis theory describes the set-point for SWB as HPMood. This is considered the vital variable that requires regulating for constancy by the homeostatic management system outlined above. As discussion progresses to an empirical demonstration of set-points for SWB, it is important to address issues relating to terminology. The term ‘set-point’ indicates normal levels of SWB. Thus, ‘set-points’ are not to be confused with the scientific term ‘baseline’, which carries no connotation of normality (Cummins et al., 2013). A ‘baseline’ measure describes an initial reliable measure, which usually represents some kind of pathology (i.e., depression). Subsequent measurements are then taken and compared to the baseline in order to evaluate treatment efficacy for reducing the pathology.

The term ‘set-point’ must also not be confused with the term ‘equilibrium level’ as introduced by Headey and Wearing (1989, 1992). This term implies that each person’s steady state for SWB is capable of going through a series of changes. Headey and Wearing elaborate to suggest that each person has an equilibrium level
for SWB that is normal for them. However, this can be shifted upwards or downwards by strong life events. They suggest that personality has the role of restoring equilibrium levels by generating probabilities for certain life events, while chronic changes in people’s lives such as changes in wealth (1992, p. 104), age (1992, p. 130), and social connections (1992, p.127) can mould personality, which leads to changes in equilibrium levels for SWB.

In more recent research (see Headey, 2008; Headey, Muffels, & Wagner, 2010, 2013), Headey and his colleagues investigate the idea that various preferences and behavioural choices can predict long-term changes in SWB above and beyond any contribution of personality traits and life events. Their aim is to offer an alternative theory that accounts for both stability and change in SWB. Using the longest running panel (longitudinal) surveys in the world as data (e.g. German Socio-Economic Panel (SOEP) (Wagner, Frick, & Schupp, 2007); Household Income, and Labour Dynamics in Australia Panel (HILDA) (Watson & Wooden, 2004); British Household Panel Survey (BHPS) (Lynn, 2006)), Headey et al. (2013) attempt to provide a direct test of medium to long-term (up to 20 years) stability and change in scores on the single item measure of SWB, commonly known as ‘General Life Satisfaction’.

As the main aim is to examine medium to long-term stability and change in SWB, the authors, first, calculate 3 to 5-year moving averages for life satisfaction scores to iron out any temporary fluctuations (Headey et al., 2013). Then each individual’s annual life satisfaction scores are regressed onto their moving average scores to account for any change. The results suggest that a significant minority of individuals experience medium to long-term gains or declines in SWB (see Headey et al., 2010). To explain why these changes may have occurred, Headey et al. (2013) conduct a series of hierarchical panel (longitudinal) regressions from each of the three panel surveys. Yet as will be shown, even these rich sources of data present various design and methodological flaws, which render their aim of a direct test of stability and change in SWB largely untestable.

Any line of inquiry that relies on pre-existing data for theory building will be constrained by pre-existing research design, and this is the major impediment for Headey et al. (2013) as they proceed with their own complex design and series of
analyses. As the main focus is to account for change in SWB within the individual over the longer-term, the first step is to control for the effects of invariant characteristics known to promote SWB stability. Drawing on existing data in the three panel surveys, the authors choose personality, gender, age (25-64yrs), age squared and age cubed (to allow for a decline in satisfaction in middle age and rise in senior years), ethnicity, marital status, the national unemployment rate, having a health disability, and the number of years already a panel respondent (to rule out social desirability bias) as control variables. These variables are subsequently entered into the first step of a series of longitudinal regression models.

A fatal flaw in their hierarchical modeling relates to the personality scales hypothesised to promote SWB stability. These scales are included at only one time point taken in 2005 in all three panels. The authors concede that in order to proceed with the study, they must use this snapshot of personality across all time points for each individual to capture (and control) the invariant component of SWB according to their theory. The implication of this is an imposed assumption through research design that no matter when personality is measured it will always be stable. More fatally, this prevents a direct test of longitudinal stability in their model.

Furthermore, the personality measures themselves appear to be unreliable particularly in panels that utilise a short, 3-item version (Gerlitz & Schupp, 2005) of the NEO-PI-R (Costa & McCrae, 1992) (e.g. SOEP, Wagner et al., 2007; BHPS, Lynn, 2006). Of most concern is Headey’s (2008) discovery in SOEP panel data that one of the three items to represent extraversion does not covary in the expected direction with SWB. Therefore, two items are used to capture the multi-faceted nature of trait extraversion and the essence of SWB stability, according to theory (e.g. Headey & Wearing, 1989, 1992; Costa & McCrae, 1980). Such unreliable indicators of stability arguably undermine findings of significant indicators of change in SWB. This is confirmed when preliminary analyses to examine the predictors of change reveal it is not possible to directly test within person changes in SWB over time.

The predictors of change include ‘partner personality traits’, ‘life goals’ (i.e., preferring career, family, or altruistic goals), ‘church attendance’, ‘achieving a work/life balance’, ‘amount of social participation’, and ‘having a healthy lifestyle’.
Their inclusion in the model is based on new ideas inspired from the econometric and positive psychology literatures that suggest priorities and behavioural choices can make a difference to SWB (see Headey et al., 2010, 2013 for reviews). However, the need to rely on pre-existing data, where only a single measure of ‘personality/partner personality’ and sporadic measures of ‘life goals’ were available, prevented the establishment of a fixed effects regression model.

The ability to use fixed effects in least squares panel regression analysis allows the researcher to examine hypothesised predictors of change in SWB within an individual over time. A basic assumption of this approach is that stable characteristics of the individual may correlate with the predictors (IVs) and confound interpretations relating to change in SWB (the DV). As a result, a fixed effects model removes any effect of all time-invariant characteristics (observed and unobserved) from the predictor variables in order to assess the predictors’ net effects (Torres-Reyna, 2007).

All analyses were instead conducted with random-effects models, which the authors (Headey et al., 2013, p.746) concede, limits inferences to between-person differences, not within-person changes, over time, and more fatally, prevents a direct test of longitudinal change in their model. With random effects, only those time-invariant characteristics that have been specified in step 1 of the regression models to influence the predictor variables are controlled. Any unobserved time-invariant variables such as ‘life events’ are not controlled and so could play a role as explanatory variables. However, a comparative fixed-effects model was established with three of the predictors: ‘achieving a work/life balance’, ‘amount of social participation’, and ‘having a healthy lifestyle’. This more precise analysis revealed that choices about these three matters predict small but significant changes in SWB in the longer term (see Headey et al., p.744).

Whether these findings indicate that equilibrium levels for SWB change, and therefore, herald the need to revise set-point theories as claimed by Headey and his colleagues (Headey, 2008, 2010; Headey et al., 2010, 2013), is moot. An alternative view is offered within the conceptual framework of SWB Homeostasis theory. This returns to the issue of terminology, where a clear distinction is made between the term ‘equilibrium level’ and the term ‘set-point’.
To re-iterate, the term ‘equilibrium level’ implies that each person’s steady state level for SWB is capable of going through a series of changes, while a ‘set-point’ for SWB is proposed as a level that is genetically set at a constant level (Cummins et al., 2014). However, the most important elaboration of SWB Homeostasis theory concerns the idea that each individual has a genetically determined and homeostatically managed set-point range for SWB (Cummins, 2000). This conception provides clarification regarding a common misunderstanding of homeostasis as a construct.

The term homeostasis does not imply fixity (Cummins et al., 2013). As previously outlined in section 1.2, homeostatic mechanisms (regulating variables) do not constrain set-points (vital variables) to some fixed parameter but instead ensure their operation meets internal and external environmental challenges (Cannon, 1939). Hence, the aim of the homeostatic management system for SWB, outlined earlier in section 1.2.1, is to maintain the variable it is managing (HPMood) within a narrow range of values. The range within which SWB normally operates may be more tightly controlled for some people than others, and so the magnitude of set-point ranges for SWB may also be an individual difference (Cummins et al., 2012, p.84).

The implication of this for reported levels of SWB is that within normal functioning of homeostatic set-points there is variation (change) in SWB within a ‘bandwidth’ (Cummins et al., 2013). It is proposed that these reported levels of SWB will be dominated by a free-floating pleasant and mildly activated core affective state characteristic of HPMood (Cummins, 2010). An empirical demonstration of the magnitude of this normal range of stability in SWB will be reviewed in the upcoming section.

It is further proposed by Cummins et al. (2013) that outside of this normal range of functioning of homeostatic set-point ranges, much greater magnitudes of variation will be evident in reported levels of SWB. Rather than indicate a changed set-point, these levels of SWB represent homeostatic failure, where overt negativity or positivity (emotions) associated with the challenging agent, dominate conscious awareness and reporting. Cummins (p. 9) provides a useful analogy that is the set-point for core body temperature (37°C). Homeostatic failure as a consequence of hypothermia represents extreme thermal challenge that causes core body temperature
to fall. It does not represent a change in set-point. Once the source of thermal challenge is removed body temperature will revert to its set-point.

In relation to the return of SWB set-points following perturbation, Cummins et al. (2013, p.16) assert, there can be no universal time-span for reverting to normal homeostatic functioning, as this depends on two forces. The first is the strength and persistence of the psychological challenge to normal homeostatic functioning, and the second is the material and psychological resources of each person, in other words, the strength of personal resilience to recover homeostatic control. In summary, the strength of SWB Homeostasis theory is its adherence to the performance requirements of homeostatic systems. In doing so, the theory provides a highly testable, theoretical framework for interpreting SWB data.

Using this understanding to interpret Headey et al.’s (2013) fixed-effects panel regression, it may be that the small contribution made by ‘personal choices’ (i.e., achieving a ‘work/life balance’, ‘maintaining ‘social connections’ and a ‘healthy lifestyle’) to the prediction of change in SWB scores, alludes to the strength of personal resilience to recover homeostatic control. However, given the magnitude of each individual’s change score was not explicitly reported, it is not possible to know whether change has occurred within or outside normal operating ranges of SWB, for that individual. Such a test is now possible in the light of a recent paper published by Cummins et al. (2013), which demonstrates set-points and set-point ranges for SWB from longitudinal data and provides norms for their distribution.

The demonstration of set-points for subjective wellbeing

The theoretical view of set-points provided within the context of SWB homeostasis theory (Cummins, 2010; Cummins et al., 2012; Cummins et al., 2013) is that each set-point represents a biologically determined positive mood state, comprising the most basic experienced feeling. This natural state of affect is coined Homeostatically Protected Mood (HPMood), to imply HPMood is the set-point, the basic steady state characteristic of the individual that homeostatic mechanisms seek to defend. According to Cummins et al. (2013, p.9), “in order for measured SWB to approximate the HPMood set-point, the respondent should be free from the experience of strong affective influences either acute or chronic”. Guided by the expectations of homeostasis theory, the aim of these researchers is to identify SWB
scores from longitudinal data that are most representative of each person, and then to use these scores to estimate set-points and set-point ranges.

The data are drawn from the first 10 consecutive waves of the Household, Income and Labour Dynamics in Australia (HILDA) Survey (Watson & Wooden, 2012). Each data point represents 10 responses from each of 7,356 individuals \((N = 73,560)\) to the question: “All things considered, how satisfied are you with your life?” (General Life Satisfaction: GLS) rated on a 0-10-point scale. All results are standardised onto a 0-100-point scale, which in this instance involved shifting the decimal point one place to the right. The procedure for the study follows an iterative process of data reduction.

The first step involves calculating a mean and standard deviation score of each individual’s responses to GLS over a 10-year period to support two basic assumptions (Cummins et al., 2013, p.10):

1. People who continue to maintain normal homeostatic function over the 10 surveys will show a personal mean and standard deviation that approximates their true set-point and set-point range. As such their individual survey scores on GLS will be normally distributed around their personal mean.

2. People who experience homeostatic failure will exhibit excursions in GLS scores over the 10 surveys, which will shift a person’s mean score either higher or lower than their true mean of their set-point range. Individual survey scores on GLS will therefore be skewed, with the extent of skew dependent on the extent of homeostatic failure.

It logically follows the most likely indicator of whether a person’s mean score approximates, or is different, from their true set-point is the magnitude of that person’s standard deviation.

The next step in this first procedure involves using individual means and standard deviations to place each individual into categories of SWB scores with a width of 5-points. A hypothetical example is as follows:
Thus, a mixture of mean and standard deviation scores are gathered within each of the SWB categories.

The second procedure involves creating a category mean score for each of the SWB categories with category members’ raw GLS survey scores. Then forming a normal distribution (2×SD) within each category to reflect genetic diversity (Lykken & Tellegen, 1996). Raw scores that lie outside of normal category ranges are reflective of homeostatic failure and are trimmed from the distribution. Following the elimination of these scores, each individual’s remaining raw scores are then used to re-calculate their individual mean and standard deviation. The implication of this for those individuals whose scores are trimmed is they are now represented by a different mean and standard deviation. This may place them into a different category as the iterative search for true set-points and set-point ranges continues.

For example, the category mean for the 75.5-80.0 GLS category after the first iteration was 78.11 (SD = 8.36), and individual approximations of set-points for this category were estimated within 95% confidence limits to fall within a range of 61.39 and 94.83 (Cummins et al., 2013, p.6). The hypothetical category member ‘Individual,’ illustrated above, will lose their reported GLS raw score of 60, as this score lies outside the normal distribution for this category of GLS scores. As a result, Individuali is left with 9 raw scores after the first iteration as follows:
As can be seen, the new mean of 81.11 places Individuali into a new GLS category (81.1-85.0). Moreover, the reduction in variance from 8.76 to 6.01 indicates progress towards a closer approximation of the HPMood set-point and set-point range for Individuali.

This iterative process conducted by the researchers was repeated five times before all values remaining in all categories fell within 95% confidence limits for each category (see Cummins et al., 2013 for a more detailed account). The criterion value, set at ≥4 raw GLS scores remaining after the final iteration, identified 61 (0.83%) participants who did not have enough raw scores to progress to the final series of analyses. This reduced the final sample size to \( n = 7,295 \).

In the final series of analyses, final means, standard deviations, and normal distributions were calculated for the GLS categories. The final mean of each category was used to approximate the average set-point for the people in that category. The final mean standard deviation of the people with this set-point represented their trimmed average response variance across the 10 surveys. This range was doubled (2×SD) to form the final normal distribution “[and] this is the approximation to the set-point range for people in [each] category” (Cummins et al., 2013, p.11-12).

The final analysis also produced a sample of category average set-points that were subsequently used to describe a ‘normal HPMood set-point distribution’. Informed by normative data from the Australian Unity Wellbeing Index project (Cummins et al., 2011), outlined previously in section 1.2.2, Cummins et al. (2013) deduced the mean of the HPMood set-point distribution should approximate the overall data median of SWB scores, found in the Australian population. These population means of SWB have demonstrated remarkable stability varying by only
3.1 percentage points over 30 surveys. This median lies in the GLS category of 75.5-80.0.

Based on the further assumption that genetically-determined normal set-point ranges will be relatively consistent, the authors logically deduced that, “after the fifth iteration, the best approximation of the normal HPMood set-point distribution will be revealed by a set of GLS categories with a consistent low standard deviation” (Cummins et al., 2013, p.11). This was evident over category ranges between 71 and 90 points where the category within-person standard deviation range varied by just 0.50 points (from 4.5 to 5.0). Doubling this range to form a normal distribution provides a 95% confidence interval for locating each resting GLS value within a 9 to 10 percentage-point range around its mean value.

The authors apply a caveat to their findings. They caution the identification of set-point ranges through the removal of non-valid variance (i.e., outlying GLS raw scores) does not detect excursions of GLS (experiences of homeostatic failure) within individuals’ statistically valid set-point ranges. Therefore, the methodological techniques used to determine set-points for GLS cannot identify inflated means influenced by undetected homeostatic failure. “[This] iterative process of data removal undoubtedly overestimates the width of the set-point range” (Cummins et al., 2013, p.17). In summary, the major finding of this work is that set-points for general life satisfaction (GLS) appear to have been demonstrated between the levels of 71 and 90 points. This estimated normal operating range (i.e., the set-point range) of 18 to 20 points is argued to be genetically determined, affective in nature, and accounts for normal levels of stability (and change) in SWB scores over the longer term.

1.2.2. Examining a Circumplex Model of Affect within the Context of SWB Homeostasis Theory

Positing that SWB is largely an affective construct has lead to the discovery that much of the research into the affect-life satisfaction relationship has been marred by inconsistencies in the definition and measurement of affect. As a result, researchers working within the theory of SWB Homeostasis have turned to the circumplex model of affect for the purpose of defining and measuring the affect
The first of these researchers to investigate affect with reference to the circumplex was Melanie Davern (Davern, 2004; Davern et al., 2007). Davern was inspired by Russell’s (Russell & Barrett, 1999; Russell, 2003) depiction of core affect as being biologically determined, along with the ability of Browne’s (1992; Fabrigar et al., 1997) CIRCUM procedure to systematically model an affective circumplex structure in accordance with a circumplex model (Guttman, 1954).

Like Russell, Davern was seeking a construct that conceptualised a biologically influenced affective atom, or core. However, her construct required a kind of affect that was unchanging and uninfluenced by percepts to characterise the dominant component of SWB, we now call HPMood.

Davern’s circumplex model of affect

The methodological approach taken by Davern (2004; see also Davern et al., 2007) in her examination of a circumplex model of affect involved a self-report questionnaire comprising 32 single-item affect measures rated according to feelings about life. The specific instructions for the affect items were “please indicate how each of the following describes your feelings when you think about your life in general”. This instruction preceded the list of affect terms.

According to Davern, the specific wording of this test question was designed to capture the affective component of SWB from each response. Whether words alone can reliably capture, in this instance, the affective component of SWB, is a highly contentious issue (e.g. Allen & Potkay, 1981; Zuckerman, 1983), with some (Zuckerman) arguing that, wording of instructions alone, cannot provide a valid assessment of a construct of interest. On the other hand, it is common practice among researchers to use words such as ‘in general’ and ‘right now’ to sufficiently distinguish trait from state measures of psychological phenomena such as affect and personality (Diener & Iran-Nejad, 1986; Robinson & Clore, 2002; Watson, Clark, & Tellegen, 1988).
Taking into account this research evidence, it seems likely it is not possible to capture the affective component of SWB from wording alone. At most, the ‘in general’ nature of Davern’s test question may have elicited a trait response and thus, produced a circumplex model of trait affect. However, this assertion is a tentative one given Davern’s circumplex model of affect was based on single items and a cross-sectional research design. A more valid assessment of whether measures are capturing state or trait responses relies on replication and the specific examination of test-retest reliability along with the internal consistency of the measures. This can only be done with a within-subjects research design and the use of composite scales (Zuckerman, 1983).

Davern’s sampling of the affective lexicon

Nevertheless, the item selection process for Davern’s affect item pool was informed by studies that reviewed common terms employed in the affect literature (e.g. Ortony et al., 1987), earlier investigations of the circumplex model (e.g. Schlosberg, 1952; Russell, 1980; Russell & Feldman Barrett, 1999), and terms used to measure the affective component of SWB (Campbell, Converse, & Rogers, 1976). Each affect measure was also designed as an intensity rating according to a unipolar response scale of (0) “not at all” to (10) “extremely”. This design supports a common contention in both the affect and the SWB literatures that unipolar response scale formats provide a clearer indication of a reciprocal affect balance relationship, or ‘true’ bipolarity (Russell & Carroll, 1999; Davern & Cummins, 2006; Segura & Gonzalez-Roma, 2003).

In addition, affect terms were chosen to slice the circumplex into octants, with four items representing each octant. Although Davern did not provide a rationale for this aspect of research design, her methodological approach resembles a common approach taken in earlier studies in the affect literature investigating circumplex structure (e.g. Yik et al., 1999; Yik et al., 2002), and the interpersonal literature (e.g. Kiesler, Schmidt, & Wagner, 1997; Wiggins, 1979; Wiggins & Trobst, 1997). As shown in Figure 9 below, Davern’s principal dimensions in her circumplex model were derived from each of four items, and these represented octants or eight vectors, spaced 45° apart.
Figure 9: Thirty-one of thirty-two affect terms create octants 45° apart, with four items representing each octant, or vector proposed by Davern (2004).

The affects were: happy, content, satisfied and pleased as pleasant affect; enthusiastic, delighted, excited and elated as pleasant-activated affect; aroused, alert, energised and elated as activated affect; stressed, nervous, annoyed and distressed as unpleasant-activated affect; sad, discontent and upset as unpleasant affect*; flat, bored, depressed and gloomy as unpleasant deactivated affect; tired, fatigued, sleepy, exhausted as deactivated affect; and relaxed, at ease, serene, and calm as pleasant deactivated affect.* Dissatisfied should have been included as a representative of unpleasant affect but its inclusion was prevented by a typographical error.

It can only be assumed that, by constructing composite scales from single items, Davern aimed to create more reliable measures for her circumplex model of affect. However, this was not explicitly stated and the internal consistency of each of the scales was not reported. Instead, Davern de-constructed the scales and explored the location of the 31 single-item affects in relation to the circumplex using a principal components analysis. In this exploratory analysis, Davern was seeking a four-component solution that inferred the four ‘cornerstone’, unipolar constructs underpinning the affective circumplex as: pleasant, unpleasant, activated, and deactivated. Whilst the results did reveal the presence of four components, these were interpreted with the assistance of oblique rotation as: pleasant-activated, unpleasant, deactivated, and pleasant-deactivated, and did not agree with Davern’s expectations. Based on these results, Davern concluded that proceeding with a linear
approach using confirmatory factor analysis would not produce useful information about the location of affect according to the circumplex.

In the light of this, Davern decided to examine the 31 single-item measures systematically, the circular way, using the CIRCUM procedure (Browne, 1992). No rationale was provided for establishing a circumplex model of affect from 31 single-item measures as opposed to establishing a circumplex model of affect from eight composite scales. Nevertheless, Davern used CIRCUM to estimate polar angles between 0° and 360° on the circumference of the circle, for her 31 affect items, in accordance with a circumplex model of affect.

To test the circumplexity of the data in this CIRCUM analysis, the reference variable *pleased* was fixed with its polar angle at zero, relative to which the locations of the other variables were estimated. No other constraints were placed on the model. The analysis converged on a solution in 58 iterations. Five free parameters were specified in the correlation function equation. The final model had a total of 67 free parameters and 429 degrees of freedom. Not all fit indices were provided. Those that were provided, indicated a model that fit the data marginally well: $\chi^2 (429, N = 460) = 2065.32$, RMSEA = .09.

However, many affects failed to fall within 20° of their theorised locations. A 20° margin is considered a confidence interval for ascertaining whether or not affects located on the circumplex meet with predictions (Remington et al., 2000). The most unreliable affect items represented negative affect. Davern’s model is presented below in Figure 10.
As can be seen, affective descriptors representing unpleasant activated (135°), unpleasant (180°), and unpleasant deactivated (225°) on the circumplex did not array in a manner consistent with theory and Davern’s predictions. Moreover, the model failed to predict the activated and deactivated vectors of the arousal dimension. Davern provided two possible explanations for these results. The first concerned insufficient sampling of the affect items in that there was a relative absence of low arousal and high arousal, neutrally valenced affect items. In addition, some affect items did not fit well semantically with the rest of the data (e.g. stressed; flat). This was highly relevant to the results given that the particular item-pool that is sampled determines the type of circumplex model produced (Feldman Barrett & Russell, 1998).

Her second possible explanation was that these circumplex results actually support findings from other studies (e.g. Feldman, 1995a, 1995b; Huelsman et al., 1998) where the pleasant and unpleasant vectors of the hedonic valence dimension dominate self-report feelings of moods and emotions, at the expense of the arousal dimension. While these studies cited by Davern did not test their data with the CIRCUM procedure, there is indeed inconsistent evidence for the presence of high activation and de-activation in affective responses in data tested with CIRCUM (see Remington et al., 2000 for a review)
However, it is the opinion of Yik (M. Yik, personal communication, July 2nd, 2012) that this demonstrated lack of reliability in Davern’s model is due to the model being established from single-item measures rather than composite scales. This opinion is contrary to the findings of Remington et al. (2000), where single-items provided the best fitting circumplex models (see section 1.3.4 for a detailed discussion). Nonetheless, it would be most informative to know whether the affect items chosen to theoretically represent Davern’s octants demonstrated a high degree of internal consistency. If this was the case, a circumplex representation of data based on eight composite scales (four items in each scale) may have provided a more robust model of affect.

A further possibility for the lack of reliability in the model concerns the re-ordering of manifest variables into a correlation matrix that must take place prior to model specification in CIRCUM. This is often done manually by the researcher and is thus, highly susceptible to errors. If the affect items were not re-ordered according to their degree of interrelatedness prior to running CIRCUM, the program would essentially be dealing with a correlational pattern of data that was not a circumplex pattern.

Furthermore, as previously discussed, it is difficult to determine from Davern’s methodological approach whether a circumplex model of trait affect has been established. However, assuming that a trait model was created from the ‘in general’ nature of the test question, intuitively this implies it would likely capture less arousal than a model of momentary affect, which asks people to indicate how each affect item describes their feelings ‘right now’, in the current moment. Presumably, this state-type of model would reflect acute fluctuation in feelings, thus capturing more variance in the arousal dimension. If it could be established that Davern’s circumplex model was indeed a model of trait affect, then this may explain why less variance was accounted for in the arousal dimension.

Most importantly, Davern’s explicitly stated desire to establish a structural model of the affective component of SWB, using the CIRCUM procedure, implies her circumplex model of affect represents the construct we now call HPMood. However, the most valid way to represent HPMood on the circumplex is to examine the degree to which an external variable, theorised to be dominated by HPMood,
relates to a circumplex model of core affect. An external variable is one not used to
define the circumplex. In accordance with the theoretical model of SWB
Homeostasis (Cummins, 2010; Cummins et al., 2012; Lai & Cummins, 2013)
variables dominated by HPMood are SWB and major correlates of SWB such as
personality, optimism, and self-esteem.

Therefore, by relating these external variables to the circumplex in a
circumplex analysis, it is possible to locate the specific blend of hedonic valence and
arousal accompanying responses to these external measures. It is this specific kind of
core affect that will identify HPMood on the circumplex. The methodological
approach employed in this thesis to pinpoint HPMood on the circumplex using
external variables like SWB is known as the Cosine Wave Method (Yik, 2009; Yik et
al., 2011). This methodology is an extension of the CIRCUM procedure (Browne,
1992) employed by Davern et al. (2007), and is discussed in detail in section 1.3.5.
The Cosine Wave Method addresses important limitations in research design and
methodology currently employed by researchers working within the theory of SWB
Homeostasis with specific regard to the construct validity of HPMood.

1.2.3. Examining the Construct Validity of HPMood within the Context of
SWB Homeostasis Theory

The theoretical model of Subjective Wellbeing Homeostasis (Cummins,
2010, 2012; Cummins et al., 2012) conceptualises HPMood as a core affective
construct, and further proposes that responses to SWB measures are dominated by
this affective component. Hence, the theory implies SWB is dominantly affective in
nature. If HPMood is a core affective construct, then the two underlying integrated
dimensions of Hedonic Valence and Arousal must best describe HPMood. In order to
identify the specific kind of core affect that is HPMood, HPMood should be
amenable to empirical validation using a structural model that best captures its
specific blend of Hedonic Valence and Arousal. That model is the circumplex model
of affect. However, until now, no study has investigated HPMood on the circumplex.

Instead, researchers (e.g. Blore et al., 2011; Davern et al., 2007) have used
linear multiple regression to examine how laypersons describe HPMood. By
simultaneously regressing multiple independent affect measures onto the single-item
dependent measure of SWB (i.e., *General Life Satisfaction (GLS)*), these studies examine which affects significantly and uniquely predict scores on GLS. The rationale for this approach is that the abstract and personal nature of the GLS question, “How satisfied are you with your life as a whole?” captures the essence, or affective ‘core’ of SWB. Thus, responses to this single-item measure will be dominated by HPMood, (Cummins, 2010).

The results of these studies reveal that the unique affective predictors of happy, contented, energised, satisfied, active, and (a lack of) stress appear to account for a portion of variance above and beyond that which is shared among all the other independent affect variables in the regression models. Subsequently the findings of these studies have been used to inform the theory of SWB Homeostasis in specific relation to establishing the construct validity of HPMood.

It is currently claimed that the unique affective predictors of happy and content accurately represent Cummins’ (2010, 2012) conceptualisation of HPMood; namely, the pleasant or positively valenced part of the HPMood construct. However, the unique affective predictors of energised and active do not accurately represent Cummins’ notion of mild activation inherent in the HPMood construct. These affective descriptors have since been replaced by the affects excited (Davern et al., 2007; Lai & Cummins, 2013), or alert (Tomyn & Cummins, 2011) to join happy and contented, when describing and measuring HPMood.

The findings of these studies indicate that much of the shared variance between SWB measures, and related variables, is accounted for by the HPMood composite, with SWB measures (GLS and PWI) most dominated by affect. These findings have led to the interpretation that SWB is mostly affective in nature, and that SWB and its major correlates are perfused with a similar form of core affect theorised as mildly positive/pleasant and activated.

However, there are limitations of this linear approach to establishing the construct validity of HPMood. Firstly, it is not possible to measure a specific blend of the two dimensions claimed to characterise HPMood. This can only be achieved on the circumplex where it is possible to systematically examine a core affective structure underlying responses to SWB measures. In this way, an empirical definition
of HPMood can be established. In contrast, findings of unique affective predictors in linear regression analyses merely allude to the existence of this kind of core affect, which Cummins (2010, 2012) describes as a ‘pleasant and mildly activated’ ‘core’ state of affect (HPMood). Moreover, the kinds of descriptors predicting participants’ scores on SWB measures change with repeated sampling (see Davern et al., 2007 and Blore et al., 2011). Therefore, seeking an accurate representation of HPMood from a composite set of affective descriptors (e.g. happy, contented, alert) becomes somewhat uncertain.

A further limitation of the linear approach is the common finding that unique affective predictors (the IVs), are highly intercorrelated as well as being highly correlated with the measure of SWB (the DV). This violates the assumption of no multicollinearity in linear multiple regression. It does not, however, violate the assumption of structural interdependence for obtaining circumplexity. Indeed, high intercorrelations among certain kinds of IVs (e.g. happy, contented/ active, energised/ excited, alert) are expected and accounted for by a shared level of complexity in the underlying structure; namely, the two underlying integrated dimensions of hedonic valence and arousal. Hence, the observed pattern of high interrelatedness among different kinds of IVs (e.g. happy, content, alert) supports the two-dimensional psychological nature of HPMood, as a core affective construct.

Taken together, these limitations point to a major flaw that involves imposing the psychological nature of HPMood through research design. Researchers currently involved in the design of the HPMood construct (e.g. Blore et al., 2011; Davern et al., 2007; Lai & Cummins, 2013; Tomyn & Cummins, 2011) include a small number of affective descriptors (e.g. happy, content, alert) that serve as operational definitions in their survey questionnaires, and the decision to include certain items (e.g. excited, alert) is not based on prior empirical investigation (e.g. Davern et al.; Lai & Cummins; Tomyn & Cummins). Participants’ responses to these single-item affect measures are then summed and averaged to form an HPMood composite variable. As such the psychological nature of HPMood as a core affective construct is presupposed. The HPMood composite variable is then treated as a mediator (Lai & Cummins, 2013), or determinant (Blore et al., 2011; Davern et al., 2007; Tomyn &
Cummins, 2011), in linear modeling to test the assumption that HPMood drives the relationship between SWB and major correlates of SWB.

The effect of imposing the psychological nature of HPmood through research design is proposing what HPmood is, before it is found. This is problematic particularly when research designs are driven by the theoretical assumption that HPmood is the determining force responsible for the stability in SWB. Indeed, it is this aspect of research design that has been most criticised (see Moum, 2007). The main contention cautions against making causal inferences when a relative lack of discriminant validity is demonstrated among measures chosen to represent the Homeostatic Model. Therefore to address these limitations a more valid way to identify the psychological nature of HPmood is now proposed using a circumplex analysis.

Representing HPmood on the Circumplex

As previously stated, in order to represent HPmood on the circumplex, research design must involve the degree to which an external variable, theorised to be dominated by HPmood, relates to a circumplex model of core affect. According to the theoretical model of SWB Homeostasis (Cummins, 2010; Cummins et al., 2012; Lai & Cummins, 2013), external variables dominated by HPmood are SWB and major correlates of SWB such as personality, optimism, perceived control, and self-esteem. By relating these variables to the circumplex model of affect in a CIRCUM analysis, it is possible to locate a specific blend of Hedonic Valence and Arousal on the circumplex that is most strongly associated with these external measures. This will reveal the type of core affect accompanying such responses, and the degree to which SWB, and major correlates of SWB, are affective in nature. Therefore, the next step in this logical sequence is to relate external variables to the circumplex in a CIRCUM analysis.

Placing external variables into the circumplex via the Cosine Wave Method

In addition to establishing a model of the affect such as the one created by Davern (2004; Davern et al., 2007) in section 1.2.2, the circumplex can provide a prediction about the pattern of correlations between the circumplex variables and an
external variable, like SWB; such predictive power is made possible by the Cosine Wave Method (Yik, 2009; Yik et al., 2011).

The principle is that an external variable that correlates with one affect within the circumplex will correlate with the remaining affects in a systematic way. The magnitude of that correlation will rise and fall in a cosine wave pattern as one moves around the circumference of the circumplex (Stern, 1970; Wiggins, 1979). It is the finding of a cosine wave, rather than the statistical significance of any individual correlation, that indicates the presence of a relation between an external variable and the affective circumplex.

Hypothesis testing using this methodology assumes no relationship between external variables (i.e., SWB) and those that make up the affective circumplex. Based on theory, which in this instance is the theoretical model of SWB Homeostasis (Cummins, 2010; Cummins et al., 2012), a prediction is made in the form of a hypothesis about the magnitude of relations. Each external variable is then placed within the circumplex, one at a time, to examine the degree to which that variable alters the cosine wave.

Notably, many variables are related to a circumplex model of affect (see Yik, 2009; Yik et al., 2011). However, the Cosine Wave Method produces for each analysis important indicators to determine how reliable and meaningful the relationship is between the external variable and the circumplex model of core affect. These indicators are discussed in detail in section 1.3.5 of the literature review. Importantly, the indicators determine the type of core affect accompanying responses to external variables, and hence can verify (or falsify) Cummins’ (2010) definition of HPMood as a ‘pleasant and mildly activated’ core state of affect. They also reveal the degree to which SWB, and major correlates of SWB, are affective in nature. Finally, with a cosine wave analysis, it is possible to compare the newly established empirical definition of HPMood with lay descriptions of HPMood (i.e., happy, content, active, energised) previously established in linear methods (Blore et al., 2011; Davern et al., 2007). This is achieved post-hoc by examining the locations of the external variables within the circumplex relative to the composite affects used to create the affective circumplex model.
1.3. ISSUES IN MEASURING THE ‘CORE’ OF AFFECT

The various theoretical perspectives discussed thus far are united by the notion of a biologically determined core state of affect, regulated for constancy via homeostasis, and that such core affect represents individual set-points for evaluating subjective wellbeing. This common understanding was elaborated on in sections 1.1 and 1.2 of this literature review. Now in section 1.3, the major issues surrounding the operationalisation of this key concept are discussed.

The section begins with an introduction to the basic assumptions underlying affective circumplex structure, as only an empirical test of circumplexity can operationalise the concept of core affect. Next, the CIRCUM procedure (Browne, 1992) for assessing circumplex structure will be outlined. Following this, the utility of circumplex analyses as either theoretical integration tools, or measurement maps to chart the relation between core affect and a variable not defined by the circumplex will be discussed. A procedure known as the Cosine Wave Method (Yik, 2009; Yik et al., 2011) will be introduced as a method for predicting the specific kind of core affect accompanying variables like subjective wellbeing. The current author was fortunate to learn this method from Professor Yik on a study exchange to the University of Science and Technology in Hong Kong, in July of 2012.

Finally, it will be shown that a number of methods artifacts can influence the fit of a circumplex model to affective data. Five study characteristics known to confound circumplex analyses are identified as (1) self-report ratings involving short time frames (i.e., momentary states) rather than longer time frames (i.e., trait judgements), (2) ratings involving felt intensity of affective experience rather than frequency ratings, (3) single-item measures rather than multi-item scales, (4) sampling of affective states from all regions of geometric space, and (5) data sets including few ambiguous affective states (Remington et al., 2000). These methods artifacts, along with the additional artifact of response scale design, will be elaborated on.

1.3.1. Assumptions Underlying Circumplex Structure

Empirical tests of circumplex structure make two basic assumptions. First, that the variables of interest (i.e., the manifest variables) are interrelated. Second, that
interrelatedness simultaneously results from two underlying dimensions in *Hedonic Valence* and *Arousal*. Together, the hedonic valence and arousal dimensions have been shown to efficiently account for similarities and dissimilarities amongst mood and emotion categories (Barrett & Bliss-Moreau, 2009; Fabrigar et al., 1997). For example, it has been shown that hedonic valence and arousal account for much of the variance in everyday ordinary feelings (Russell, 1980, 2003, 2009; Russell & Barrett; Barrett, 2009; Barrett & Bliss-Moreau; Yik et al., 1999; Yik et al., 2011), work-related affective wellbeing (Goncalves & Neves, 2011), and laypersons’ cognitive representations for judging emotion from facial or vocal expressions (Green & Cliff, 1975; Schlosberg, 1952). These dimensions also best describe the basic properties underlying human language (Bush, 1973; Osgood, May, & Miron, 1975; Russell, 1978). Theoretical and empirical discussion surrounding core affect and the circumplex is limited to verbal self-reports herein.

**Self-report affective circumplexes**

That verbally reported feelings are interrelated due to an underlying two-dimensional structure is by no means unique to circumplex representations (Fabrigar et al., 1997). What distinguishes circumplex structure from other two dimensional structural models is that participants’ responses to mood and emotion categories cannot be ordered in a linear fashion, as is the case with Thurstone’s (1947) simple structure. Instead, when responses (manifest variables) are projected into two-dimensional space using a form of factor analysis, variables order along the circumference of a circle. This observed circular pattern depicts what is similar (or dissimilar) between mood and emotion categories (based on people’s psychological responses to them), and implies that the strength and direction of associations among variables is a function of the distance between variables on the circumference of the circle (Fabrigar et al.).

This means that mood and emotion categories close in proximity on the circumference of the circle (i.e. happy and contented) are experienced as qualitatively similar, and are therefore, highly, positively correlated. As the distance between affects on the circumference increases (i.e. happy and euphoric), their degree of similarity decreases, and the correlation becomes smaller. For circumplex representations comprising negative correlations, as in the case of affective data,
variables 90° apart from one another on the circle are completely independent (unrelated). Variables that are 180° apart from one another are maximally dissimilar thus, are highly, negatively correlated (Barrett & Bliss-Moreau, 2009; Fabrigar et al., 1997).

Importantly, a circumplex pattern of self-reported feelings depicts ordinal relationships and so, alone, provides a nonparametric view of relatedness in geometric space (Barrett & Bliss-Moreau, 2009). It is nonparametric in the sense that arbitrary re-ordering of the manifest variables entered in a correlation matrix will destroy a circumplex pattern (see Chapter 1.1.3 for a visual display of a correlation matrix depicting a circumplex pattern). In order to systematically account for a circumplex representation of data, a test of circumplexity must quantify what is similar and different about self-reported feelings. A circumplex analysis can achieve this via the CIRCUM procedure (Browne, 1992; Fabrigar et al., 1997). CIRCUM is outlined in section 1.3.2 to follow. In short, CIRCUM takes the nonparametric circle and imbeds it within two-dimensional space to examine the extent to which the underlying structure of the correlation matrix conforms to a circumplex pattern (Barrett & Bliss-Moreau; Browne; Fabrigar et al; Grassi, Luccio, & Di Blas, 2010).

In sum, any one test of circumplexity can clarify how different kinds of feelings are interrelated in the way they are, and uncover the dimensions of mood and emotion categories that appear ubiquitous in this area of study. Because of this, contemporary researchers argue that circumplex analyses are parsimonious representations of the correlational structure of mood and emotion (see Barrett & Bliss-Moreau, 2009; Fabrigar et al., 1997; Larsen & Diener, 1992; Russell, 1980, 2003, 2009; Yik et al., 1999; Yik et al., 2002; Yik et al., 2011).

One final assumption concerns the orientation of the axes within two-dimensional space. Psychometrically speaking, rotation does not affect the ability of a circumplex representation to explain the structure of relationships among variables. Orientation is therefore a theoretical issue (Fabrigar et al., 1997), and attempts to locate the basic dimensions of affect are indeed contentious (Larsen & Diener, 1992; Mehrabian & Russell, 1974; Watson & Tellegen, 1985; Watson, Wiese, Vaidya, & Tellegen, 1999; Yik et al., 2002).
Generally, researchers attempt to locate basic dimensions by charting their relation to external variables. An external variable is one not defined by an affective circumplex. The main aim is to find a ‘correspondence’ between a theoretically hypothesised set of core affective dimensions and the external variable. Correspondence here means the same processes underlie both (Yik et al., 2011). For instance, Watson and Tellegen (1985) choose to anchor the affective circumplex at 45° and 135° to hypothesise personality variables of extraversion (45°) and neuroticism (135°) correspond to this specific blend of hedonic valence and arousal they call ‘positive affectivity’ (45°) and negative affectivity’ (135°).

However, Yik et al. (2011) point out this approach fails to consider that a circumplex analysis allows an external variable to fall at any angle within the space, indicating extraversion or neuroticism may have many correspondences to the underlying affect structure. Therefore, instead of assuming that an external variable correlates with only one of the named dimensions, or falls at multiples of 45°, researchers are forced to be open to any location. Indeed Yik et al. (2002) examined the relation between the Five-Factor Model of personality (Costa & McCrae, 1992) and a core affective structure across five language cultures (English, Spanish, Chinese, Japanese, and Korean). Her findings suggest that personality is systematically linked to core affect similarly (although not identically) across these different language cultures. Most interestingly, the personality variables did not locate Watson and Tellegen’s (1985) understanding of core affect as ‘positive affectivity’ (45°) and negative affectivity’ (135°). Instead, they found the horizontal and vertical dimensions of ‘pleasant-unpleasant’ (0°-180°), and ‘activated-deactivated’ (90°-270°) came closer to the personality dimensions, which points to a structure of core affect best described by hedonic valence and arousal.

In sum, underlying any one location on the circumference of the circle is an integral blend of valence and arousal. In other words, these are the salient psychological elements that best distinguish what is similar and dissimilar about people’s psychological reactions to self-report measures. In this sense, a circumplex representation of data represents a systematic graphical display of psychological responses at a given moment. It also explains how these responses can be defined as a combination of two independent and bipolar dimensions commonly referred to as
pleasant-unpleasant and activation-deactivation, or in lay terms, feeling good or bad, feeling lethargic or energized (Russell, 2003, 2009).

1.3.2. Tools to Measure Circumplex Structure

The CIRCUM procedure

To test the circumplexity of affect data, a correlation matrix for the manifest variables is submitted to structural equation modeling using the circular stochastic process model with a Fourier series (CSPMF), commonly known as ‘CIRCUM’ (Browne, 1992). CIRCUM is a mathematical tool for a specific type of structural equation modeling designed to assess circumplex structure. Like standard covariance structure models, CIRCUM assumes that variance in people’s psychological responses (the observed scores) can be divided into common score variance and unique score variance. Common score variance refers to the portion of variation in participants’ responses that is shared between two or more of the variables, and unique score variance refers to the variation in responses that is unique to a single variable (Fabrigar et al., 1997; Remington et al., 2000).

When it comes to modeling circumplexity, a key assumption of CIRCUM is that common score variance is a true score of structural interdependence, or a perfect circumplex structure. Structural interdependence occurs when variables of ‘equal complexity’ differ from each other in the content they convey (Di Blas, 2007). Therefore, a circumplex will not hold for unique score variance because uniqueness signifies a difference in the level of complexity in the underlying structure. Given a correlation structure yielding the required pattern is based on observed scores, which contain both common score variance and unique score variance, circumplexes will never be true indicators of structural interdependence, or represent perfect circumplex structures. In Guttman’s (1954a) terms, circumplex structures based on observed scores produce ‘quasi-circumplex’ structures. The utility of a statistical procedure such as CIRCUM is that the program can partial out the effects of unique score variance by treating it as random error in measurement (Browne, 1992). However, CIRCUM cannot partial out the effects of non-random measurement error. Therefore, the circumplex model produced will comprise true scores of structural interdependence plus deviation (error).
Assessing Circumplexity

Like traditional covariance structure models, CIRCUM can be fit to a (pre-ordered) sample correlation matrix of variables using standard covariance structure modeling parameter estimation (e.g., maximum likelihood estimation, or generalised least squares estimation). This allows the researcher to systematically assess the fit of a circumplex model to data, with ‘model fit’ implying that the strength and direction of associations among variables is a function of the distance between variables on the circumference of the circle (Fabrigar et al., 1997).

CIRCUM provides fit indices in the form of the chi square ($\chi^2$) likelihood statistic and the root mean square error of approximation (RMSEA) to measure the extent to which a hypothesised model of the interrelationships among a group of variables (i.e., an implied model) fits the actual relationships existing in the data set (i.e., the observed model). The chi square ($\chi^2$) goodness-of-fit statistic is an overall measure of the discrepancy between the coefficients estimated for the hypothesised model and the coefficients obtained for the observed model. When the discrepancy is negligibly small, indicated by a $p$ value greater than .05, it can be assumed that the hypothesised model fits the data well. Larger discrepancy, indicated by a $p$ value less than .05, alludes to a poor fitting model (Tabachnick & Fidell, 2007).

However, the magnitude of the chi-square goodness-of-fit statistic is sensitive to large sample size as illustrated by the formula below:

$$\chi^2 = (N - 1) F_{\text{min}}$$

Where $F_{\text{min}}$ is the minimum fit function produced by the maximum likelihood (ML) estimation. ML is the most commonly employed form of parameter estimation in circumplex analyses and functions to maximise the probability that the observed (actual) covariances are derived from a population assumed to be the same as that reflected in the coefficient estimates (implied model) (Browne, 1992). Therefore, even trivial differences between the implied and the observed models may often yield a significant difference as the minimum fit function is multiplied by $N - 1$. While interpreting model fit in larger samples based on the $\chi^2$ statistic is unrealistic (see Joreskog & Sorbom, 1993; Thompson, 2000), $\chi^2$ is useful for model
modification (i.e., determining the relative fit of different models using the same data set) (Fossum & Barrett, 2000).

Whereas $\chi^2$ is considered a ‘goodness of fit’ test, the root mean square error of approximation (RMSEA) measures error or ‘badness of fit’ in the hypothesised model as if it were generalised to a population (if it were available) (Thompson, 2000). As illustrated in the formula below, the RMSEA attempts to correct for the tendency of the $\chi^2$ statistic to reject hypothesised models with large sample sizes. The index also corrects for model complexity by dividing $F_0$ by degrees of freedom. The assumption being that for any data set and for any population, the more complex model will always fit as well and usually better (Steiger, 2000).

$$RMSEA = \frac{\sqrt{F_0}}{df_{\text{implied mode}}} \text{ where } F_0 = \frac{X^2_{\text{implied model}} - df_{\text{implied mode}}}{N}$$

When the hypothesised (implied) model is a perfect fit to the population, then $F_0 = 0$. Greater model misspecification causes larger values in $F_0$, and increased average error between the hypothesised model and the assumed population. However, the philosophy behind estimation of the RMSEA states badness of fit is seldom zero. The task therefore is to ascertain how large is the error and how precisely it has been determined (Steiger, 2000).

There is inconsistency in the literature regarding criteria indicative of such precision. For example, Fossum and Barrett (2000) qualify RMSEA values less than .100 indicate good fit and values less than .050 indicate ‘very good fit’. Browne and Cudeck (1992) suggest RMSEA values of .050 or less indicate good fit, values of .051 to .080 constitute acceptable fit, values of .081 to .100 constitute marginal fit, and values greater than .100 constitute poor fit. The guidelines set forth by Browne and Cudeck will be followed in the current analysis as their discussion of model fit indices specifically relates to a direct assessment of circumplex structure.

Importantly, the RMSEA relies on the maximum likelihood discrepancy function, which is asymptotically equivalent to a ‘weighted’ function of the sum of squared differences between the observed and implied correlation matrices. The weights are inversely related to the variances of the parameter estimates (Yik et al., 2011, p.711; Steiger, 2000, p.160). When variables are very highly correlated, as is
often found with affective and personality variables, these weights become inflated. This can inflate the RMSEA value even when the model reproduces the correlation matrix well (Yik et al., 2011). Therefore, as Steiger (p.161) points out, when one considers the structure of the measure, it seems the use of precise numerical ‘cut-off’ values’ (like .05) should not be taken too seriously. Yik et al. agree and argue this may be one of the reasons why RMSEA values in CIRCUM analyses can be inflated.

Finally, CIRCUM makes use of a Fourier series, a possibly infinite set of cosine functions, which mathematically define the relationship between theta (θ) (i.e. the polar angle or location on the circle) and the correlation coefficient (i.e. the direction and magnitude of associations among the common score variables) (Browne, 1992; Fabrigar et al., 1997). The model allows for a family of cosine functions that can be fit to data and the ability to specify free parameters in order to increase the range of possible functions to improve model fit. The minimum number of free parameters that must be specified in a Fourier series is \( m \geq 1 \) (Browne). However, when \( m > 1 \), the correlation function may not be monotonic decreasing. This is a key assumption of the model that states the correlation coefficient must decrease as the point representing one common score variable (\( c_j \)) on the perimeter of the circle moves further away from the point representing \( c_i \) (Browne). Remington et al. (2000) in their review examined the number of free parameters specified by researchers whose research designs provided optimal representations of circumplex structures. They found the number of free parameters specified in these models ranged from 1 to 7.

The methodology for parameter estimation employed by Yik (M. Yik, personal communication, July 6th, 2012) will be followed in all CIRCUM analyses, which employs the routine use of an \( m = 3 \) model. However, to fully examine the best fitting model, the model will be tested specifying parameters one through five, and an assessment of the best overall fit will be made.

Additional information provided by CIRCUM

In addition to assessing the circumplexity of the data, CIRCUM estimates the location within the circumplex for the manifest variables. These locations are provided in the form of polar angles, designated theta (θ). The researcher chooses a reference variable on the circle and the locations of all other common score variables
on the circle are derived by fitting the model to the sample correlation matrix (Fabrigar et al., 1997). The choice of the reference variable is arbitrary and does not affect model fit. However, the reference variable fixed to 0˚ is routinely designated ‘pleased’ or ‘pleasant’ (see Russell, 1980; Yik et al., 2002; Davern et al., 2007) to theoretically correspond to the pleasant end of the valence axis. The location of other variables estimated from this fixed location can be read off in degrees, and increase anti-clockwise. CIRCUM also provides zeta (ζ), which is a communality index. Communalities are the proportion of variance explained in each variable by both underlying dimensions in the CIRCUM model. Confidence intervals also can be obtained for θ and ζ. From these estimates, a graphical representation of the data may be constructed.

The psychological nature of the ‘core’ of affect underlying the data

Another useful piece of information derivable from the circumplex model is the minimum common score correlation (MCSC), which is an estimate of the correlation between common score variables that are 180˚ apart from one another on the circle (Fabrigar et al., 1997). From this estimate, one can interpret the psychological nature of the circumplex dimensions underlying the data. The circumplex model is a thoroughly bipolar model, and assumes variables located 180˚ apart from one another on the circle are highly, negatively correlated. The minimum common score correlation at 180˚ should equal -1.00 in error-free data. This is rarely observed due to the attenuating effects of non-random forms of measurement error that CIRCUM cannot control for.

1.3.3. Circumplex Analyses: Integration Tools

Researchers who conduct circumplex analyses seek alternative solutions to affect structure. The search for alternatives is informed by response patterns found in affective data. As previously discussed in section 1.3.1, correlations among affective variables do not generally produce solutions that represent simple structure. Seeking ‘simple’ solutions to affect structure is driven by a predominant assumption that the dimensions of affect (e.g. anxiety, emotional stability) are unipolar and independent of one another (McLachlan, 1976; Thayer, 1967; Tellegen, Watson, & Clark, 1999). Hence, seeking simple structure is a methodological practice, which involves rotating a correlation matrix in the hope of producing a solution where the manifest
variables display non-zero factor loadings on only one (unipolar and independent) factor.

Conversely, the methods employed by researchers measuring affect structure, the circular way (e.g. Browne, 1992; Guttman, 1952, 1954a, 1954b; Yik et al., 1999; Yik et al., 2011), are driven by the assumption that different perspectives need not compete. So, these researchers utilise the circumplex to explore the possibility that various perspectives may be integrated into one descriptive model, best described by the concept of core affect. In doing so, debates such as whether or not the dimensions of affect are independent, or bipolar opposites of, one another can be compared and reconciled (Tellegen et al., 1999; Green, Goldman, & Salovey, 1993; Russell & Carroll, 1999). The following section discusses in more detail how the circumplex has been used to integrate various theoretical perspectives and structural models.

Circumplex structures that integrate various theoretical perspectives

Contemporary psychological constructionists (e.g. Yik et al., 1999; Yik, 2009; Yik et al., 2011) have utilised the circumplex as an integration tool to demonstrate how various theoretical models of affect (e.g. Barrett & Russell, 1998; Larsen & Diener, 1992; Mehrabian & Russell, 1974; Thayer, 1996; Watson & Tellegen, 1985) fit meaningfully into a circumplex structure underpinned by the two independent and bipolar dimensions of hedonic valence (i.e., pleasant – unpleasant) and arousal (i.e., activated – deactivated). An illustration of these models of affect integrated into a two-dimensional space is provided by Yik et al. 1999, and is reproduced in Figure 11 below.
Figure 11: A circumplex representation of 16 affect scales representing various theoretical models of affect structure using CIRCUM, and produced by Yik et al. (1999).

A = Activated; D = Deactivated; U = Unpleasant; P = Pleasant. In Yik et al.’s. representation, two separate analyses have been superimposed on one another. Ns = 198 (Boston sample) and 217 (Vancouver sample).

The locations of the affect constructs on the circumference of the circle (black dots), estimated by CIRCUM, represent polar angles (with 95% confidence intervals). The researchers designated Barrett and Russell’s (1998) ‘Pleasant’ scale as the reference variable, constrained at 0° on the circle. The locations of all other common score variables (the affect scales) are left free to vary. Their locations in degrees, can be read-off in an anticlockwise direction, and are derived by fitting the model to a sample correlation matrix formed from the 16 affect scales.

As an integration tool, the circumplex depicted in Figure 11 has modelled the conceptual complexity of emotional life in a parsimonious way through the scientific/technical concept of core affect. Take, for example, Larsen and Diener’s (1992) ‘Unactivated Pleasant Affect’ dimension of affect and Watson and Tellegen’s (1985) ‘Low Negative Affect’ dimension. These two constructs represent
conceptually diverse aspects of two different theories of affect structure. Both constructs are operationalised from vastly different kinds of mood and emotion categories. Larsen and Diener’s affect scale is constructed from the categories relaxed, contented, at rest, calm, serene, and at ease. Watson and Tellegen’s scale is constructed from the categories nervous, afraid, scared, distressed, jittery, upset, irritable, hostile, guilty, and ashamed. A major assumption of Watson and Tellegen’s affect theory is that low scores on these ‘high-pole markers’ designed to capture ‘High Negative Affect’ will indicate ‘Low Negative Affect’. Therefore, scale construction to capture the ‘Low Negative’ dimension of affect, in their theory, involves the researcher reverse-scoring these items post-test.

Despite this conceptual diversity, the circumplex analysis reveals that both scales are highly related to one another. This is evidenced by their close proximity to one another on the circle. Moreover, both dimensions share a similar correspondence to the underlying structure, that is, a type of core affect (deactivated and pleasant) located at approximately 315˚ on the circle. Indeed, Watson and Tellegen’s (1985), Larsen and Diener’s (1992), Thayer’s (1989), and Barrett and Russell’s (1998) structures are all highly interrelated, and hence this supports Yik et al.’s. (1999, p.612) thesis, that they are alternative descriptions of the same two-dimensional space. Even though these constructs are highly interrelated, the authors point out that a relative lack of overlap among confidence intervals for the polar estimates suggests the scales are not interchangeable. In sum, it is possible with one test of circumplexity to determine what is similar and discrete about these various structural models.

It is also possible to address the issue of simple structure versus circumplex structure. The circumplex analysis represented in Figure 11 reveals a lack of simple structure, with many variables (affect constructs) falling in between the two orthogonal axes of hedonic valence and arousal. In a simple structure, most variables would fall on only one of these primary axes (Acton & Revelle, 2004).

In regards to Figure 11, the black dots represent the locations in degrees (polar angles) for the 16 affect constructs. However, their positioning on the circumference of the circle carries the implication that all of the variance in all 16 variables is accounted for by the two-dimensional structure of core affect. In other
words, communalities for the 16 variables are all equal to 1.00. Such a result is not reported in this analysis where communalities were left free to vary (Yik et al., 1999, p.614). Whilst a circumplex that accounts for 100% of the variance in affective data is not a sufficient condition to establish circumplex structure, because a simple structure could also show this property (Acton & Revelle, 2004), the image in Figure 11 is somewhat misleading as it does not illustrate actual vector length for a given variable.

A vector possesses both the magnitude and direction of association acting at a particular polar angle for a given variable (Acton & Revelle, 2004), and is depicted in graphical displays as a straight line extending from the centre of the circle to the polar angle estimated for that variable. Vector length represents the square root of a variable’s communality on the two circumplex dimensions, and reveals the extent to which a structure of core affect accounts for the variance in the measures (Yik et al., 1999; Yik et al., 2011). Vectors representing communalities less than 1.00 will therefore not reach the circumference of the circle as is depicted in Figure 11.

Even though this structure of core affect does not account for 100% of the variance in self-report affective data, the two substantive dimensions of hedonic valence and arousal do account for a vast proportion of this variance (Yik et al. 1999; Yik et al., 2011). The authors of the studies under review qualify that a circumplex analysis is an approximation of affect structure due to CIRCUM’s inability to control for systematic error variance. Therefore, the percentage of variance left unaccounted for in a circumplex model may be a statistical artifact caused when correlated measurement error attenuates statistical indices. On the other hand, it may also represent other substantive dimensions of affect beyond hedonic valence and arousal that are involved in self-reported experiences, such as cognitive appraisal (Smith & Ellsworth, 1985) and beliefs about the antecedents and consequences of affective experiences (Russell, 1978). Whilst it is not possible to determine the existence of these substantive dimensions with a circumplex analysis, it is possible to determine how various types of measurement error can influence the fit of a circumplex model to affective data. This issue will be addressed in section 1.3.5.
1.3.4. Circumplex Analyses: Charting the Relation Between Core Affect and Variables not Defined by the Circumplex.

As an integration tool, the circumplex is also utilised as a measurement map to chart a relation between a structure of core affect and an external variable (Gurtman, 1992; Yik, 2009; Yik et al., 2011). An external variable is one that is not part of an originally established circumplex model of affect. In this use of the circumplex, research design involves two stages. The first stage requires the establishment of an affective circumplex model. Such a model is based on certain study characteristics that prepare an ‘optimal’ correlation matrix for model specification with the CIRCUM procedure. These study characteristics will be elaborated on in section 1.3.5 to follow. The second stage involves using the established circumplex model of affect as a measurement map to chart a relation between a structure of core affect and an external variable. The procedure employed in this thesis is known as the Cosine Wave Method (Yik, 2009; Yik et al., 2011), and is the focus of the current section.

The Cosine Wave Method

In addition to establishing a model of the affect structure, the circumplex provides a prediction about the pattern of correlations between the circumplex variables and an external variable, such as subjective wellbeing (SWB). The principle is that an external variable that correlates with one affect within the circumplex will correlate with the remaining affects in a systematic way. The magnitude of that correlation will rise and fall in a cosine wave pattern as one moves around the circumference of the circumplex (Stern, 1970; Wiggins, 1979). It is the finding of a cosine wave, rather than the statistical significance of any individual correlation, that indicates the presence of a relation between an external variable and an affective circumplex model. Figure 12 provides a hypothetical example of the relationship between a measure of SWB (ordinate) and an affective circumplex model (abscissa).
Figure 12: A hypothetical correlation function of the single-item measure of SWB (General Life Satisfaction) (ordinate) with hypothetically established angles within an affective circumplex model (abscissa). The value for the correlation at 0° is repeated at 360° to show the complete cosine wave.

In this hypothetical example, the external variable that has been placed within the circumplex, via the Cosine Wave Method, is subjective wellbeing (SWB) in the form of the single-item measure general life satisfaction (GLS). As can be seen, the type of association formed by relating GLS with the circumplex affects has created a cosine wave pattern. That the addition of GLS into the model of affect does not alter the cosine wave pattern indicates that GLS is reliably related to a circumplex model of affect. The strongest point of association with the core affective structure further indicates the predicted location of GLS. This occurs at 0°, in this hypothetical example. This result would be interpreted as, participants who rated their general life satisfaction had a strong tendency to report a specific type of core affect (pleasantness) that is best characterised by the peak of the fitted curve at 0° within the circumplex.

Notably, many variables are related to a circumplex model of affect. However, how reliable and meaningful the relationship is between the external variable and the circumplex affects is determined by the Cosine Wave Method (Yik, 2009; Yik et al., 2011), which produces for each analysis three indicators: The first
indicator, \(\hat{\alpha}\) (a-hat), is the estimated angle in degrees of the external variable within the affective circumplex. In the hypothetical example provided, and further illustrated below in Figure 13, GLS (the external variable) is located at 0°. The second indicator, \(r_{\text{max}}\) (r-max), is the maximum correlation between the external variable and a vector within the affective circumplex at the angle \(\hat{\alpha}\). The vector possesses both the magnitude and direction of association acting on the point at 0°. Hence, \(r_{\text{max}}\) is an effect size. In this hypothetical example, \(r_{\text{max}} = .80\) to indicate 64% of the variance in GLS is accounted for by a pleasant state of core affect at 0°. The third indicator, \(VAF\) (variance accounted for), is the amount of variance explained by the cosine wave. That is, the percentage amount of variance accounted for by the two underlying integrated dimensions of hedonic valence and arousal when GLS (the external variable) is included in the model. VAF indicates how reliable the relationship is between GLS and core affect.

![Figure 13: A hypothetical illustration of a relationship between the single-item measure of SWB (General Life Satisfaction) and a structure of core affect produced by the Cosine Wave Method.](image)

The significance level of VAF is determined by a Monte Carlo simulation study, which involved assigning each angle of the ‘12-point circumplex model of affect’, established by Yik et al. (2011), to a correlation drawn randomly with replacement from a set of 996 correlations. The application of this technique determines that values of VAF greater than or equal to 45.5% are significant at \(p < .05\) while values greater than or equal to 57.6% are significant at the \(p < .01\) level. In
addition, values of rmax that are less than .15 indicate the external variable is unrelated to the affective circumplex.

To chart the relation between an external variable and an affective circumplex model, the Cosine Wave Method relies on the general form of the cosine function:

$$Y = a + b \cdot \cos(X + d)$$

Where $Y$ is the correlation between each segment and the external variable; $X$ is the angle for the segment within the circumplex model. $a$, $b$, and $d$ are constants to be estimated in a nonlinear regression estimation procedure. In this equation, $a$ adjusts the values of $Y$ to fit the cosine function; $b$ indicates the amplitude of the cosine wave; $d$ indicates the start value of $X$ when it does not start at 0. If $a = 0$, $b = 1$, and $d = 0$, the general form of the cosine function reduces to the commonly seen $Y = \cos(X)$ (Yik et al., 2011, p. 718).

In sum, the Cosine Wave Method provides a method for predicting the pattern of correlations between circumplex affects and an external variable, for circumplex analyses. Hypothesis testing using this methodology assumes no relationship between external variables and those that make up an affective circumplex model. Based on theory, which in this instance is the theory of SWB Homeostasis (Cummins, 2010; Cummins et al., 2012), a prediction is made in the form of a hypothesis about the magnitude of relations. Then each variable is placed within the circumplex, one at a time, to examine the degree to which that variable alters the cosine wave.

External variables entered into an affective circumplex model via the Cosine Wave Method will be those identified in the homeostatic model as subjective wellbeing, self-esteem, perceived control, optimism, and extraversion. According to theory these variables are reliably related to HPMood. The rationale for employing this methodology in this thesis is to chart a relation between these listed variables and a structure of core affect. Their locations in degrees on the circumplex, precisely estimated by the Cosine Wave Method, will pinpoint the specific kind of core affect accompanying each variable and the degree to which that variable is affective in nature. By relating external variables in the homeostatic model to a structure of core
affect, in a circumplex analysis, it will be possible to identify the ‘core’ of affect Cummins’ (2010, 2012) terms, HPMood.

1.3.5. Methods Artifacts

The first researchers to discuss potential methods artifacts were Remington et al. (2000). These authors empirically re-examined 47 correlation matrices drawn from 14 articles testing circumplex structure with the CIRCUM procedure. They identified five study characteristics that influenced the fit of a circumplex model to self-reported affective experiences. These included: (1) self-report ratings involving short time frames (i.e., momentary states) rather than longer time frames (i.e., trait judgements), (2) ratings involving felt intensity of affective experience rather than frequency ratings, (3) single-item measures rather than multi-item scales, (4) sampling of affective states from all regions of geometric space, and (5) data sets including few ambiguous affective states. Each of these study characteristics, along with the additional artifact of response scale design, will now be elaborated on in specific regard to how research design can influence statistical indices, which in turn, shapes conceptual understanding regarding the nature of affect.

The great bipolarity debate

One of the most controversial issues impeding understanding of the nature of affect is the ongoing debate of whether dimensions of affect are independent of, or bipolar opposites of, one another. A circumplex analysis that controls for the influence of these study characteristics can reconcile this controversy by demonstrating how both independence and interdependence occurs, and why.

Early research (e.g. Guilford, 1954; Nowlis & Nowlis, 1956) set out to investigate the structure of self-reported affective experience with the common-sense assumption that the main dimensions would be bipolar. Experientially, this means that a happy person is one who is not sad, and that a sad person cannot be simultaneously happy (Green et al., 1993). Psychometrically, bipolarity is detected when participants’ scores on one dimension are strongly and inversely related. If happy and sad are not independent but interdependent constructs, then one can assume that happy and sad represent opposite ends of the same underlying continuum (i.e., the hedonic valence dimension).
Yet conceptual understanding that affective space is bipolar was dispelled by the introduction of factor analytic rotational procedures used in early correlational research (e.g. Bradburn, 1969; McLachlan, 1976; Thayer, 1969). In this work, when bipolar adjectives chosen to measure the dimensional structure of affect were factor analysed, hypothesised opposites formed independent unipolar factors instead of single bipolar ones. This early research inspired a modern tradition in the psychometric measurement of affect where employing factor-analysis along with varimax rotational procedures, to investigate the underlying structure of affect, became the gold standard for scale development.

Although the unipolar view became the dominant view, those maintaining a strong stance for the bipolarity of affective space (e.g. Green et al., 1993; Helson, 1964; Russell & Carroll, 1999; Segura & Gonzalez-Roma, 2003) insisted the evidence for structural independence was actually an artifact of method. These artifacts produce the biased effect of unipolarity and independence by attenuating correlational indices. Given affective space is bipolar, according to circumplex theory, it is crucial to control for such attenuating effects on statistical indices. The first of these methods effects concerns the time frame specified in questionnaires for eliciting self-reports of affective experience.

*Time frame specified in self-reports*

Time frames asking how one feels *right now* are thought to elicit ‘state’ judgements (i.e., momentary affect) (Russell, 2003, 2009), whereas time frames longer than the current day elicit ‘trait’ judgements (i.e., a predisposition to experience certain levels of affect) (Robinson & Clore, 2002). Researchers investigating the unipolar or bipolar nature of positive affect and negative affect (Diener & Iran-Nejad, 1986; Watson et al., 1988) concede that positive and negative affect are negatively correlated but the correlation decreases as the time frame increases. In other words, momentary (state) judgements are more likely to shift inferences towards structural interdependence, whereas trait judgements are more likely to infer structural independence.

Relating these findings to circumplex analyses, Remington et al. (2000) compared state versus trait judgements, after statistically partialling out the effects of the study characteristics listed above. Adjusted mean scores indicated that state
judgements (RMSEA = .08; MCSC = -.64) rather than trait judgements (RMSEA = .10; MCSC = -.45) provided a better fit to the data. To re-iterate, the root mean square error of approximation (RMSEA) assesses the fit of a circumplex model to affective data, and the minimum common score correlation (MCSC) is the minimum correlation obtained between variables on the circumplex that are located 180° from one another in a circumplex analysis. This evidence supports Russell’s (1980, 2003, 2009) claim that core affect, described by two independent and bipolar dimensions, is most clearly represented in momentary feeling states, elicited from questions about how one feels, ‘right now’.

Intensity versus frequency ratings

Researchers investigating the independence of positive and negative affect in the context of Subjective Wellbeing (SWB) (Diener, 1984; Diener & Emmons, 1984; Diener, Larsen, Levine, & Emmons, 1985; Diener, Smith, & Fujita, 1995; Schimmack & Diener, 1997) have examined the combined effects of the time frames specified in self reports, and intensity versus frequency ratings. In this early work (see Diener et al., 1985), intensity ratings for a sample of mood descriptors representing positive affect and negative affect, are measured on a Likert-type scale ranging from 0 (‘Not at all’) to 6 (‘Extremely’), and then summed and averaged. Frequency ratings represent the number of ‘happy’ days, and involve adding up separately the number of instances positive affect predominates over negative affect, over the course of the day, for each individual. ‘Happy’ counts are captured within short time frames (not more than a day) and converted to a percentage. These percentage scores are then represented on a scale of 0% (‘The most unhappy persons’) to 100% (‘Most happy persons’).

The predominance of ‘happy’ days is indicated by a moderate, positive association with positive affect ($r = .59$) and a strong, negative association with negative affect ($r = -.79$). This implies that the more frequently positive affect is experienced, the less frequently negative affect would be experienced (Diener et al., 1985). The strong inverse association between the predominance of ‘happy’ days and negative affect supports a long-held claim that it is not possible to experience multiple momentary affective states, simultaneously (Green et al., 1993; Helson, 1964; Russell & Barrett, 1999).
In contrast, when measures of positive affect and negative affect are worded in terms of intensity of experience, and specified over time-periods longer than one day (i.e., trait judgements), the correlation between positive and negative affect indicates structural independence ($r = -.23$ to $.24$). When intensity is partialled out, and the time frame reduced (i.e., state judgements), the correlation becomes highly inverse ($r = -.46$ to $-.86$) to indicate structural interdependence. These results imply that people rely heavily on the intensity of felt experiences when asked to review their affective states over longer time-periods (Diener et al., 1985).

From this study, it appears that, when measures of positive affect and negative affect are designed to elicit the frequency of state responses, interpretations about the dimensional structure of affect, within the context of SWB, support structural interdependence, or bipolarity. Conversely, when measures seek the intensity of trait responses, correlations shift interpretations towards the notion of independence, and unipolarity.

However, these partnerships do not always go hand-in-hand in study designs. This was observed by Remington et al. (2000) in their re-examination of circumplex structure. Of the 14 studies reviewed, state judgements almost always involved intensity ratings, whereas trait judgements tended to involve frequency ratings. According to the review authors, this common confounding of study characteristics is likely responsible for inconsistent findings and interpretations of the structure underlying affective experience.

As an example of this confounding, Remington et al. (2000) demonstrated that, prior to partialling out the effects of all other study characteristics listed above, frequency and intensity ratings produced inconsistent findings in terms of model fit. For instance, the RMSEA indicated frequency not intensity ratings provided a better fit to data yet the MCSC at $180^\circ$ indicated intensity ratings provided a better fit. When the effects of all other study characteristics were controlled, fit indices became consistent and showed intensity ratings provided the best overall fit to data (RMSEA = .08 and .10; MCSC = -.60 and -.50, for intensity and frequency, respectively). This finding has intuitive appeal as it implies that drawing on sensational and automatic processes (intensity) rather than computational and effortful processes (frequencies) provide a more accurate description of self-reported affective experience.
Single-item versus multi-item measures

Of the 14 studies reviewed by Remington et al. (2000), single-item measures rather than multi-item scales provided a better fit of a circumplex model to data (RMSEA = .08 and .10; MCSC = -.60 and -.53, respectively). This finding contradicts a common consensus in the literature that composite scales are more reliable than single-item measures. Indeed, a circumplex analysis established from composite scales is prescribed by researchers who use the circumplex as a measurement map to chart a relation between an affective circumplex model and variables external to the model, such as personality, optimism, and subjective wellbeing (SWB) (e.g. Yik et al., 2002; Yik, 2009; Yik et al., 2011). These researchers claim that only an affective circumplex, established from composite scales, can consistently produce a model for projecting external variables into the circumplex. The provision of a more robust model, in effect, improves the signal to noise (measurement error) ratio for detecting the magnitude of effect.

However, the composition of scales to capture as many regions of the circumplex as possible hinges on the use of affective synonyms (i.e., affect terms that are highly interrelated). As an example, a composite scale to predict a vector located at 45° (‘pleasant-activated’) can include the terms lively, peppy, and overjoyed. These synonyms are designed to capture an underlying two-dimensional structure of hedonic valence and arousal at a specific point on the circumplex at 45°. If researchers combine terms that predict various points on the circumplex, a circumplex test will be distorted.

This is indeed what Remington et al. (2000) discovered about the composition of multi-item scales employed in various studies of circumplex structure. Typically, composite scales comprised affect terms that were not synonyms. A composite scale to predict a vector located at 135° (‘unpleasant-activated’) on the circumplex, for instance, comprised the terms fearful (135° ‘unpleasant-activated’), blue (180° ‘unpleasant’), and shocked (90° ‘activated’). This type of scale composition may adequately capture a broader construct such as ‘negative affect’, but falls short in describing and clarifying more subtle similarities and differences among people’s descriptions of affective experience. Therefore, the kinds of affective descriptors to include in scale construction, in conjunction with
techniques to examine narrowly defined dimensions, are important for describing the structure of affect.

*The multi-dimensional nature of affect*

The ability to examine multiple dimensions of the affect structure exposes a misunderstanding in circumplex analyses, which is reflected in research design. One type of design may seek to examine how many separate parts (i.e., independent dimensions) are required to describe the affect structure. However, this is not the same as asking about the multi-dimensional nature underlying the affect structure (Russell & Carroll, 1999, p.5). Watson and Tellegen’s (1985; Watson et al., 1988) model of affect is one example of the blurring of this distinction.

The theoretical model proposed by Watson and Tellegen (1985) predicts that, the personality dimensions of *extraversion* and *neuroticism* will locate the ‘core’ of affect on the circumplex. Known as the 45° hypothesis (Yik et al., 1999; Yik et al., 2011), Watson and Tellegen’s basic dimensions are defined as *positive affectivity* and *negative affectivity*, and are rotational variants of Russell’s (1980) hedonic valence and arousal axes (i.e., pleasant-unpleasant and activated-deactivated). Watson and Tellegen argue that their two independent (descriptively bipolar and affectively unipolar) axes are better conceptual representatives of the underlying affect structure because they describe the personality structure of affect (Watson & Clark, 1984).

In Watson and Tellegen’s (1985) terms, *descriptively bipolar* means that structural interdependence is accounted for graphically on the circumplex. Figure 14 below locates Watson and Tellegen’s positive affective and negative affective axes according to Russell’s (1980) hedonic valence and arousal axes.
Figure 14: The location of the Watson and Tellegen (1985) positive affectivity (PA) and negative affectivity (NA) according to the Russell (1980) hedonic valence and arousal axes, and re-produced from Davern and Cummins, (2006, p.2).

The broken lines in Figure 14 infer the presence of affective antonyms (semantic opposites) located 180° apart on the circle. The kinds of experiences on the positive affectivity dimension can range from attentive and alert states at one end of the dimensional continuum (high PA at 45°), to sluggish and dull states at the other end (low PA at 225°). Negative affectivity can range from fear and distress (high NA at 135°) to tranquil and calm (low NA at 315°). Figure 14 also locates Watson and Tellegen’s (1985) axes 90° apart on the circle, to indicate the two descriptively bipolar axes are independent, or unrelated to each other.

Importantly for their conception, each axis is considered to be affectively unipolar, in Watson and Tellegen’s (1985) terms. This means that when it comes to measuring the underlying structure of affect described on the circumplex, there is no need to operationalise low PA and low NA (e.g. calm, tranquil, sluggish, dull, etc.) as these are adequately captured by low ratings on the high-pole markers. The positive and negative affect schedule (PANAS; Watson & Tellegen, 1985; Watson et al., 1988) reflects this assumption and is designed to measure the conceptual model of the (personality) structure of affect. The positive affectivity scale (PA) describes the extent to which a person avows a ‘zest for life’, and the negative affectivity scale
(NA) describes the extent to which a person reports feeling upset or unpleasantly aroused (Watson & Tellegen, 1985, p.221). Each scale comprises 10 items listed below in Table 3.

Table 3:
*The 20-items of the Positive and Negative Affect Schedule (PANAS) (Watson & Tellegen, 1985).*

<table>
<thead>
<tr>
<th>Item#</th>
<th>Positive Affectivity (PA)</th>
<th>Negative Affectivity (NA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>active</td>
<td>afraid</td>
</tr>
<tr>
<td>2.</td>
<td>alert</td>
<td>ashamed</td>
</tr>
<tr>
<td>3.</td>
<td>attentive</td>
<td>distressed</td>
</tr>
<tr>
<td>4.</td>
<td>determined</td>
<td>guilty</td>
</tr>
<tr>
<td>5.</td>
<td>enthusiastic</td>
<td>hostile</td>
</tr>
<tr>
<td>6.</td>
<td>excited</td>
<td>irritable</td>
</tr>
<tr>
<td>7.</td>
<td>inspired</td>
<td>jittery</td>
</tr>
<tr>
<td>8.</td>
<td>interested</td>
<td>nervous</td>
</tr>
<tr>
<td>9.</td>
<td>proud</td>
<td>scared</td>
</tr>
<tr>
<td>10.</td>
<td>strong</td>
<td>upset</td>
</tr>
</tbody>
</table>

A major limitation of Watson and Tellegen’s (1985) structural model is that there is no empirical test to support the assumption that low ratings on the PANAS items capture the experience of low PA and low NA. All that can be inferred from low ratings is the reduced presence of the experience of high-pole items. Therefore, the PANAS is not a proxy for inferring the underlying structure of affect as it is conceptualised by Watson and Tellegen. It does, however, describe two separate (unipolar) parts (dimensions) of a whole structure, and is therefore useful for providing a fine-grained description of the underlying ‘core’ nature of affect.

When the PANAS scales are used in this way, they can be treated as manifest variables along with other related scales (e.g. Diener & Larsen, 1992; Barrett & Russell, 1998; Thayer, 1989), which are then entered into a correlation matrix and submitted to CIRCUM. High PA and high NA provide a fine-grained description of the underlying core of affect located at 45° (95% CI: 39°-51°) and at 152° (95% CI:
145°-160°) on the circle, respectively (Yik et al., 1999). Alternatively, the PANAS scales can be treated as external variables to examine the degree of relatedness between this commonly used measure and a structure of core affect using the Cosine Wave Method, which was previously outlined. When treated in this way, the strongest points of association between high PA and high NA, and a structure of core affect, correspond to regions on the circle at approximately 39° and 162°, respectively (Yik et al., 2011).

The question as to whether the PANAS represents the personality structure of affect has also been examined in this way. The PANAS, along with measures of extraversion and neuroticism (e.g. NEO-FFI; Costa & McCrae, 1992) are treated as external variables and related to core affect (see Yik et al., 2011). Watson and Tellegen’s (1985) affect theory predicts that, both high PA and extraversion should share identical correspondences to an underlying structure of core affect, as should high NA and neuroticism. Yik et al. find that all four dimensions share many similarities. However, they do not provide identical correspondences to the underlying core (e.g. high PA (39°) and extraversion (33°); high NA (162°) and neuroticism (182°)).

These kinds of results demonstrate that many separate dimensions can elucidate the specific nature of the kind of core affect accompanying these measures. Much of this nature is accounted for by an integral blend of two independent and bipolar dimensions in hedonic valence and arousal.

*Sampling affective states from all regions of the circle*

Research designs seeking to investigate the underlying ‘core’ of affect begin with establishing a working semantic model on the circumplex. The aim is to represent all regions of the circle. The purpose is not to establish the structure of the language of affect, but to utilise this model as a means to empirically question whether affective experience conforms to the semantic hypothesis of bipolarity (Russell & Carroll, 1999). Feldman Barrett and Russell (1998) claim that, for a test to be considered an empirical test of bipolarity, three conditions must be met:

1. Affective descriptors representing poles 180° apart on the circumplex must be semantic opposites (affective antonyms).
This may seem obvious and easy to achieve given bipolarity is a key feature of the language of affect (moods and emotions). However, not every affect term has a bipolar opposite, and not all bipolar pairs lie directly on the valence dimension (the x axis) since arousal (the y axis) has fanned them out (Russell & Carroll, 1999).

2. The sample of affective descriptors must reflect the multidimensional nature of affect.

This can be illustrated by slicing the circumplex in half, vertically. Then the right half of the circle will represent ‘positive affective states’, and the left half of the circle will represent ‘negative affective states’. To achieve this balance semantically, both halves must comprise a range of words that vary in level of activation. Then by slicing the circumplex in half, horizontally, the top half of the circle will represent ‘activation’ whereas the bottom half of the circle will represent ‘deactivation’. These halves must comprise a range of words that vary in valence. Evidently, any straight line placed through the centre of circumplex will test the semantic hypothesis of bipolarity. This type of sampling configuration also allows for the observation that any test of structural interdependence (bipolarity) depends on which region of the circle is sampled (Barrett & Russell, 1998) as illustrated in Figures 15 a, b and c below.
3. For those tests focused on a more general analysis (i.e., ‘positive affect’ and ‘negative affect’), as opposed to a specific category (i.e., ‘fear’), the affective descriptors chosen to represent the broader construct must adequately tap the full range of either pleasant affect terms, or negative terms. In this more general sense, a semantic circumplex model can inform the item selection process when constructing composite scales.

This raises an additional question in the affect literature of whether semantic terms used to describe all regions of the circle refer to people’s affective experiences, or not?

**The use of ‘ambiguous’ terms**

Some commentators (e.g. Clore et al., 1987; Ortony et al., 1987; Diener et al., 1985; Diener et al., 1995) have criticised the largely intuitive approach taken when it comes to selecting semantic terms to describe affect. As a result, attempts have been made to systematise the affective lexicon. The work of Ortony et al. (see also Clore et al.) draws on methodology employed in the linguistic literature to establish taxonomy for affective conditions. For example, these authors conducted a componential analysis (see Goodenough, 1956), which is designed to uncover the principles governing the use of language. Their language sample comprised 585 English words taken from the affect literature.
Their main research aim was to create a referential structure to discriminate between a more specific language of moods and emotions and a broader, ‘ambiguous’ language of affect. According to Ortony et al. (1987, p.343), this ‘ambiguous’ language refers to words that have been used in the affect literature to label any valenced judgement or condition. Classification of words was based on the assumption that different linguistic contexts (i.e., a being context and a feeling context) can discriminate the language of moods and emotions from ‘non-emotions’. For example, being angry and feeling angry would be equally rated as an experience of an emotion. Concomitantly, being tired and feeling tired would be equally rated as a non-emotion. However, being certain and feeling certain would not concur, according to Ortony et al.’s rationale. The word certain likely refers to cognition as it rates highly in the being condition, and therefore does not have affect as a referential focus.

The referential structure created from the componential analysis was then empirically tested with 435 undergraduate students using a series of discriminant function analyses (see Clore et al., 1987). The results supported the rationally derived classification system. The best examples of mood and emotion words were those that (a) people used to refer to their own internal mental conditions, as opposed to some external physical event, and (b) had affect as a predominant referential focus as opposed to behaviour (e.g. careful) or cognition (e.g. certain). These words were coined affect focal terms.

Comparing Ortony et al.’s (1987) taxonomy of affect focal descriptors with a list compiled by Remington et al. (2000), of affective descriptors commonly employed in circumplex analyses, there is a paucity of affect focal terms to describe ‘activation’, ‘deactivation’, and unpleasant-deactivation’, and shown in Table 4.
Table 4: A list of affective descriptors representing octants of circumplex structures reviewed in Remington et al. (2000). Items highlighted in blue indicate ‘affect-focal’ terms. Terms highlighted in black indicate a broader language of affect, according to Ortony et al. (1987).

<table>
<thead>
<tr>
<th>Pleasant</th>
<th>θ</th>
<th>Pleasant-Activated</th>
<th>θ</th>
<th>Activated</th>
<th>θ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Happy</td>
<td>0°</td>
<td>Elated</td>
<td>45°</td>
<td>Aroused</td>
<td>90°</td>
</tr>
<tr>
<td>Contented</td>
<td>0°</td>
<td>Excited</td>
<td>45°</td>
<td>Activated</td>
<td>90°</td>
</tr>
<tr>
<td>Delighted</td>
<td>0°</td>
<td>Enthusiastic</td>
<td>45°</td>
<td>Active</td>
<td>90°</td>
</tr>
<tr>
<td>Glad</td>
<td>0°</td>
<td>Full of Pep</td>
<td>45°</td>
<td>Astonished</td>
<td>90°</td>
</tr>
<tr>
<td>Joyful</td>
<td>0°</td>
<td>Lively</td>
<td>45°</td>
<td>Intense</td>
<td>90°</td>
</tr>
<tr>
<td>Pleased</td>
<td>0°</td>
<td>Peppy</td>
<td>45°</td>
<td>Energetic</td>
<td>90°</td>
</tr>
<tr>
<td>Satisfied</td>
<td>0°</td>
<td></td>
<td></td>
<td>Surprised</td>
<td>90°</td>
</tr>
<tr>
<td>Warm-hearted</td>
<td>0°</td>
<td></td>
<td></td>
<td>Wide-awake</td>
<td>90°</td>
</tr>
<tr>
<td>Cheerful</td>
<td>0°</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kind</td>
<td>0°</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Playful</td>
<td>0°</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unpleasant-Activated</th>
<th>θ</th>
<th>Unpleasant</th>
<th>θ</th>
<th>Unpleasant-Deactivated</th>
<th>θ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angry</td>
<td>135°</td>
<td>Blue</td>
<td>180°</td>
<td>Depressed</td>
<td>225°</td>
</tr>
<tr>
<td>Ashamed</td>
<td>135°</td>
<td>Disappointed</td>
<td>180°</td>
<td>Discouraged</td>
<td>225°</td>
</tr>
<tr>
<td>Afraid</td>
<td>135°</td>
<td>Discontented</td>
<td>180°</td>
<td>Drowsy</td>
<td>225°</td>
</tr>
<tr>
<td>Annoyed</td>
<td>135°</td>
<td>Dissatisfied</td>
<td>180°</td>
<td>Half asleep</td>
<td>225°</td>
</tr>
<tr>
<td>Distressed</td>
<td>135°</td>
<td>Gloomy</td>
<td>180°</td>
<td>Sleepy</td>
<td>225°</td>
</tr>
<tr>
<td>Fear</td>
<td>135°</td>
<td>Joyless</td>
<td>180°</td>
<td>Sluggish</td>
<td>225°</td>
</tr>
<tr>
<td>Irritated</td>
<td>135°</td>
<td>Miserable</td>
<td>180°</td>
<td>Tired</td>
<td>225°</td>
</tr>
<tr>
<td>Nervous</td>
<td>135°</td>
<td>Sad</td>
<td>180°</td>
<td>Bored</td>
<td>225°</td>
</tr>
<tr>
<td>Worried</td>
<td>135°</td>
<td>Unhappy</td>
<td>180°</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jittery</td>
<td>135°</td>
<td>Grouchy</td>
<td>180°</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hostile</td>
<td>135°</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
According to Ortony et al.’s (1987) referential structure, most of the descriptors highlighted in black would represent clear cases of ‘non-emotions’. These words were discriminated as internal physical (non-mental), or bodily states in their empirical analysis. Indeed, when Remington et al. (2000) re-analysed studies with ‘optimal’ study characteristics for circumplexity, the most poorly predicted regions of the circle were ‘activation’ and ‘deactivation’. However, ‘unpleasant-deactivated’ was relatively well predicted.

Whether these results reflect a lack of understanding among participants to associate words like quiet and astonished with internal, mental-affective conditions, is a moot point. It is more likely that these words do not adequately capture momentary experiences, under normal operating conditions. Such conditions would be accompanied by a relative absence of perceived high activation or deactivation, and hence the word astonished, may indeed reflect cognition as Clore et al. (1987) point out. However, if a participant experiences high activation at a given moment, they may require a label to describe that experience. In this instance of perceived high arousal, the word astonished has come to be labelled an emotion, and therefore becomes a necessary item for inclusion in a circumplex model of affect.

*Response scale formats*

The primary measurement tool in survey research is the self-report response scale. Among the various formats employed in the literature, Likert-type scales hold precedence. These formats provide an interval scale of measurement as their design is assumed to provide respondents with the means to make equal interval judgements (Mazaheri & Iran, 2011). The researcher, guided by theory, places numbers along the response scale to create the intervals, and then labels choice-points on the scale to
characterise the nature of the construct of interest. This response language explicitly signals to participants how a response scale should be interpreted. Whether or not participants’ interpretations are based on such explicit guidance, and whether Likert scales meet the assumption of an interval scale of measurement are contentious issues. These issues are addressed in the following sections, in specific relation to their confounding effects on component structure analyses.

Response language

Early studies (see Meddis, 1972; Russell, 1979) conducted in the affect literature expose the confounding effects of response language imposed by research design. One of these effects is the observed formation of bimodal distributions in the data, which is caused by imposing a mid-point label of ‘neutral’ or ‘cannot decide’ on the response scale. Bimodal distributions were found to distort correlation coefficients used to interpret the component structure of affect by shifting correlations in a positive direction, towards an artificial interpretation of structural independence.

Concomitantly, the observed formation of bimodal distributions in the data interferes with the interval nature of the response scale, and may even preclude ordinal data. For, as Russell (1979, p.346) points out, a ‘cannot decide’ label may elicit all manner of things other than a feeling of intensity somewhere between the neighbouring intervals. Furthermore, mid-point labels encourage ‘satisficing’ in response to scale items (Krosnick et al., 2002). This means that midpoints activate and promote lower level engagement with the task of filling out survey questionnaires. At the very least, this jeopardises the validity of the opinions expressed.

Other forms of response language designed to impose unipolarity and bipolarity on the data can also confound interpretations of component structure. The design of these formats involves the explicit labelling of the extreme end-points of the response scale.
**Bipolar response formats**

According to Russell and Carroll (1999, p.8-10), when a bipolar response format is employed, an item is conceptually and operationally defined as its full underlying continuum. Here is an example for the positive item ‘contented’.

In this example, research design explicitly specifies bipolar opposites with labels (affective antonyms) at the extreme ends of the scale. When tested on population samples, the scale aims to assign scores along the full underlying bipolar continuum. For instance, the item in the example represents its underlying dimension (pleasant-unpleasant) that extends continuously from the most extreme positive feeling, labelled contented, through to the most extreme negative feeling, labelled discontented, with the midpoint representing a complete lack of the feeling. This type of response format implies that adjacent scale items are separated by 180˚, and that their relationship to one another is linear.

However, the linear assumption that, changes in one affect predict the same changes in the opposite affect, is a main assumption of the Pearson product-moment correlation. Applied to a bipolar response scale, this assumption requires scores on contented items to be the inverse of scores on discontented items. Therefore, the theoretical (error-free) product-moment correlation between them should equal -1.00. Conceptually, however, it is not logical that someone with a complete lack of contentment (a score of 0) must be extremely discontented (a score of -5). Empirically, the assumption underlying the product-moment correlation, applied to a bipolar model, is also not supported.

Researchers testing the linear bipolarity principle (see Segura & Gonzalez-Roma, 2003) have utilised item response theory (IRT) methods to examine how individual participants respond to bipolar response formats. The results indicate that when a bipolar response format is employed, product-moment correlations between affective antonyms (bipolar opposites) vary between -.39 and -.70. These indices do
not approach scale redundancy, which is a pre-condition for the true nature of the bipolarity concept, according the assumption underlying the product-moment correlation.

Proponents of the bipolarity thesis (e.g. Russell & Carroll, 1999; Schimmack, 2001) attempt to address these conceptual and empirical issues. They clarify that the linear bipolarity principle assumed in the product-moment correlation is not a main assumption of a bipolar model. Rather, a main assumption of a bipolar model asserts that, changes in one affect often have no relation to changes in the opposite affect. For instance, a bipolar model predicts someone who feels 3 out of 10 contented does not feel discontented at the same time. That is, they have registered a complete absence of discontentment on the response scale (a score of 0). In the event that contentment increases to 7 out of 10, discontentment should still be absent (a score of 0) because content and discontent are mutually exclusive.

**Unipolar response formats**

According to the bipolarity thesis, with this conceptual distinction now clarified, an unbiased test of bipolarity requires two unipolar response formats, which conceptually and operationally define content and discontent as two parts of the underlying bipolar continuum, the median of which is zero (Russell & Carroll, 1999).

**Unipolar Response Format**

Do you feel content? YES NO (Circle one). If you circled YES, please indicate how much:
Russell and Carroll provide a rationale for this specific design, which they call a ‘strictly’ unipolar response format. The first part of the question, “Do you feel content (discontent)?” is designed to force a yes/no response, with a response of ‘NO’ assigned a score of zero. This forced response of ‘NO’ is thought to provide an unambiguous indicator of ‘a complete lack of’ contentment (or discontentment), which then leaves the ‘felt’ experience free to vary. Some doubts as to the validity of this reasoning, however, remain.

First, it is questionable whether it is possible to qualitatively experience a complete absence of a feeling. Second, it is a matter of opinion whether this question can eliminate ambiguity. A person can construe content in any number of ways (e.g. ‘ultimate contentment’; ‘content – more so than usual’). The point is, a ‘NO’ response could be registered and achieve a zero score while feeling 2 out of 10 contented. Also, four questions or steps are required to measure the underlying bipolar continuum. This type of design seems cumbersome and unnecessary. If a ‘NO’ response is meant to indicate ‘a lack of’, or ‘None’, then it would appear more parsimonious to create two questions that run from 0 (No contentment at all) to 6 (Extremely content). This still achieves Russell and Carroll’s (1999) stated outcome of explicitly defining content as a part of the whole underlying bipolar continuum, namely the part above zero, whereas discontent is defined as a part of the whole underlying bipolar continuum, namely the part below zero as follows:

```
<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Slightly)</td>
<td>(Extremely)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
```

Unipolar Response Format

1. Do you feel content? YES  NO (Circle one). If you circled YES, please indicate how much:

   - 1: Slightly
   - 2: 3: 4: 5: 6: Extremely

2. Do you feel discontent? YES  NO (Circle one). If you circled YES, please indicate how much:

   - 1: Slightly
   - 2: 3: 4: 5: 6: Extremely
There are further operational implications for persisting with Russell and Carroll’s (1999) logic concerning their specific design of a ‘strictly’ unipolar response format. For instance, their understanding of mutual exclusivity is reflected in a strictly unipolar format. This fixes one of two parts (i.e., content or discontent) of an underlying bipolar continuum to a value of zero. This restriction of one half of the continuum prevents an interval scale of measurement for the whole underlying bipolar continuum. Data collected for the two unipolar parts (e.g. measures of content and discontent items) are now ordinal measures of the underlying affect structure. This poses a violation of an assumption of the bipolarity thesis, that the underlying bipolar continuum must be theoretically (error-free), normally distributed. To avoid such a violation, the transformation of interval measures to ordinal measures through research design requires the use of polychoric correlations, and not product-moment correlations, for inferring structural interdependence (bipolarity) in correlational analyses of component structure.

According to Russell and Carroll (1999), researchers commonly and erroneously employ the product-moment correlation, for interpreting structural interdependence (bipolarity), in component structure analyses. As a result, when combining the scores from two ‘strictly’ unipolar response scales (content, discontent), the theoretic product-moment correlation when one of each correlational pair is zero will equate to -.467. It is therefore both the misuse of statistical indices and the specific design of response formats that contribute to reported negative (product-moment correlations) as low as -.40s.

Revisiting the work of Segura and Gonzalez-Roma (2003), they utilised item-response theory (IRT) methods to investigate how participants actually respond to the differential use of unipolar and bipolar response formats. Their findings reveal imposing assumptions on response scale design to be unnecessary. Specifically, they
tested Russell and Carroll’s (1999) principle that correlations between affective antonyms vary between -0.467 and -1.00, depending on the differential use of unipolar or bipolar response design formats. They employed the graded response model (Samejima, 1997), which is a parametric IRT model for polytomous items. This analysis is able to psychometrically pinpoint the response location along the underlying continuum. Their results indicated that the design of the response format did not influence the magnitude of the correlation. Instead, respondent’s construal of the scales favoured a bipolar response regardless of the scale design.

This implicit bipolar response tendency was initially interpreted by the researchers as a type of Western cultural response bias based on interpretations of studies investigating the component structure of the more general constructs of positive affect and negative affect (see Bagozzi, Wong, & Yi, 1999; Schimmack, Oishi, & Diener, 2002; Yik, 2007). These studies suggest that Western cultures tend to report about their affective experiences in oppositional terms (happy/sad, love/hate, and so on). This is because the individual experience of affect in Western thought is used to differentiate oneself from others, to categorise people, and to explain one’s own actions and the actions of others. In contrast, Confucian thought does not use affect to polarise the self from external objects or events (Bagozzi et al.). Instead, individual affective experiences are synchronised to a value system with a normative imperative for balance and harmony. This leads to a representation of positive affect and negative affect in Confucian thought as simultaneous (independent).

However, a closer inspection of the results of the IRT analysis conducted by Segura and Gonzalez-Roma (2003) revealed that respondents’ implicit bipolar construal of response scales did not guarantee stronger negative correlations indicative of structural interdependence (bipolarity). Instead, the more polarisation present in the population sample, that is, the greater number of participants feeling extremely content or extremely discontent, the more negative the resulting correlation. Extreme responses had the effect of increasing the number of respondents endorsing an item and rejecting its opposite. As an example, on a 0 to 10-point scale, someone who reported feeling extremely content (a score of 10) was more likely to register a score of zero on the opposite item discontent. This polarised
response pattern produced an additional effect of reducing the proportion of respondents rejecting (failing to endorse) both items (affective antonyms). Statistically, polarised response patterns produced more linear-shaped distributions and stronger negative correlations. As an average indication of the degree of polarisation in their population samples, approximately 15% of participants reported extreme responses for positive items. Approximately 5% reported extreme responses for negative items.

In summary, different response design formats reflect epistemological assumptions about how individuals experience affect. It appears from results conducted with IRT methods however that, participants’ interpretations of response scales are not influenced by formats (e.g. unipolar or bipolar) reflecting these assumptions. Instead, respondents implicitly construe response scales in favour of a bipolar response. Moreover, the more polarised the response (extremely happy/no sadness), the more linear is the relationship between affective antonyms, and hence stronger negative correlations are observed. It was also shown that certain response design formats (i.e., ‘strictly’ unipolar formats) could alter an interval scale of measurement. This carries further implications for choosing appropriate statistics for subsequent inferential analyses of component structure.

Relating these findings to examining circumplex structure, it is concluded that research design must consider, first and foremost, that a test of circumplexity includes a test of bipolarity. Therefore, it is imperative that the observed variables used to establish a circumplex model of affect are measured on unipolar response scales so as to maintain the logic of mutual exclusivity, albeit not the ‘strict’ logic imposed by Russell and Carroll (1999) in their design. The previously suggested design of a unipolar response scale where zero indicates “NO contentment at all”, and 10, indicates “Extremely contented” will be adhered to in the upcoming studies of this thesis. Whilst studies in this review of response scale formats suggest that no amount of rigor in design can control for the possibility of implicit response tendencies, the researcher must identify and control, a priori, those study characteristics that serve as potential sources of measurement error. This is crucial given the CSPMF (i.e., the CIRCUM procedure) (Browne, 1992) cannot separate sources of systematic error from common score variance.
Therefore, based on all literature reviewed in section 1.3.5, of potential confounders in circumplex analyses, research design in the upcoming studies to establish an affective circumplex structure will include the following study characteristics to demonstrate rigor in design:

1. Unipolar response scale formats labelled 0 (No contentment at all) to 10 (Extremely contented), with no midpoint labels.

2. Self-report ratings involving longer (i.e., trait judgements) versus shorter time frames (i.e., momentary judgements).

3. Ratings involving felt intensity of affective experience.

4. A model established with single-item measures.

5. Sampling of affective states from all regions of geometric space.

6. A consideration of the literature to include affect-focal terms.
1.4. OVERVIEW OF AIMS AND HYPOTHESES

A primary aim of this thesis is to improve upon research designs within the context of SWB Homeostasis theory to investigate the affective core of subjective wellbeing (SWB), called Homeostatically Protected Mood (HPMood). Based on the present review of the literature, it is proposed that, a more valid way to describe HPMood is to examine the degree to which an external variable, theorised to be dominated by HPMood, relates to a circumplex structure of core affect. To re-iterate, an external variable is one not used to define a previously established core affective structure. In accordance with the theoretical model of SWB Homeostasis (Cummins, 2010; Cummins et al., 2012; Davern et al., 2007; Lai & Cummins, 2013), variables dominated by HPMood are SWB and major correlates of SWB such as extraversion, optimism, self-esteem, and perceived control. By relating these external variables to the circumplex, it is possible to locate the specific blend of Hedonic Valence and Arousal accompanying responses to these variables, and to examine the degree to which these variables are affective in nature. It is this specific kind of core affect that will identify HPMood, as a core affective construct, on the circumplex.

The methodological approach employed to pinpoint HPMood on the circumplex, and examine HPMood’s magnitude of association with variables like SWB, is discussed as the Cosine Wave Method (Yik, 2009; Yik et al., 2011). This methodology is an extension of the CIRCUM procedure (Browne, 1992) employed by Davern et al. (2007). The Cosine Wave Method is able to address important limitations in research design and methodology currently employed by researchers working within the theory of SWB Homeostasis, with specific regard to the construct validity of HPMood.

With this improvement in research design and methodology this thesis proceeds to testing two central aspects of SWB Homeostasis theory. According to theory (Cummins, 2010, 2012), HPMood is conceptualised as a pleasant and mildly activated ‘core’ state of affect that is always present and providing a background sense of SWB. However, it has been shown that no study has empirically validated HPMood with a structural model that best describes its specific blend of Hedonic Valence and Arousal. This thesis addresses this gap by validating the theoretical nature of HPMood on the circumplex. The second aspect to be tested concerns
empirical findings with linear models (Blore et al., 2011; Davern et al., 2007; Lai & Cummins, 2013; Tomyn & Cummins, 2011), that a small composite of affects (e.g. happy, content, excited/alert/active) dominates the content of SWB and major correlates of SWB such as self-esteem, optimism, perceived control and extraversion. This thesis tests the magnitude of association between HPMood and variables in the Homeostatic Model of SWB, on the circumplex.

Testing will begin with re-examining an affective circumplex structure within the context of SWB Homeostasis theory (Cummins, 2010; Cummins et al., 2012) in a CIRCUM analysis (Browne, 1992). Davern’s (2004; Davern et al., 2007) original research design will be extended to incorporate Yik’s (2009; Yik et al., 2011) methodology and procedural approach for conducting circumplex analyses. The intention is to improve upon Davern’s original results, and to distinguish between an entire structure of core affect, and the specific form of core affect (HPMood) that accompanies responses to SWB and its major correlates. Therefore, the suggestion that the specific design of the test question, to elicit feelings about life in general, produces an entire circumplex structure of HPMood is not assumed herein. Instead, it is proposed that the in general nature of the test question is not assumed herein. Instead, it is proposed that the in general nature of the test question will produce a circumplex structure of core affect from trait responses. The established structure will then be used as a measurement map, in a cosine wave analysis (Yik, 2009; Yik et al., 2011), to test the two central aspects of SWB Homeostasis theory.

1. Verifying the nature of HPMood

Traditionally, researchers working within the theory of SWB Homeostasis (Blore et al., 2011; Davern et al., 2007; Lai & Cummins, 2013; Tomyn & Cummins, 2011) refer to the affective circumplex to inform the item selection process in linear multiple regression analysis, to determine HPMood’s character. By simultaneously regressing multiple independent affect items onto the single-item dependent measure of SWB (i.e., General Life Satisfaction (GLS)), these studies examine which affects significantly and uniquely predict scores on GLS. The rationale for this methodological approach is that the abstract and personal nature of the GLS question, “How satisfied are you with your life as a whole?” captures the essence, or affective ‘core’ of SWB. Thus, responses to this single-item measure will be dominated by HPMood (Cummins, 2010).
While the use of a linear model to verify a non-linear state of core affect underlying responses to SWB undermines Cummins’ (Cummins, 2010, 2012) theorising about HPMood’s character, these findings consistently show that only certain kinds of affects (e.g. content, happy, satisfied, active, energised, stressed) predict GLS, which is considered a proxy for the set-point HPMood. This alludes to the shared existence among these lay terms of a specific blend of Hedonic Valence and Arousal. Therefore, based on these findings, it will be hypothesised that, the specific type of core affect located on the circumplex by GLS will support Cummins’ theoretical definition of HPMood as a ‘pleasant and mildly activated’ ‘core’ state of affect.

2. HPMood’s magnitude of association with SWB and its major correlates

The second aspect of SWB Homeostasis theory to be tested concerns a growing body of evidence derived from linear methods (Blore et al., 2011; Davern et al., 2007; Lai & Cummins, 2013; Tomyn & Cummins, 2011), to suggest that a small composite of affects dominates the content of SWB, and major correlates of SWB such as self-esteem, optimism, perceived control, and extraversion. In these study designs, HPMood is presumed to be best operationalised as happy, content, alert/excited/active. The HPMood composite variable is then treated as a mediator (Lai & Cummins, 2013), or determinant (Blore et al., 2011; Davern et al., 2007; Tomyn & Cummins, 2011), in linear structural modeling to test the assumption that HPMood explains or drives the relationship between SWB its and major correlates.

The findings of these studies indicate that much of the shared variance between SWB measures, and related variables, is accounted for by the HPMood composite, with SWB measures (GLS and PWI) most dominated by affect. These findings have led to the interpretation that SWB is mostly affective in nature, and that SWB and its major correlates are perfused with a similar form of core affect theorised as mildly pleasant and activated. An additional aim is to test these assumptions of linears findings, on the circumplex. It will be hypothesised that, the specific type of core affect located on the circumplex by any one of the externally listed variables in the investigation (e.g. SWB, GLS, self-esteem, optimism, perceived control, and extraversion), will elucidate where HPMood resides within the circumplex. It will also be hypothesised that a substantial association between a
circumplex structure of core affect and all of the listed external variables will be
evidenced, with the strongest magnitude of association evidenced by SWB measures.

The final aim of the investigation is based on the assertion that the level of
SWB is normally maintained within a restricted range (Cummins, 2010; Cummins et
al., 2014). Therefore, it is argued, HPmood as the affective core of SWB is regulated
for constancy by homeostatic mechanisms. The implication of this for construct
validation is that HPmood must demonstrate a constant structure. Therefore, the
reliability of HPmood’s character, and its magnitude of association with SWB and its
major correlates, will be tested with replication on the circumplex.

Methodology

The entire investigation will be conducted across four studies. Two studies
will test the circumplexity of affective data using the Circular Stochastic Process
Model with a Fourier Series (CSPMF), commonly known as CIRCUM (Browne,
1992). These studies will be labelled Study 1 Part A and Study 2 Part A. An
additional two studies will utilise each established model of core affect to investigate
the psychological nature of HPmood, and its magnitude of association with SWB
and its major correlates, on the circumplex. These studies will be labelled Study 1
Part B and Study 2 Part B.
CHAPTER 2:
STUDY 1: PART A

RE-EXAMINING A CIRCUMPLEX MODEL OF AFFECT WITHIN THE CONTEXT OF SWB HOMEOSTASIS THEORY

AIMS AND PREDICTIONS

Building on the theory of SWB Homeostasis, the first study aims to re-examine the component structure of affect, the circular way, using the CIRCUM procedure. Not since the work of Davern (2004; Davern et al., 2007) has the theoretical model and statistical tool designed to measure circumplexity been used to map a core affective structure within the theory of SWB Homeostasis. Davern’s methodological approach will be replicated and extended in the following ways:

1. Preliminary statistical analyses will explore the component structure of affect in relation to the circumplex using principal components analysis. Davern’s methodology will be extended to adhere to Yik’s (2009; Yik et al., 2001) methodology concerning preliminary tests of circumplex structure. Whereas Davern’s analysis sought a solution interpreted as four independent parts of the two bipolar dimensions in Hedonic Valence and Arousal, Yik anticipates a solution interpreted as two interdependent parts of the two bipolar dimensions in Hedonic Valence and Arousal. From here, Yik generates a factor plot for the two bipolar dimensions and examines the pattern of interrelatedness among the response items for circularity. Yik’s rationale is to utilise the results of PCA as a measure of convergent validity for later confirmatory structural analyses using the CIRCUM procedure.

2. A further preliminary analysis will examine the internal consistency of the affect items chosen, in the current study, to theoretically represent eight segments of an affective circumplex. Based on the reliability of the composite scales, an 8-point circumplex structure will be tested using the CIRCUM procedure.
3. In addition, Davern’s (2004; Davern et al., 2007) methodology will be replicated in order to re-examine a circumplex model of affect from single-item measures. The results of the preliminary analyses along with confirmatory results of the CIRCUM analyses will then be presented. Yik’s procedural approach for conducting circumplex analyses will be followed in all CIRCUM analyses. This approach was outlined in section 1.3.2 of the literature review. The author of the current thesis was privileged to learn this technique from Professor Yik on a study exchange to the Hong Kong University of Science and Technology, in July 2012.

2.1. METHOD

**General Overview of the Australian Unity Wellbeing Index**

The Australian Unity Wellbeing Index measures how satisfied people feel about their own life and life in Australia. The index is applied twice each year via a telephone survey of 2,000 people aged 18 years or over. This cross-sectional project was established in 2001. As of July 2014, 30 surveys had been conducted; each one involving a new sample generated through the use of random telephone numbers within defined geographic regions. These regions include urban and rural areas, with the majority of participants residing in major capital cities. The number of people sampled within each region is proportional to that region’s contribution to the national population. Hence, each new sample is considered representative of the Australian population. At the end of their interview, participants are asked whether they would like to join the associated written survey to identify the beliefs that maintain wellbeing. It is this project, which supplies all data for this PhD thesis. While names, telephone numbers and addresses are obtained from those participants who wish to participate, these identifiers remain confidential and unavailable to the researchers. A unique numerical identifier is used to code each participant. In this way, the data from the initial telephone interview and subsequent mailed surveys are matched to individual participants. It must be noted that this data source is not longitudinal as its title suggests, but rather a source of rolling cohorts. This means that individuals who agree to participate in subsequent waves of the written surveys are not required to respond consecutively. Due to the time constraints of producing
this thesis, and the need to ensure the power of any one specific test, this data source was utilised cross-sectionally.

Creation of a Circumplex Model of Affect

In Study 1 Part A, participants completed a questionnaire asking them to indicate how each of 24 affect items described their feelings when they thought about their life, in general. The overall aim was to integrate participants’ responses to these measures into one structure to create a measurement map of affective feelings on the circumplex.

Participants

Participants were 978 adults (455 men and 523 women), with an age range between 21 and 96 years (\(M = 59.9\) years, \(SD = 14.6\)), who took part in the Australian Unity Wellbeing Index Longitudinal Project labelled as ARC21, with data collected over the period June to September 2011.

Procedure

Ethics approval was obtained from the Deakin University Human Research Ethics Committee (DU-HREC). An external mail-house distributed questionnaire packs to both new recruits and to those who had participated in previous waves of data collection. The packs included introductory letters and plain language statements along with the written survey. Participants’ ability to provide informed consent, their right to confidentiality, and the storage and ownership of data were provided in the information packs. In total, 4,015 questionnaires were mailed to previous participants and the first 978 questionnaires returned formed the current sample. These participants comprise approximately 25% new participants recruited from telephone Survey 21 (June, 2011), the remainder comprising continuing participants from previous waves of the written surveys.

Measures

Twenty-four affect terms were chosen to theoretically represent eight 45° segments of a circumplex model of affect shown in Figure 16.
Figure 16: Twenty-four affect terms chosen to represent a circumplex model of affect. Eight segments, or vectors 45° apart inside the circle, indicate theoretical locations of the chosen affect measures.

The total number of affects ($N = 24$) was restricted by the amount of space allocated to this study on the survey questionnaire. The specific instructions for the affect items were “please indicate how each of the following describes your feelings when you think about your life, in general”. This instruction preceded the list of affect terms and was designed to replicate Davern’s (2004; Davern et al., 2007) research methodology, which was outlined in section 1.2.2 of the literature review. Respondents rated their level of intensity in respect of each item using a unipolar response scale of (0) “not at all” to (10) “extremely”.

The item selection process was informed by previously reviewed studies that distinguish between affective and non-affective terms commonly employed in the affect literature (e.g. Clore et al., 1987; Ortony et al., 1987), investigations of the influence of the affects sampled in circumplex analyses (e.g. Remington et al., 2000; Russell & Barrett, 1998), and studies examining affect terms that capture the dimensions of dispositional mood (see Huelsman et al., 1998). The order of presentation of affect items in the questionnaire was systematic and replicated Davern’s (2004) methodological approach. Using the analogy of the clock and progressing in a clockwise direction from 12 o’clock (the opposite direction to theoretical locations), one affect term was chosen from each octant. Three
revolutions of the clock were made to complete the ordering of items in the questionnaire.

**Preliminary data cleaning**

All study variables had missing data, three of which had more than 5% missing values; *active*, *aroused*, and *still* had 5.3%, 5.8%, and 5.3% missing, respectively. A missing data analysis revealed the data were not missing completely at random $\chi^2 (2452, n = 979) = 2879.63, p < .05$. Results of the separate variance $t$ test revealed the pattern of missing data was significantly related to the participants’ age (*active* $t(57) = -4.2, p = .000$, *aroused* $t(66) = -7.7, p = .000$, and *still* $t(60) = -7.6, p = .000$). In addition to age, the affect measures of *satisfied* $t(39) = -3.3, p = .00$ and *pleased* $t(40) = -2.8, p = .01$ were significantly related to the pattern of missing data for *aroused* while the affect measures of *distressed* $t(30) = 2.2, p = .04$, *upset* $t(29) = 3.6, p = .00$, *miserable* $t(25) = 2.7, p = .01$, and *contented* $t(41) =-2.9, p = .01$ were significantly related to the pattern of missing data for *still*.

To address the statistical issue of missing data, study variables with more than 5% missing values were replaced with regression replacement (Tabachnick & Fidell, 2007), while variables with less than 5% missing data were dealt with by means of listwise deletion. The decision to deal with the majority of missing data by means of listwise deletion was afforded by a large sample size that allowed retention of the original response pattern of the sample without jeopardising the power of any one specific test due to a reduction in $N$.

However, this decision was ultimately governed by an observation made by Remington et al (2000) in their assessment of measurement issues related to the CIRCUM procedure (Browne, 1992). CIRCUM will be utilised in the current analysis to model a circumplex structure of affect. Of the 47 correlation matrices Remington et al. re-examined for circumplex structure, the only correlation matrix they were unable to fit to a circumplex model was based on pairwise (rather than listwise) deletion of missing data. Pairwise deletion can present problems for fitting covariance structure models such as the CIRCUM procedure to data because pairwise deletion uses whatever data is at hand. This can result in the formation of an ‘impossible’ intercorrelation matrix (Howell, 2007), or intercorrelations that are
inconsistent. Given that all solutions follow directly from a completed intercorrelation matrix, results based on these inconsistent matrices become unstable.

Data were examined for univariate outliers by z-score and multivariate outliers by Mahalanobis distance. Numerous outliers were detected. In the case of univariate outliers, an inspection of trimmed mean values using the Explore option in SPSS (IBM Corp., 2013) revealed negligible discrepancy between means and trimmed means for most variables. However, there was an increase of up to two points difference for the variable happy. A further inspection of the tails of the histogram and the boxplot revealed six participants who reported extremely (low) scores for this variable. Extreme points on the boxplots (indicated by an asterisk *) are those that extend more than three box-lengths from the edge of the box, in which 50% of cases are located (Pallant, 2007). These univariate outliers were re-assigned a value one unit lower than the next extreme (low) score in the distribution (Tabachnick & Fidell, 2007).

In the case of multivariate outliers, an inspection of the Mahalanobis distances revealed 6.5% of scores \(n = 51\) exceeded the critical chi-square value for extreme scores on two or more variables. However, to determine whether multivariate outliers may have potentially influenced the results, the Cook’s distance index was also inspected. The value of .047 indicated no major problems since it falls well below the critical value (of greater than 1) (Tabachnick & Fidell, 2007), for consideration of the removal of participants from the data set. Preliminary data screening reduced the sample size to 790 participants (366 men and 424 women), with an age range between 21 and 90 years \(M = 58.6\) years, \(SD = 14.5\), and did not alter the original composition of the sample.

Statistical analyses

In accordance with the theory of SWB Homeostasis, all affect data were transformed onto a 0-100 scale by shifting the decimal point one step to the right. For example, a response of 5.0 on the 0-10 scale became 50 points.

Data transformation via ‘ipsatisation’

There appears to be agreement among researchers that ‘ipsatising’ raw scores, increases the sensitivity of psychometric criteria used in the assessment of
circumplex structure (see Acton & Revelle, 2004; Di Blas, 2007; Yik & Russell, 2003; Yik, 2009; Yik et al., 2011). According to these authors, manipulating raw scores through ipsatisation removes non-substantive individual differences in grand means and variances. This non-substantive ‘general factor’ attracts positive loadings from all items, and is commonly referred to as ‘acquiescence’. Acquiescence is a tendency to respond in a positive way regardless of the test question’s meaning, and its existence in affective ratings has long been discussed (Bentler, 1969).

To ipsatise a score for the ‘happy’ item, for instance, an individual’s grand mean must be, first, calculated from all affect items. The grand mean is then deducted from the individual’s ‘happy’ rating; the difference is then divided by the standard deviation of all affect ratings for the same individual. It is argued that transforming the data in anticipation of the existence of a general factor is a justifiable practice. For if a general factor does exist, ipsatisation improves the effectiveness of psychometric criteria used in detecting circumplexity; if one does not, ipsatisation has little effect (Acton & Revelle, 2004; Di Blas, 2007; M. Yik, personal communication, July 7th, 2012).

In the following exploratory analysis each affect item was ipsatised in order to follow Yik’s methodological approach for conducting preliminary analyses of circumplex structure. However, in order to observe the stated effect of ipsatisation on the data, principal components analysis will be conducted with both ipsatised and non-ipsatised scores, and the results compared.

Principal Components Analysis (PCA)

A principal components analysis was conducted to examine the distribution of 23 of the 24 affect items on the circumference of an imaginary circle drawn around a two-component space. The affect item ‘satisfied’ was excluded from this investigation of circumplex structure due to its similarity with SWB measures, which use the term ‘satisfaction’ in scale construction. In the next study, SWB measures will be mapped onto this circumplex structure in order to examine the relationship between SWB and a structure of core affect.

This exploratory analysis follows Yik’s methodological approach for conducting preliminary analyses of circumplex structure (M. Yik, personal
communication, July 7th, 2012). The aim of the analysis is to reduce scores obtained from the 23 single-item measures to scores on a small set of linear composite variables, or principal components, whilst retaining as much information from the original variables as possible (Fabrigar, Wegener, MacCallum, & Strahan, 1999). As a result, the variance accounted for in a principal components solution will contain both common score variance and unique score variance. Common score variance refers to the portion of variation in participants’ responses that is shared between two or more of the measured variables, and unique score variance refers to the variation in responses that is unique to a single variable (Fabrigar et al., 1997; Remington et al., 2000).

However, an important assumption of principal components analysis is that little unique score variance is present in the measured variables (Fabrigar et al., 1999). This assumption unites principal components analysis with the most basic assumption of a circumplex analysis; that a circumplex will not form if unique score variance is present (Acton & Revelle, 2004). Key assumptions of the CIRCUM procedure were presented in Section 1.3.1 of the literature review. To briefly re-iterate, common score variance is a true score of circumplexity. Circumplexes will not hold for unique score variance because uniqueness signifies a difference in the level of complexity in the underlying structure.

Instead, circumplex structures form when variables of equal complexity differ from each other in the content they convey (Di Blas, 2007). In other words, a structure where the measured variables are equally complex indicates a structure where different kinds of measured variables are influenced to the same degree by the same latent dimensions. In specific relation to an affective circumplex, the latent dimensions exerting influence over different kinds of affective states are Hedonic Valence and Arousal. Conversely, uniqueness, or difference in the level of complexity, alludes to the existence of latent dimensions that exert influence on only one of the measured variables in a battery (Fabrigar et al., 1999).

Therefore, principal components analysis will be used for data reduction. Two-components are anticipated from the solution, interpreted as the bipolar dimensions of Hedonic Valence and Arousal. Once revealed, a component plot will be generated for these two dimensions in order to examine the pattern of
interrelatedness among the measured variables for circumplexity. This is achieved by estimating the angular position for each item using its loadings on the two components. The results of the principal components analysis will be used as a measure of convergent validity for later confirmatory structural analyses using the CIRCUM procedure.

2.2. RESULTS: EXPLORATORY ANALYSES

Results of the Principal Components Analysis with non-ipsatised scores

Using the 23 non-ipsatised affects as data, the single-item measures were intercorrelated, and subjected to principal components analysis. The Kaiser-Meyer-Olkin value was .928, exceeding the recommended values of .6 (Kaiser, 1970, 1974) and Bartlett’s Test of Sphericity (Bartlett, 1954) reached statistical significance, supporting the factorability of the correlation matrix. Principal components analysis revealed the presence of four components with eigenvalues exceeding 1, accounting for 43.7%, 13.3%, 7.3%, and 4.4% respectively.

However, the results of Parallel Analysis (Horn, 1965), which involves comparing the size of the eigenvalues with those obtained from a randomly generated data matrix of the same size (23 variables × 790 respondents) indicated that only the first three eigenvalues obtained in the principal components analysis exceeded the values of the randomly generated results presented in Table 5 below.

Table 5:
Total variance explained, initial eigenvalues, and eigenvalues generated from Parallel Analysis.

<table>
<thead>
<tr>
<th>Initial Eigenvalues</th>
<th>% of Variance accounted for</th>
<th>Cumulative %</th>
<th>Eigenvalues generated from Parallel Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.061</td>
<td>43.74</td>
<td>43.74</td>
<td>1.318</td>
</tr>
<tr>
<td>3.055</td>
<td>13.28</td>
<td>57.03</td>
<td>1.267</td>
</tr>
<tr>
<td>1.683</td>
<td>7.32</td>
<td>64.35</td>
<td>1.230</td>
</tr>
<tr>
<td>1.015</td>
<td>4.41</td>
<td>68.76</td>
<td>1.198</td>
</tr>
</tbody>
</table>

Based on these results, it was decided to retain the three-components for further investigation. The three-component solution accounts for a total of 64.3% of
the variance, with component one (C1) contributing 43.74%, component two (C2) 13.28%, and component three (C3) 7.32%. Interpretation is based on an unrotated solution to be in line with Yik’s methodological approach for conducting preliminary analyses of circumplexity. The criterion for determining a loading on a component is set at .4. Table 6 below, shows the unrotated loadings of each of the items on the three components along with the communalities. Communalities are the amount of variance accounted for in each item by the three-component solution. Communalities less than .3 are of no utility as they indicate that the particular item does not fit well with the other items on its component (Pallant, 2007). As can be seen from Table 6, all of the communalities exceed .3.

Table 6:

*PCA with a forced three-component, unrotated solution of non-ipsatised affect items interpreted as hedonic valence and arousal in accordance with the circumplex model of affect.*

<table>
<thead>
<tr>
<th>Affect Measure (Theoretical Angle)</th>
<th>Component Matrix</th>
<th>Communalities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C1</td>
<td>C2</td>
</tr>
<tr>
<td>Pleased (P: 0°)</td>
<td>.830</td>
<td>.272</td>
</tr>
<tr>
<td>Happy (P: 0°)</td>
<td>.827</td>
<td>.285</td>
</tr>
<tr>
<td>Contented (P: 0°)</td>
<td>.829</td>
<td>.202</td>
</tr>
<tr>
<td>Excited (PA: 45°)</td>
<td>.644</td>
<td>.436</td>
</tr>
<tr>
<td>Alert (PA: 45°)</td>
<td>.660</td>
<td>.288</td>
</tr>
<tr>
<td>Lively (PA: 45°)</td>
<td>.696</td>
<td>.406</td>
</tr>
<tr>
<td>Aroused (A: 90°)</td>
<td>.396</td>
<td>.533</td>
</tr>
<tr>
<td>Active (A: 90°)</td>
<td>.606</td>
<td>.268</td>
</tr>
<tr>
<td>Energised (A: 90°)</td>
<td>.749</td>
<td>.392</td>
</tr>
<tr>
<td>Upset (UA: 135°)</td>
<td>-.750</td>
<td>.346</td>
</tr>
<tr>
<td>Distressed (UA: 135°)</td>
<td>-.763</td>
<td>.373</td>
</tr>
<tr>
<td>Annoyed (UA: 135°)</td>
<td>-.701</td>
<td>.366</td>
</tr>
<tr>
<td>Irritable (U: 180°)</td>
<td>-.729</td>
<td>.370</td>
</tr>
<tr>
<td>Miserable (U: 180°)</td>
<td>-.773</td>
<td>.311</td>
</tr>
<tr>
<td>Sad (U: 180°)</td>
<td>-.747</td>
<td>.267</td>
</tr>
<tr>
<td>Bored (UD: 225°)</td>
<td>-.621</td>
<td>.356</td>
</tr>
<tr>
<td>Affect Measure (Theoretical Angle)</td>
<td>Component Matrix</td>
<td>Communalities</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>------------------</td>
<td>---------------</td>
</tr>
<tr>
<td></td>
<td>C1</td>
<td>C2</td>
</tr>
<tr>
<td>Sluggish (UD: 225°)</td>
<td>-.621</td>
<td>.426</td>
</tr>
<tr>
<td>Tired (UD: 225°)</td>
<td>-.585</td>
<td>.394</td>
</tr>
<tr>
<td>Sleepy (D: 270°)</td>
<td>-.361</td>
<td>.515</td>
</tr>
<tr>
<td>Still (D: 270°)</td>
<td>-.003</td>
<td>.477</td>
</tr>
<tr>
<td>Quiet (D: 270°)</td>
<td>.136</td>
<td>.403</td>
</tr>
<tr>
<td>Calm (PD: 315°)</td>
<td>.667</td>
<td>.209</td>
</tr>
<tr>
<td>Relaxed (PD: 315°)</td>
<td>.743</td>
<td>.230</td>
</tr>
<tr>
<td>Satisfied( PD: 315°)</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Note: ‘The affect measure of satisfied was excluded from exploratory and confirmatory analyses of circumspecty due to its similarity with SWB measures, which use the term satisfaction in scale construction. In part 2 of study 1, SWB measures will be mapped onto this circumplex structure in order to examine the affect-SWB relationship. P: Pleasant; PA: Pleasant-Activated; A: Activated; UA: Unpleasant-Activated; U: Unpleasant; UD: Unpleasant-Deactivated; D: Deactivated; PD: Pleasant Deactivated. N = 790.

Component one (C1) is interpreted as the bipolar dimension of *Hedonic Valence*. Positive and negative signs indicate a range of pleasant states at one end of the dimensional continuum to unpleasant states at the other end. In addition, affects representing the deactivated end of the *Arousal* dimension (*still, quiet, sleepy*) failed to load on C1 due to these items’ predicted orthogonality with the valence dimension. However, only one of the purely activated states (*aroused*) demonstrated orthogonality.

Component two (C2) appears to represent *Acquiescence*, or what was previously defined as a tendency to respond in a positive way, regardless of the test question’s meaning (Bentler, 1969). Classical test theory defines this acquiescent component of a test score as *systematic variance*, and assumes that, participants’ desire to distort responses in a positive direction is associated with all item measures in the analysis (Ziegler & Buehner, 2009). ‘Acquiescence’ is also considered to be a *non-substantive* rather than a *substantive* form of systematic variance (Acton & Revelle, 2004; Di Blas, 2007; Yik, 2009). In other words, ‘acquiescence’ is a *style* of responding that is unique to a particular sample population, rather than a *trait* property of the item measures. In factor analytic studies, systematic variance such as ‘acquiescence’ appears as a ‘general factor’, which attracts positive loadings from all items.
As can be seen in Table 6, all 23 items, regardless of item content, attracted positive loadings on C2. However, only seven items attracted loadings of .4 or higher. Given the current analysis is based on non-ipsative scores, it is tentatively assumed for now that acquiescent response bias largely accounts for this systematic variance, and is differentially associated with item content.

Component three (C3) appears not to account for an Arousal dimension in test scores. Conceptually, positive and negative signs should indicate activated and deactivated states respectively. This was not obtained in the solution. Statistically, C3 does not meet the criterion of three items to form a factor. Therefore, it is not possible to interpret a structure of affect according to the circumplex from non-ipsative scores. A principal components analysis will now be conducted, with ipsative scores.

Results of the Principal Components Analysis with ipsatised scores

Using the 23 ipsatised affects as data, principal components analysis revealed the presence of three components with eigenvalues exceeding 1, accounting for 37.8%, 18.2%, and 6.2% respectively. This was further supported by the results of Parallel Analysis presented in Table 7. All three eigenvalues obtained with ipsative scores exceeded the values of the randomly generated results.

Table 7:
Total variance explained, initial eigenvalues, and eigenvalues generated from Parallel Analysis and based on ipsatised data.

<table>
<thead>
<tr>
<th>Initial Eigenvalues</th>
<th>% of Variance Accounted for</th>
<th>Cumulative %</th>
<th>Eigenvalues generated from Parallel Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.682</td>
<td>37.75</td>
<td>37.75</td>
<td>1.318</td>
</tr>
<tr>
<td>4.174</td>
<td>18.15</td>
<td>55.90</td>
<td>1.267</td>
</tr>
<tr>
<td>1.430</td>
<td>6.22</td>
<td>62.12</td>
<td>1.230</td>
</tr>
</tbody>
</table>

Comparing the results of both analyses, the three-component, ipsatised solution has accounted for a total of 62.1% of the variance. This is 2.23% less variance than the total variance accounted for in the non-ipsatised solution (64.4%). Table 8 below, shows the unrotated loadings of each of the ipsatised items on the three components along with the communalities.
Table 8:

PCA with an unrotated component solution of ipsatised affect items interpreted as Hedonic Valence (C1) and Arousal (C3) in accordance with a Circumplex Model of Affect.

<table>
<thead>
<tr>
<th>Affect Measure (Theoretical Angle)</th>
<th>Component Matrix</th>
<th>Communalities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C1</td>
<td>C2</td>
</tr>
<tr>
<td>Pleased (P: 0°)</td>
<td>.772</td>
<td>.288</td>
</tr>
<tr>
<td>Happy (P: 0°)</td>
<td>.743</td>
<td>.302</td>
</tr>
<tr>
<td>Contented (P: 0°)</td>
<td>.729</td>
<td>.178</td>
</tr>
<tr>
<td>Excited (PA: 45°)</td>
<td>.627</td>
<td>.481</td>
</tr>
<tr>
<td>Alert (PA: 45°)</td>
<td>.598</td>
<td>.362</td>
</tr>
<tr>
<td>Lively (PA: 45°)</td>
<td>.696</td>
<td>.455</td>
</tr>
<tr>
<td>Aroused (A: 90°)</td>
<td>.404</td>
<td>.505</td>
</tr>
<tr>
<td>Active (A: 90°)</td>
<td>.551</td>
<td>.359</td>
</tr>
<tr>
<td>Energised (A: 90°)</td>
<td>.718</td>
<td>.464</td>
</tr>
<tr>
<td>Upset (UA: 135°)</td>
<td>-.700</td>
<td>.454</td>
</tr>
<tr>
<td>Distressed (UA: 135°)</td>
<td>-.710</td>
<td>.463</td>
</tr>
<tr>
<td>Annoyed (UA: 135°)</td>
<td>-.642</td>
<td>.470</td>
</tr>
<tr>
<td>Irritable (U: 180°)</td>
<td>-.693</td>
<td>.422</td>
</tr>
<tr>
<td>Miserable (U: 180°)</td>
<td>-.726</td>
<td>.393</td>
</tr>
<tr>
<td>Sad (U: 180°)</td>
<td>-.672</td>
<td>.377</td>
</tr>
<tr>
<td>Bored (UD: 225°)</td>
<td>-.573</td>
<td>.432</td>
</tr>
<tr>
<td>Sluggish (UD: 225°)</td>
<td>-.574</td>
<td>.480</td>
</tr>
<tr>
<td>Tired (UD: 225°)</td>
<td>-.527</td>
<td>.472</td>
</tr>
<tr>
<td>Sleepy (D: 270°)</td>
<td>-.306</td>
<td>.538</td>
</tr>
<tr>
<td>Still (D: 270°)</td>
<td>.008</td>
<td>.500</td>
</tr>
<tr>
<td>Quiet (D: 270°)</td>
<td>.206</td>
<td>.497</td>
</tr>
<tr>
<td>Calm (PD: 315°)</td>
<td>.608</td>
<td>.345</td>
</tr>
<tr>
<td>Relaxed (PD: 315°)</td>
<td>.715</td>
<td>.372</td>
</tr>
<tr>
<td>Satisfied (PD: 315°)</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Note: aThe affect measure of satisfied was excluded from exploratory and confirmatory analyses of circumplexity due to its similarity with SWB measures, which use the term satisfaction in scale construction. In part 2 of study 1, SWB measures will be mapped onto this circumplex structure in order to examine the affect-SWB relationship. P: Pleasant; PA: Pleasant-Activated; A: Activated; UA: Unpleasant-Activated; U: Unpleasant; UD: Unpleasant-Deactivated; D: Deactivated; PD: Pleasant Deactivated. N = 790.
Like the prior analysis, component one (C1) is interpreted as the bipolar dimension of *Hedonic Valence*. Positive and negative signs indicate a range of pleasant states at one end of the dimensional continuum to unpleasant states at the other end. However, factor loadings on C1 are now lower. This may be due to the removal of some variance associated with acquiescent response *style*, via ipsisation. There is some evidence to suggest that this non-substantive systematic variance, affects covariance structure by inflating all intercorrelations (Pauls & Crost, 2005). In addition, affects representing the deactivated end of the *Arousal* dimension (*still, quiet, sleepy*) failed to load on C1 due to these items predicted orthogonality with the valence dimension. Yet ipsatisation did not improve the expected finding of orthogonality for purely activated states (*aroused, active, energised*). Instead, these items achieved the highest loadings on the valence dimension. Based on the results of both analyses, it is possible the particular affects sampled to describe feelings of high activity and attention, were inappropriately selected in order to capture variance in the activated part of the *Arousal* dimension.

Also like the prior analysis, all 23 ipsatised items, regardless of item content, attracted positive loadings on component two (C2) although, the number of items loading $\geq .4$ has now doubled ($n = 14$). This suggests C2 is now a more robust component of the test scores. In addition, it is assumed the reduction in the total variance accounted for (2.23%) and the lower communalities in Table 8, signal the removal of non-substantive systematic variance, via ipsisation. Whilst it is not possible to determine the source of the systematic variance remaining on C2 from this exploratory analysis, it appears that such variance represents more *substance* (a trait component) than *style* (acquiescence) (McCrae & Costa, 1983).

Component three (C3) is now interpreted as the bipolar dimension of *Arousal*. Positive and negative signs indicate a range of activated states at one end of the dimensional continuum to deactivated states at the other end. In addition, affects representing the ‘Pleasant’ (*happy, contented, pleased*) and ‘Unpleasant’ (*sad, miserable, irritable*) vectors of the *Hedonic Valence* dimension failed to load on this component. This was expected due to these items predicted orthogonality with the *Arousal* dimension.
Therefore, conceptually, it appears that the ipsatisation process has achieved the desired aim of enabling the detection of circumplexity in the data. However, statistically, the arousal dimension is very weak, comprising just two clean items. This does not meet the criterion of three items to form a factor. Whilst together, Hedonic Valence and Arousal accounted for 44% of the variance, the existence of an arousal dimension in participants’ self-reported feelings about life, in general appears minimal.

To explore this further, the two-unrotated components, interpreted as Hedonic Valence and Arousal, were used to generate a factor-plot by estimating the angular position for each item using its factor loadings. From this plot, it is possible to observe a circular ordering of the items. The factor plot produced is shown in Figure 17.

![Factor plot generated from principal components analysis unrotated, two-component solution of twenty-three ipsatised affect items.](image)

*Figure 17: Factor plot generated from principal components analysis unrotated, two-component solution of twenty-three ipsatised affect items.*

The solid lines represent the orthogonal and bipolar dimensions of hedonic valence and arousal. The dotted lines slice the two-dimensional space into octants. The blue dots approximate angular locations for the manifest variables.

It appears from these preliminary results that the sampled affects have insufficiently accounted for the ‘activated’ vector of the Arousal dimension. Of
particular note are the concentric circles extending from the centroid to the circumference. These represent incremental increases in communality indices (i.e., 0.2, 0.4, 0.6, 0.8, and 1.00). None of the blue dots approximating angular locations for the manifest variables array on the circumference of the circle, in other words, no measure has produced a communality that is equal to 1.00. This shows that not all of the variance in these affective data is accounted for by a structure of core affect. However, as was previously stated in section 1.3.3 of the literature review, a circumplex that accounts for 100% of the variance in affective data is not a sufficient condition to establish circumplex structure, because a simple structure could also show this property.

The preliminary results further indicate that the items did not cluster in multiples of $45^\circ$ and did not reveal simple structure as would have been evidenced by all variables loading, substantially, on only one component. Rather items fell at various angles throughout the two-dimensional space. These findings support Yik’s (2009) contention that slicing the circumplex into octants is an arbitrary decision. The findings also raise doubt as to whether those affects sampled in the current study will produce reliable composite scales to represent the theorised octants. A further preliminary analysis will now examine the internal consistency of the affect items chosen to theoretically represent eight segments, or octants spaced $45^\circ$ apart, of an affective circumplex.

**Internal consistency of eight composite affect scales**

In this analysis, the data were explored with the aim of establishing a more robust model of the affect structure, according to the circumplex, from composite scales. Based on the total number of affects sampled ($N = 24$), and the $45^\circ$ hypothesis previously outlined in the literature review (see sections 1.2.2 and 1.3.3), single-item affect measures were grouped into eight composite scales, with three items in each scale. To conduct the analysis, the affect item ‘satisfied’ was included in order to construct the composite scale of ‘Pleasant’ from a minimum of three items. The psychometric properties of the eight scales are presented in Table 9.
Table 9:  
Psychometric properties of the eight composite scales representing octants of an affective circumplex.

<table>
<thead>
<tr>
<th>Composite affect measure</th>
<th>Variable</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(Theoretical angle designated theta (θ))</td>
<td>θ</td>
<td>M</td>
<td>SD</td>
<td>Skew</td>
<td>α</td>
</tr>
<tr>
<td>Pleasant</td>
<td>(0')</td>
<td>72.64</td>
<td>17.91</td>
<td>-1.14</td>
<td>.92</td>
</tr>
<tr>
<td>(Pleased, Happy, Contented)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pleasant Activated</td>
<td>(45')</td>
<td>63.17</td>
<td>17.37</td>
<td>-0.78</td>
<td>.79</td>
</tr>
<tr>
<td>(Alert, Lively, Excited)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Activated</td>
<td>(90')</td>
<td>57.81</td>
<td>18.48</td>
<td>-0.58</td>
<td>.75</td>
</tr>
<tr>
<td>(Aroused, Active, Energised)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unpleasant Activated</td>
<td>(135')</td>
<td>23.49</td>
<td>20.54</td>
<td>0.78</td>
<td>.87</td>
</tr>
<tr>
<td>(Distressed, Upset, Annoyed)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unpleasant</td>
<td>(180')</td>
<td>21.02</td>
<td>20.04</td>
<td>0.94</td>
<td>.85</td>
</tr>
<tr>
<td>(Irritable, Miserable, Sad)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unpleasant Deactivated</td>
<td>(225')</td>
<td>30.91</td>
<td>21.01</td>
<td>0.38</td>
<td>.75</td>
</tr>
<tr>
<td>(Bored, Sluggish, Tired)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deactivated</td>
<td>(270')</td>
<td>48.75</td>
<td>17.81</td>
<td>-0.48</td>
<td>.47</td>
</tr>
<tr>
<td>(Quiet, Still, Sleepy)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pleasant Deactivated</td>
<td>(315')</td>
<td>69.96</td>
<td>17.03</td>
<td>-0.95</td>
<td>.85</td>
</tr>
<tr>
<td>(Satisfied, Calm, Relaxed)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The mean scores for the composite scales, theoretically representing an 8-point circumplex structure, were highest for feelings of ‘Pleasantness’ (M = 72.64, SD = 17.91) and lowest for feelings of ‘Unpleasantness’ (M = 21.02, SD = 20.04). Levels of ‘Positive Affect’ were experienced as significantly more deactivated (‘Pleasant Deactivated’: M = 69.96, SD = 17.03) than activated (‘Pleasant Activated’: M = 63.17, SD = 17.37), t(902) = 14.73, p < .0005 (two-tailed). The mean difference in ‘Pleasant Activated’ and ‘Pleasant Deactivated’ scores was 6.81 with a 95% confidence interval ranging from 5.91 to 7.72. The eta-squared statistic (.19) indicated a large effect size (Cohen, 1988, pp. 284-7) suggesting this difference in mean scores was highly meaningful. All of the composites demonstrated an internal consistency > .70 with the exception of ‘Deactivated’, which demonstrated poor internal consistency (.47).
In sum, the major finding of the exploratory analyses is that there appears to be a relative absence of neutrally valenced, highly activated affects \((N = 24)\). In addition, principal components analysis revealed that this sample of affects appears to provide a reasonable *conceptual* representation of an affective circumplex, in that they were located meaningfully on the circumplex. This implies the absence of simple structure.

These findings undermine the results of the internal consistency analysis, which did not convincingly indicate whether an affective circumplex would be best represented by the 23 single-item measures, or the eight composite scales. According to Yik (M. Yik, personal communication, July 2nd-July 15th, 2012) additional adjectives are required to capture the full circumplex. Yik’s Chinese circumplex model of affect (CCMA) is based on 48 single-item measures, represented by 12 composite scales, derived from each of four items. This ‘12-point circumplex structure’ provides a robust representation of self-reported feelings on the circumplex, in Cantonese (see Yik, 2009).

All this implies the need to increase the nomological net in order to capture more regions of the circumplex. A future study aim will be to refine the item selection process, and also increase the number of affects sampled. If Yik’s methodology can be replicated, it will offer a comparative 12-point circumplex model of affect, in English.

**2.3. RESULTS: CONFIRMATORY ANALYSIS**

To re-cap, the overall aim of the current study is to integrate 24 single-item measures of feelings about life, *in general* on the circumplex to establish a structure of core affect.

The methodology employed by Yik (M. Yik, personal communication, July 6th, 2012) is followed in all CIRCUM analyses. Specifically, an inductive approach is taken in establishing the model. Therefore the manifest variables submitted to a CIRCUM analysis will be left free to fall at any location on the circumplex, in the form of single-item measures. The model will be tested, by specifying parameters one through five, and an assessment of which model provides the best overall fit will be made. Notably, CIRCUM cannot be fit to a sample correlation matrix of variables.
that have been ipsatised (M. Yik, personal communication, July 7th, 2012). Therefore, all analyses conducted using the CIRCUM procedure are based on a pre-ordered correlation matrix of the original scores. The results of the CIRCUM analysis, using 23 single-item measures as data, will now be presented.

To test the circumplexity of the data, the pre-ordered correlation matrix for the manifest variables was submitted to structural equation modeling using the circular stochastic process model with a Fourier series (CSPMF), or ‘CIRCUM’ (Browne, 1992). The single-item reference variable pleased was fixed with its polar angle ($\theta$) at zero, relative to which the locations of the other single-item variables were estimated. No other constraints were placed on the model. The analysis converged on a solution in 19 iterations. Three free parameters were specified in the correlation function equation; additional free parameters did not improve the model fit. The final model had a total of 71 free parameters and 205 degrees of freedom. The fit indices for the model were $\chi^2$ (205, $N = 790$) = 1452.38, RMSEA = .09 (90% CI = .08 - .09), and MCSC = -.53. Values of $\zeta$ ranged from .54 to .96. The results are given in Table 10, and a graphical display is presented in Figure 18.
Table 10:  
*Psychometric properties of the 23 single-item affect measures.*

<table>
<thead>
<tr>
<th>Affect Measure</th>
<th>Variable</th>
<th>(Theoretical Angle)</th>
<th>$\theta$</th>
<th>CI</th>
<th>$\zeta$</th>
<th>CI</th>
<th>$M$</th>
<th>SD</th>
<th>Skew</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pleased (0°)</td>
<td></td>
<td>0°</td>
<td>-</td>
<td>.89</td>
<td>.87-.90</td>
<td>70.89</td>
<td>19.78</td>
<td>-1.11</td>
<td></td>
</tr>
<tr>
<td>Happy (0°)</td>
<td></td>
<td>356°</td>
<td>354-359°</td>
<td>.87</td>
<td>.85-.89</td>
<td>73.85</td>
<td>17.67</td>
<td>-1.10</td>
<td></td>
</tr>
<tr>
<td>Contented (0°)</td>
<td></td>
<td>353°</td>
<td>351-356°</td>
<td>.86</td>
<td>.84-.88</td>
<td>72.20</td>
<td>20.79</td>
<td>-1.13</td>
<td></td>
</tr>
<tr>
<td>Excited (45°)</td>
<td></td>
<td>16°</td>
<td>12-20°</td>
<td>.73</td>
<td>.69-.76</td>
<td>60.62</td>
<td>20.01</td>
<td>-.66</td>
<td></td>
</tr>
<tr>
<td>Alert (45°)</td>
<td></td>
<td>18°</td>
<td>13-22°</td>
<td>.68</td>
<td>.64-.72</td>
<td>67.76</td>
<td>21.05</td>
<td>-1.16</td>
<td></td>
</tr>
<tr>
<td>Lively (45°)</td>
<td></td>
<td>33°</td>
<td>29-37°</td>
<td>.90</td>
<td>.88-.92</td>
<td>60.44</td>
<td>20.72</td>
<td>-.74</td>
<td></td>
</tr>
<tr>
<td>Aroused (90°)</td>
<td></td>
<td>27°</td>
<td>21-33°</td>
<td>.54</td>
<td>.49-.59</td>
<td>46.24</td>
<td>26.02</td>
<td>-.40</td>
<td></td>
</tr>
<tr>
<td>Active (90°)</td>
<td></td>
<td>27°</td>
<td>22-32°</td>
<td>.67</td>
<td>.63-.71</td>
<td>67.37</td>
<td>19.22</td>
<td>-.95</td>
<td></td>
</tr>
<tr>
<td>Energised (90°)</td>
<td></td>
<td>33°</td>
<td>30-37°</td>
<td>.96</td>
<td>.95-.98</td>
<td>59.41</td>
<td>21.69</td>
<td>-.72</td>
<td></td>
</tr>
<tr>
<td>Upset (135°)</td>
<td></td>
<td>149°</td>
<td>145-154°</td>
<td>.93</td>
<td>.91-.95</td>
<td>21.80</td>
<td>22.10</td>
<td>1.05</td>
<td></td>
</tr>
<tr>
<td>Distressed (135°)</td>
<td></td>
<td>153°</td>
<td>148-157°</td>
<td>.93</td>
<td>.91-.94</td>
<td>22.10</td>
<td>22.78</td>
<td>1.03</td>
<td></td>
</tr>
<tr>
<td>Annoyed (135°)</td>
<td></td>
<td>159°</td>
<td>154-164°</td>
<td>.78</td>
<td>.75-.81</td>
<td>27.99</td>
<td>23.84</td>
<td>.71</td>
<td></td>
</tr>
<tr>
<td>Irritable (180°)</td>
<td></td>
<td>179°</td>
<td>174-183°</td>
<td>.80</td>
<td>.77-.83</td>
<td>21.77</td>
<td>22.40</td>
<td>1.03</td>
<td></td>
</tr>
<tr>
<td>Miserable (180°)</td>
<td></td>
<td>182°</td>
<td>178-186°</td>
<td>.83</td>
<td>.81-.86</td>
<td>17.16</td>
<td>21.62</td>
<td>1.40</td>
<td></td>
</tr>
<tr>
<td>Sad (180°)</td>
<td></td>
<td>186°</td>
<td>181-190°</td>
<td>.77</td>
<td>.73-.80</td>
<td>25.09</td>
<td>24.76</td>
<td>.90</td>
<td></td>
</tr>
<tr>
<td>Bored (225°)</td>
<td></td>
<td>174°</td>
<td>168-179°</td>
<td>.63</td>
<td>.59-.68</td>
<td>26.87</td>
<td>25.19</td>
<td>.83</td>
<td></td>
</tr>
<tr>
<td>Sluggish (225°)</td>
<td></td>
<td>216°</td>
<td>212-221°</td>
<td>.80</td>
<td>.77-.84</td>
<td>29.01</td>
<td>25.03</td>
<td>.68</td>
<td></td>
</tr>
<tr>
<td>Tired (225°)</td>
<td></td>
<td>218°</td>
<td>213-223°</td>
<td>.80</td>
<td>.76-.83</td>
<td>38.18</td>
<td>27.04</td>
<td>.21</td>
<td></td>
</tr>
<tr>
<td>Sleepy (270°)</td>
<td></td>
<td>232°</td>
<td>226-238°</td>
<td>.72</td>
<td>.67-.76</td>
<td>39.11</td>
<td>26.67</td>
<td>.17</td>
<td></td>
</tr>
<tr>
<td>Still (270°)</td>
<td></td>
<td>275°</td>
<td>267-283°</td>
<td>.55</td>
<td>.47-.62</td>
<td>47.22</td>
<td>26.36</td>
<td>-.26</td>
<td></td>
</tr>
<tr>
<td>Quiet (270°)</td>
<td></td>
<td>288°</td>
<td>282-294°</td>
<td>.73</td>
<td>.66-.80</td>
<td>60.13</td>
<td>23.21</td>
<td>-.64</td>
<td></td>
</tr>
<tr>
<td>Calm (315°)</td>
<td></td>
<td>330°</td>
<td>325-334°</td>
<td>.78</td>
<td>.74-.81</td>
<td>71.78</td>
<td>18.72</td>
<td>-1.07</td>
<td></td>
</tr>
<tr>
<td>Relaxed (315°)</td>
<td></td>
<td>334°</td>
<td>330-338°</td>
<td>.83</td>
<td>.80-.85</td>
<td>68.30</td>
<td>19.72</td>
<td>-.92</td>
<td></td>
</tr>
<tr>
<td>Satisfied*(315°)</td>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

Note: The circumplex model of affect is constructed from 23 single item affect measures above and the hypothesised angles represent 45° octants. "The affect measure of satisfied was excluded from the analysis due to its similarity with SWB measures, which use the term satisfaction in scale construction. In study 2, SWB measures will be mapped onto this circumplex structure in order to examine the affect-SWB relationship. N = 790. Possible scores range from 0 to 100 for each affect item measure. The angle ($\theta$), the communality index ($\zeta$), and confidence intervals for both indices were computed in the CIRCUM analysis for all 23 affects measured."
Figure 18: Twenty-three affects encompassing both mood and emotion terms commonly drawn from the Circumplex Model of Affect. Polar angles show θ (theta) along with confidence intervals. The length of the solid blue line from the centre shows the communalities ζ (zeta). n = 790.
The results for the four cornerstone constructs (i.e., pleasant, unpleasant, activated, deactivated) indicate that single-item measures representing ‘pleasant’ (i.e., pleased, happy, contented) are located close to the predicted value of 0°. ‘Unpleasant’ affects (i.e., irritable, miserable, sad) are between 179° and 186° away. Affects representing ‘activated’ (i.e., aroused, active, energised) do not correspond to the predicted value of 90°. Instead they correspond to the ‘pleasant-activated’ region of the circle within a range of 27° to 33°. Whilst still and quiet represent ‘Deactivated’ at around 270°, as predicted, sleepy is located in the ‘unpleasant-deactivated’ region at 332°, closer in proximity to the affect measures of sluggish and tired.

The results for the remaining constructs indicate other anomalies. The single-item measures representing ‘pleasant-activated’ at 45° (i.e., excited, lively, alert), and ‘unpleasant-activated’ at 135° (i.e., upset, distressed, annoyed), do not correspond to the predicted values. Instead ‘pleasant-activated’ affects correspond to a region of the circle within a range of 16° to 33°, and ‘unpleasant-activated’ affects within a range of 149° to 159°. In contrast, single-item measures representing ‘pleasant-deactivated’ at 315° (i.e., calm, relaxed), and ‘unpleasant-deactivated’ at 225° (i.e., tired, sluggish, bored), are located close to the predicted values, with the exception of bored. This affect corresponds to a slightly activated and negatively valenced region of the circle at 174°.

In summary, the bottom half of the circle is relatively well predicted. Affects hypothesised to fall at 270° (i.e., sleepy, quiet, still), at 225° (i.e., tired, sluggish, bored), and at 315° (i.e., calm, relaxed) generally correspond to the predicted locations, with the exception of the two affects already mentioned as anomalous (sleepy, and bored). In contrast, the top half of the circle is not as well predicted. Affects hypothesised to fall at 90° (i.e., aroused, active, energised), at 45° (i.e., excited, alert, lively), and at 135° (i.e., upset, distressed, annoyed) are drawn closer towards the valence dimension (i.e., ‘pleasant’ (0°) – ‘unpleasant’ (180°)).
2.4. DISCUSSION

In this Study 1 Part A, participants completed a questionnaire asking them to indicate how each of 24 affect items described their feelings when they thought about their life, *in general*. The overall aim was to integrate participants’ responses to these measures into one structure to create a measurement map of affective feelings on the circumplex. The findings in relation to examining the precise locations of affective states on the circumplex indicate that, the sample of affects chosen to represent an affective circumplex structure \( n = 23 \) predicted the bottom half of the circle relatively well. However, the top half of the circle was not as well predicted.

Elaborating on the findings, these results are very similar to those of Remington et al. (2000) discussed in sections 1.1.4 and 1.3.5 of the literature review. In short, the review authors re-submitted to CIRCUM, only those correlation matrices with ‘optimal’ study characteristics \( n = 10 \) in order to examine the precise locations of affective states on the circumplex. In all 10 tests of circumplex structure, none of the affects hypothesised to fall at \( 90^\circ \) (‘activated’) and at \( 45^\circ \) (‘pleasant-activated’) met with theoretical predictions. Instead, these affects were consistently drawn closer towards \( 0^\circ \) (‘pleasant’). This was replicated here in the current CIRCUM analysis. The review findings further indicated that, whether or not affects hypothesised to fall at \( 135^\circ \) (‘unpleasant-activated’) met with theoretical predictions, depended on the affects sampled. For instance, some terms (i.e., afraid, nervous) consistently corresponded to this region of the circle whereas other terms (i.e., ashamed, annoyed, fearful, worried) consistently corresponded to values closer to \( 180^\circ \) (‘unpleasant’). This latter finding replicates the current findings.

It is possible that the current findings point to the difficulty in capturing high activation in participants’ responses from semantic labels. This is also the opinion of Yik who speaks of the item selection process as iterative and exhaustive (M. Yik, personal communication, July 6th, 2012). It is also possible that the ‘life, *in general*’ nature of the test question confounded the ability to capture high activation in participants’ responses. According to Remington et al. (2000) the best fitting circumplex models in their review were based on self-report ratings involving short time frames (i.e., momentary states) rather than longer time frames (i.e., trait judgements).
While the activated region of the circumplex is not as well predicted, all of the measured affects arrayed on the circumplex in a meaningful way. Therefore, the results demonstrate strong substantive validity. According to Gurtman (1997; see also Di Blas, 2007), substantive validity of an empirical circumplex addresses the question of the extent to which the observed order of the variables is meaningful, and whether this ordering corresponds to established models. In this respect, the affective circumplex established in the current analysis is a most valid representation of the affect structure. Moreover, it is a more substantively valid model than Davern’s (2004; Davern et al., 2007) model, of which current research design is based. In Davern’s model (see section 1.2.2 of the literature review), single items eliciting a ‘life, in general’ response that were designed to capture ‘unpleasant activated’ (135°), ‘unpleasant’ (180°), and ‘unpleasant deactivated’ (225°), did not array on the circumplex in a meaningful way, or correspond with previously established models (e.g. Remington et al., 2000; Yik et al., 2011).

In addition to assessing substantive validity, Gurtman (1997) also asserts that an empirical circumplex must be further scrutinised on the basis of the structural integrity of the model produced. This refers to the psychometric properties of a circular array of variables. Based on the guidelines set forth by Browne and Cudeck (1992) for assessing circumplex structure, psychometric criteria in the current analysis indicate a marginal fit of a circumplex model to single-item affect measures (RMSEA = .09, CI: .08-.09). However, given RMSEA values, on average, range from .07 (Remington et al., 2000) to .12 (see Yik, 2009; Yik et al., 1999; Yik et al., 2011), the obtained value of .09 is interpreted as most adequate. This structural indicator of model fit also replicates the findings of Davern (2004; Davern et al., 2007). In addition, the minimum common-score correlation at 180° (MCSC = -.53) supports a core affective structure that is bipolar in nature (Russell & Carroll, 1999; Segura & Gonzalez Roma, 2003). Furthermore, the systematic circular array converges with the circular array explored in the principal components analysis and thus, strengthens the validity of the model produced.

The added findings of no equal spacing of affects around the circumference of the circle, or of clusters of affects spaced 45° apart, does not violate assumptions of circumplex structure. Indeed, CIRCUM allows variables to fall at any location
around the perimeter of a circle (Brown, 1992; Fabrigar et al., 1997; Guttman, 1952). The fact that the variables did not form vectors spaced 45° apart supports Yik’s (2009) previously stated contention that, slicing the circumplex into segments is an arbitrary decision. According to Yik, a more systematic decision is to allow CIRCUM to provide precise angles for the measured variables. In this sense, research interpretations are not vested in obtaining a particular correspondence with a structure of core affect (Yik et al., 2011). The precision of the estimates CIRCUM provides is determined by 95%, one at a time, confidence intervals. As shown in Table 10 in the current CIRCUM analysis, all reported angles for each of the manifest variables fell within a 5°-13° interval, indicating the angles are quite precise. It has been previously suggested by Remington et al. (2000) that a confidence interval of 20° is sufficient for determining precision in such measurement.

However, no measured affect is completely accounted for by a two-dimensional integrated structure. In other words, in each self-reported affective response, there remains a portion of the total variance that cannot be attributed to some specific blend of Hedonic Valence and Arousal (i.e., core affect). This is evidenced by the communality values (ζ), which range from .54 to .96. This implies that when participants reported feeling energised (ζ = .96), for example, a particular state of core affect best described by a specific blend of Hedonic Valence and Arousal at 33°, accounted for approximately 92% of the total variance in the response. Whilst 8% of the total variance cannot be attributed to this state of core affect, when it came to reports of feeling energised, participants mainly reported a state of core affect.

In contrast, when participants reported a feeling theoretically synonymous with energised, as aroused (ζ = .54), a similar state of core affect located at 27°, accounted for only 30% of the total variance in the response. In this instance, the contribution of core affect was greatly reduced for this descriptor. This implies that responses to feeling aroused, about ‘life, in general’, could be confounded by social desirability response biases that the CIRCUM analysis cannot control for (Browne, 1992). Alternatively, this question may lose its relevance when the response is tied to feelings about life in general. This would imply that other elemental processes
become involved in responding to the question of how *aroused* one feels about life, *in general*. In line with a psychological constructionist approach (e.g. Barrett, 2009; Russell, 2009; see Chapter 1 section 1.1.4 of this thesis for a detailed discussion), elemental processes are components of the mind that cannot be reduced to anything simpler at a psychological level. These basic elements are claimed to accompany every psychological moment, and reflect the interaction between the reported state of core affect at 27°, memories of what is known about *arousing* events, and attentional processes that control which conceptual elements are activated and suppressed in the reporting of the response. These processes may explain substantive systematic variance observed in the exploratory principal components analysis after ipsatisation.

In summary, the aim of this study was to re-examine a circumplex model of affect. Not since the work of Davern (2004) and her colleagues (Davern et al., 2007) has the structure of affect been investigated on the circumplex within the context of the theory of SWB Homeostasis. Overall, the results provide strong support for a circumplex model of affect. The findings from both exploratory methods, using principal components analysis and confirmatory methods using the CIRCUM procedure, converged to suggest a core affective structure that is bipolar in nature, and lacking in simple structure. Therefore, researchers should consider seeking alternative solutions to affect structure that are informed by response patterns found in the data. This inductive approach not only adds to a researcher’s statistical toolbox, it supports various theoretical perspectives regarding the structure of affect (e.g. Green et al., 1993; Russell & Carroll, 1999; Thayer, 1967; Tellegen et al., 1999), and a major contention (see Browne, 1992; Guttman, 1954a, 1954b; Yik et al., 1999; Yik et al., 2011) that different perspectives need not compete.

However, both exploratory and confirmatory analyses revealed that less variance was accounted for in the Arousal dimension. Most notably, high activation was absent from participants’ intensity ratings in respect to how they felt about their life, *in general*. This finding partially replicates Davern’s (2004; Davern et al., 2007) CIRCUM results and strengthens support for the notion that insufficient sampling of the affect terms may have confounded the results. This is also the opinion of Yik (M. Yik, personal communication, July 6th, 2012) who speaks of the difficulty in capturing this region of the circumplex from semantic labels. Therefore, refining the
item selection process and increasing the number of affects sampled to 48 items, to offer a comparative 12-point circumplex model of affect (Yik, 2009) in English, will be a major focus of research design in the third study.

A further aim of future research design returns to the ‘state’ versus ‘trait’ debate (see Allen & Potkay, 1981; Zuckerman, 1983) discussed in section 1.2.2 of the literature review. This discussion focused specifically on the nature of the test question as an explanation for the reduced contribution of arousal in Davern’s (2004; Davern et al., 2007) circumplex model, which has now been replicated in the current model. The explanation was based on the intuitive assumption that, unlike the model created in the current analysis, which is based on an *in general* response, a model of momentary affect based on feelings in the *current moment* will reflect acute fluctuation in these feelings. Empirically, this will likely capture more variance in the arousal dimension than a trait model based on an *in general* response.

However, as previously discussed in section 1.2.2 of the literature review, this assumption remains intuitive as it can only be tested with replication within-subjects, and with a model established from composite scales (Zuckerman, 1983). Unfortunately, the results of the internal consistency analysis, used to explore the possibility of constructing an 8-point circumplex structure from composite scales, were not strong enough to justify testing. The cross-sectional nature of study designs in this thesis further precludes a more valid assessment of the state/trait distinction. Therefore, the main aims of research design in the third study include:

a) Refining the item selection process, and increasing the number of affects sampled to capture more regions of the circumplex.

b) Constructing an affective circumplex model from self-report ratings involving shorter time frames (i.e., momentary states) rather than longer time frames (i.e., trait judgements) to observe whether more acute fluctuation is captured in feeling responses.

c) Establishing a 12-point circumplex model of momentary affect from composite scales to replicate Yik’s current methodology (see Yik, 2009; Yik et al., 2011).
The amount of arousal captured from the hypothesised trait-based affect model established in this first study will then be compared to the amount of arousal captured from a newly constructed momentary affect model. Investigating a circumplex model of affect from composite scales in this way along with increasing the sample of affects will likely provide a more robust platform from which to investigate where HPMood resides within the circumplex. An investigation to validate HPMood on the circumplex, for the first time, is the main research focus of the next study to follow in Chapter 3.
CHAPTER 3:
STUDY 1: PART B

ESTABLISHING THE CONSTRUCT VALIDITY OF HPMOOD ON THE CIRCUMPLEX

Study 1 Part A established a circumplex model of core affect from 23 single-item affect measures. This model will be used in the upcoming study to chart a relation between the established structure of core affect and variables in the Homeostatic Model of SWB.

Locating HPMood on the circumplex

According to SWB Homeostasis theory (Cummins, 2010, 2012), HPMood is conceptualised as a pleasant and mildly activated ‘core’ state of affect that is always present and providing a background sense of SWB. HPMood is further proposed as the basic steady mood-state that homeostatic mechanisms seek to defend. It approximates each individual’s set-point for SWB because SWB is found to be highly saturated with affect in linear models (Blore et al., 2011; Davern et al., 2007; Lai & Cummins, 2013; Tomyn & Cummins, 2011). HPMood, as a core affective construct, is also proposed to pervade conscious experience, and is most strongly perceived in all semi-abstract self-perceptions.

Cognitive ‘buffers’

Three of these self-perceptions are discussed. Each one reflects a positive sense of value and worth as self-esteem (Rosenberg, 1979), a perceived ability to change the environment according to one’s desires as control (Folkman & Moskowitz, 2000), and a sense of optimism for the future (Peterson, 2000). Together, these perceptions act as ‘cognitive buffers’ for maintaining the most abstracted self-perceptions (i.e., SWB). All are in constant interaction with momentary experience, and all are strongly related to positive-activated mood (HPMood), which is delivered at the set-point (Cummins, 2013). Their role is to re-frame adverse life events in such a way as to minimise negativity and maximise advantage to the self. All of this allows the maintenance of the perceived self as positive, leading to ‘self satisfaction’
(Cummins & Nistico, 2002), and feeling satisfied with life as a whole (Diener & Diener, 1995).

**Personality**

The proposition that HPMood pervades all conscious experience carries an additional assumption that, HPMood is also perceived in all higher process. This includes personality. Extraversion is an aspect of personality that is highly related to SWB (Costa & McCrae, 1980, 1992; Headey & Wearing, 1989, 1992). Furthermore, there is evidence to suggest that the central component of extraversion is positively affective in nature (Costa & McCrae, 1980; Lucas et al., 2000). Researchers working within the theory of SWB Homeostasis (Blore et al., 2011; Davern et al., 2007; Tomyn & Cummins, 2011), propose a more fundamental level of description for the positive affective component of extraversion. This is based on findings to indicate that a small composite of affects (e.g. happy, content, excited/alert/active), alluding to HPMood’s nature as a core affective construct, accounts for almost all of the shared variance between extraversion and SWB.

**External variables**

Informed by this understanding of HPMood’s nature and its perfusion of SWB, personality, and cognition, the measures of SWB, self-esteem, optimism, perceived control, and the personality trait of extraversion, will be treated as external variables to locate HPMood’s character, on the circumplex.

**AIMS AND PREDICTIONS**

The main aim of the current study is to test two central aspects of the theory of Subjective Wellbeing Homeostasis. The first concerns the construct validity of the affective core of Subjective Wellbeing (SWB) called Homeostatically Protected Mood (HPMood). As previously stated, HPMood is conceptualised as a pleasant and mildly activated ‘core’ state of affect that is always present and providing a background sense of SWB. However, no study has empirically validated HPMood with a structural model that best describes its specific blend of Hedonic Valence and Arousal. This study addresses this gap by validating the theoretical nature of HPMood on the circumplex. The second aspect to be tested concerns empirical findings with linear models (Blore et al., 2011; Davern et al., 2007; Lai & Cummins,
2013; Tomyn & Cummins, 2011), that a small composite of affects (e.g. happy, content, excited/alert/active) dominates the content of SWB and major correlates of SWB such as self-esteem, optimism, perceived control, and extraversion. This study tests these findings on the circumplex.

The Cosine Wave Method (Yik, 2009; Yik et al., 2011) will be used to validate HPMood on the circumplex and to test HPMood’s magnitude of association in the following way:

- Measures of SWB and major correlates of SWB in personality, self-esteem, and optimism, will be treated as external variables. These variables will be placed within the circumplex in the upcoming cosine wave analysis, one at a time, to examine the presence of a relation between each external variable and an entire structure of core affect. The degree to which SWB and related variables are affective in nature will also be examined.

Due to the restricted space allocated to the survey questionnaire in the second study (Study 2 Part A and Part B: ARC 24), it was not possible to include perceived control to locate HPMood’s nature on the circumplex. Therefore, to maintain consistency throughout, the decision was made to exclude this homeostatic variable from both investigations.

- The observed locations of the external variables will be compared to the observed locations of the composite affects used to create the affective circumplex model in the previous study. The aim is to examine whether lay descriptors of HPMood (e.g. happy, contented, alert/excited/active) are commensurate with the newly established empirical definition of HPMood hypothesised as a mildly pleasant and activated ‘core’ state of affect.

Whereas the previous circumplex analysis took a largely inductive approach to investigating a core affective structure, the upcoming analysis will utilise the circumplex to make a number of predictions based on SWB Homeostasis theory (Cummins, 2010; Cummins et al., 2012).

The first hypothesis is that the strongest point of association between the model of core affect and any one of the external variables will elucidate where HPMood resides within the circumplex. Justification for this prediction is based on
the theoretical assumption that all listed external variables are infused with a form of core affect described as ‘mildly positive and activated’. By relating these external variables to the circumplex model of core affect established in the previous study, it will be possible to examine a specific blend of Hedonic Valence and Arousal accompanying responses to these variables. The locations, in degrees, of each external variable entered into the circumplex, will represent the strongest point of association between that variable and a core affective structure. These empirical locations will essentially map out a range for where HP\textit{Mood} resides within the circumplex.

The second hypothesis is that the specific type of core affect located on the circumplex by the listed external variables will support Cummins’ theoretical definition of HP\textit{Mood} as a ‘pleasant and mildly activated’ core state of affect. Justification for this prediction is based on the consistent finding in linear regression models (Blore et al., 2011; Davern et al., 2007) that only certain kinds of lay descriptors (happy, content, active, energised) uniquely predict scores on GLS, which is considered a proxy for the set-point HP\textit{Mood}. This alludes to the shared existence among these lay terms of a specific blend of Hedonic Valence and Arousal. Cummins (2010, 2012) has theorised, this blend is ‘mildly pleasant and activated’. This fundamental level of description for HP\textit{Mood} can now be empirically validated with a structural model that can best capture its specific blend of Hedonic Valence and Arousal.

The third hypothesis is that a substantial association between a circumplex model of core affect and all of the listed external variables will be evidenced, with the strongest magnitude of association evidenced by SWB measures. Justification for this prediction is based on a growing body of research (Blore et al., 2011; Davern et al., 2007; Lai & Cummins, 2013; Tomyn & Cummins, 2011) that indicates much of the shared variance between SWB measures, and related variables is accounted for by a small composite of affects (e.g. happy, content, excited/alert/active), with SWB measures most dominated by these affects.
3.1. METHOD

External Measures

The participants registered responses to the following measures, which formed part of the Australian Unity Wellbeing Index Longitudinal Project labelled as ARC21. The entire survey contained 95 items, and included the 23 single-item affect measures used to create a circumplex model of affect reported in the first study. Table 11 presents the external measures used in the current analysis to validate HPMood on the circumplex.

Table 11:
External variables used to locate where HPMood resides within the circumplex.

<table>
<thead>
<tr>
<th>Scale</th>
<th>Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Life Satisfaction (GLS)</td>
<td>Single item measure of SWB</td>
</tr>
<tr>
<td>Personal Wellbeing Index (PWI)</td>
<td>Composite measure of SWB</td>
</tr>
<tr>
<td>Rosenberg Self-Esteem Scale (RSES)</td>
<td>Self Esteem</td>
</tr>
<tr>
<td>Life Orientation Test - Revised (LOT-R)</td>
<td>Optimism</td>
</tr>
<tr>
<td>NEO-Five Factor Inventory (FFI) 60-item Short Form (Extraversion 12-item scale)</td>
<td>Personality</td>
</tr>
</tbody>
</table>

The respondents used an 11-point end-defined unipolar response scale for all rating measures in the study. Researchers working within the theory of SWB Homeostasis employ this response format for its simplicity and scale sensitivity (Cummins, 2003). All ratings are made from 0 to 10 using a unipolar response scale so as not to impose bipolarity on the data through research design (Davern & Cummins, 2006; Russell & Carroll, 1999). This unipolar format also increases scale sensitivity since respondents tend to use the positive half of the response scale when making a rating about the self. This is particularly evident in SWB data (Cummins & Gullone, 2000).

However, this increased sensitivity has been shown to jeopardise the interval nature of the response scale. A recent Rasch analysis by Forjaz et al. (2012) of the Personal Wellbeing Index (PWI; International Wellbeing Group, 2013) revealed respondents could not discriminate between intervals 1 to 4 on such an 11-point scale. This calls into question the use of parametric statistics for data analysis.
However, these authors found that, when the points on the scale were recoded as 01111234567 this 8-point scale provided an interval measure of SWB. The authors also acknowledge their results may have been sample dependent. However, their use of a category label for the mid-point on the scale may also have contributed to their results. There is common agreement that such labelling interferes with the interval nature of a response scale (see Meddis, 1972; Cummins and Gullone, 2000; Russell, 1979). Clearly, there is debate surrounding the structure of response scales (see section 1.3.4 of the literature review for a detailed discussion). In the current study, data analysis will be performed on raw scores.

**General Life Satisfaction (GLS)**

This is a single-item measure of SWB, which asks: “Thinking about your own life and personal circumstances, how satisfied are you with your life as a whole?”

**Subjective Wellbeing**

While GLS is useful for estimating the homeostatic set-point, it cannot provide information about the aspects of life that also contribute, positively or negatively, to Subjective Wellbeing (SWB) (Cummins, Lau, & Stokes, 2004). This requires questions to be directed at satisfaction with life domains. The Personal Wellbeing Index (PWI; International Wellbeing Group, 2013) is a domain-level representation of GLS. To meet criteria for inclusion, each domain (item) must contribute unique, as well as shared variance, to the prediction of GLS. This is determined with multiple regression, where all domains are simultaneously regressed against GLS.

Eight life domains comprise the PWI as ‘standard of living’, ‘health’, ‘achieving in life’, ‘relationships’, ‘safety’, ‘community-connectedness’, ‘future security’, and ‘spirituality/religion’. In Australia, the ‘spirituality/religion’ domain is no longer included as part of the composite scale (International Wellbeing Group, 2013). The ‘safety’ domain does not contribute unique variance but is retained because it does so in other countries (refer to Appendix C of the test manual for an elaboration). The combination of both unique and shared variance by the seven domains typically accounts for 40-60 percent of the variance in GLS.
In terms of the validity of the PWI, a single stable component accounts for approximately 50% of the variance in Australia and overseas (Cummins et al., 2004). Convergent validity with the Satisfaction with Life Scale (SWLS; Diener, Emmons, Larsen, Griffin, 1985) \((r = .78)\) has also been established in non-clinical samples (Thomas, 2005). In terms of reliability, Cronbach alpha coefficients range between .70 and .90 in Australia and overseas. Item-total correlations range between .50 and .75 (International Wellbeing Group, 2013), and test-retest reliability has been demonstrated across a 1-2 week interval (intra-class \(r = .81 - .84\)) (Lau & Cummins, 2005).

In the current study, the seven domains were regressed against GLS, and accounted for 64 percent of the variance. The domains of ‘Safety’ and ‘Community-Connectedness’ failed to make unique contributions to the prediction of GLS. However, these items were retained in order to generalise the results to normative populations in Australia and overseas. A principal components analysis with varimax rotation revealed a single component, accounting for 54% of the variance. Cronbach’s alpha for the seven items is .86 and item-total correlations range between .52 and .71. The seven items were aggregated and averaged to form a composite measure of subjective wellbeing.

Self-Esteem

The Rosenberg Self-Esteem scale (RSE) (Rosenberg, 1965) is a 10-item scale designed to capture a global evaluation of ‘self-concept’. According to Rosenberg (1979, p.73) the self-concept reflects the attributes of self-respect, a person of worth, and an appreciation of one’s own merits. The scale enjoys wide appeal as its construction is thought to reflect the ideas presented in psychological theories about the self, yet is also consistent with the layperson’s view of self-esteem (Gray-Little, Williams, & Hancock, 1997).

The RSE scale demonstrates good internal consistency \((\alpha = .72 - .88)\) and test-retest reliability across a 1-2 week interval (intra-class \(r = .82\)) (Gray-Little et al., 1997). However, reliability appears to decrease over longer time periods (i.e., six-month follow-up, \(r_{T-R} = .63\); 12-month follow-up, \(r_{T-R} = .50\)) (Byrne, 1983; McCarthy & Hoge, 1984). There is also strong evidence for a bidimensional factor structure where one factor comprises five positively worded items, and is labelled ‘positive
self-esteem’. The other factor comprises five negatively worded items, and is labelled ‘self-depreciation’ (see Greenberger, Chen, Dmitrieva, & Farruggia, 2003 for a review).

As the purpose of administering the RSE scale in the current study is to capture a positive evaluation of one’s self-concept, only the five positively worded items are included in the research design. A principal components analysis with varimax rotation revealed a single component, accounting for 78% of the variance. Cronbach’s alpha for the five items is .93. The five items were aggregated and averaged to form a composite measure of self-esteem.

**Optimism**

The Life Orientation Test-Revised (LOT-R) (Scheier, Carver, & Bridges, 1994) is a 10-item measure of optimism versus pessimism, defined as a generalised expectation of good versus bad outcomes in life. The 10 items of the LOT-R consist of three positively worded items, labelled ‘optimism’, and three negatively worded items, labelled ‘pessimism’. Four additional ‘filler’ items are included to protect against a type of measurement error known as assimilation effects, which is due to the proximity of items causing a response set (Schwarz & Strack, 1999).

As the purpose of administering the LOT-R in the current study is to capture ‘optimism’ from participants’ responses, only the positively worded items are included in the research design. A principal components analysis with varimax rotation revealed a single component, accounting for 76% of the variance. Cronbach’s alpha for the three items is .85. The three items were aggregated and averaged to form a composite measure of optimism.

**Personality (Extraversion)**

The NEO Five Factor Inventory (NEO-FFI) is a 60-item shortened version of the revised 240-item NEO Personality Inventory (NEO PI-R) (Costa Jr. & McCrae, 1992). The NEO-FFI was developed to provide a concise measure of the five domains of personality as: extraversion, neuroticism, openness to experience, conscientiousness, and agreeableness. The inventory may be administered to individuals 17 years or older, and requires a sixth-grade reading level. A 12-item
scale represents each personality domain, and the extraversion scale is utilised in the current analysis.

Typically, individuals who score higher on the NEO-FFI extraversion scale are likely to describe themselves as friendly and thus, prefer the company of others. ‘Extraverts’ tend to speak their minds, are highly active, and like to seek out exciting and stimulating environments. The positive emotions most likely reported by extraverts are described by feelings of happiness, joy, love, and excitement. According to the test authors (Costa Jr. & McCrae, 1980), the positive emotions facet of extraversion is most relevant to the prediction of happiness and life satisfaction.

‘Intraverts’, on the other hand, are not considered opposites of ‘extraverts’. That is, intraverts do not describe themselves as unfriendly, inactive, or unhappy. Intraverts can be viewed more in terms of an absence of extraversion. Therefore intraverts, defined by low scores on extraversion are more reserved. They tend not to seek social stimulation, and would prefer others do the talking. Intraverts are more relaxed and leisurely, with little desire for thrill-seeking. In terms of emotions, intraverts do not report feeling unhappy, they merely feel less high-spirited.

In terms of the psychometric properties of the scale, both convergent validity \( (r_s \text{ ranging between } .72-.90) \) and divergent validity \( (r_s < .20) \) have been established using norming data from the original NEO-PI-R scales in non-clinical American samples (Costa Jr. & McCrae, 1992, McCrae & Costa, 2004). Cross-cultural validity has also been established in Swiss, English, Chinese, Korean, Japanese, and Spanish samples (Yik et al., 2002; Aluja, Garcia, Rossier, & Garcia, 2005), and Cronbach alpha coefficients for the five domains range between .72 and .85. Test re-test reliability has also been established over short and medium time periods (two-weeks: \( r_{T-R} = .86 \text{ to } .90; \) four-years: \( r_{T-R} = .53 \text{ to } .70) \) (Roberts & DelVecchio, 2000; Robins, Fraley, Roberts, & Trzesniewski, 2001). Overall, the test authors claim such well-established criteria permits the widespread use of the NEO-FFI, as a brief measure of the Five-Factor Model of personality (McCrae & Costa Jr., 2007).

Yet despite widespread popularity, a major criticism of the NEO-FFI is that its construction is based on results from the NEO-PI-R norming data. As a result, the necessary diversity of item content governed by the broader NEO-PI-R inventory,
serves to reduce the internal consistency of the briefer NEO-FFI at the item-factor level. As evidence for this assertion, Hull, Beaujean, Worrell, and Verdisco (2010), constructed correlation matrices from seven previously published studies. These were then subjected to multiple factor analytic procedures, including principal components analysis, and exploratory and confirmatory factor analysis. A total of 11 such analyses were conducted. To aid in the interpretation of the results, Hull et al. employed both orthogonal and oblique rotational procedures for comparative purposes.

In specific relation to the NEO-FFI extraversion scale, the 12-items selected from the original NEO PI-R inventory include warmth (1 item), gregariousness (2 items), assertiveness (1 item), excitement-seeking (1 item), activity (3 items), and positive emotions (4 items). To determine the reliability of the scale, each item in turn was judged as ‘poor’ if it attracted a loading of < .3 on its corresponding factor and/or a loading of > .3 on a non-corresponding factor, and if this occurred for the item in more than 30% of the 11 analyses conducted. The results revealed five of the 12 items underperformed. These problematic items are listed in Table 12.

Table 12: Five of twelve NEO-FFI extraversion scale items judged as unreliable by Hull et al. (2010).

<table>
<thead>
<tr>
<th>Item#: Item Measure of NEO-FFI (Facet Scale of NEO-PI-R)</th>
<th>Problematic item in more than 30% of the 11 analyses conducted</th>
</tr>
</thead>
<tbody>
<tr>
<td>27: I usually prefer to do things alone* (Gregariousness)</td>
<td>55%</td>
</tr>
<tr>
<td>32: I often feel as if I’m bursting with energy (Activity)</td>
<td>36%</td>
</tr>
<tr>
<td>47: My life is fast-paced (Activity)</td>
<td>36%</td>
</tr>
<tr>
<td>52: I am a very active person (Activity)</td>
<td>55%</td>
</tr>
<tr>
<td>57: I would rather go my own way than be a leader of others* (Assertiveness)</td>
<td>55%</td>
</tr>
</tbody>
</table>

Note. *Reverse-Scored item.

The findings of this review call into question the reliability and validity of the NEO-FFI, at the item-factor level. However, test authors McCrae and Costa Jr. (2004) argue that, such findings merely highlight the challenge to capture the multifaceted nature of extraversion using a brief measure. They also state that the NEO-
FFI should not be used as a definitive measure of the personality structure “[but], more a brief measure yielding reasonable estimates of the five factors” (p.592).

There is no doubt that the brevity for speed and convenience in administration is a highly desirable feature of the NEO-FFI. Whilst brevity may be a necessary requirement, it should not alone be sufficient to justify the utility of the NEO-FFI. An earlier study conducted by Saucier (1998) suggests an alternative use for the NEO-FFI that improves the structural integrity of this brief inventory. Saucier examined the component structure of each of the personality domains, separately, using principal components analysis and promax (oblique) rotation. In specific relation to extraversion, the results indicated three components or facets, interpreted as sociability (4 items), activity (4 items), and positive affect (4 items) most reliably represented the 12-item NEO-FFI extraversion scale. Saucier’s results in relation to extraversion are presented in Table 13.

Table 13:
*Principal components analysis of the NEO-FFI 12-item extraversion scale, according to Saucier (1998).*

<table>
<thead>
<tr>
<th>Item#</th>
<th>Personality Measure (Facet Scale from the original NEO-PI-R)</th>
<th>NEO-FFI Extraversion Facet Scale (Cronbach alpha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>I really enjoy talking to people <em>(Warmth)</em> *</td>
<td>Sociability <em>(α = .57)</em></td>
</tr>
<tr>
<td>2</td>
<td>I like to have a lot of people around me <em>(Gregariousness)</em></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>I usually prefer to do things alone’ <em>(Gregariousness)</em> *</td>
<td></td>
</tr>
<tr>
<td>57</td>
<td>I would rather go my own way than be a leader of others*(Assertiveness)*</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>I like to be where the action is <em>(Excitement-seeking)</em> *</td>
<td>Activity <em>(α = .52)</em></td>
</tr>
<tr>
<td>32</td>
<td>I often feel as if I’m bursting with energy <em>(Activity)</em> *</td>
<td></td>
</tr>
<tr>
<td>47</td>
<td>My life is fast-paced <em>(Activity)</em> *</td>
<td></td>
</tr>
<tr>
<td>52</td>
<td>I am a very active person <em>(Activity)</em> *</td>
<td></td>
</tr>
<tr>
<td>42</td>
<td>I am a cheerful optimist <em>(Positive emotions/affect)</em> *</td>
<td>Positive Affect <em>(α = .72)</em></td>
</tr>
<tr>
<td>12</td>
<td>I am very “light-hearted” <em>(Positive emotions/affect)</em> *</td>
<td></td>
</tr>
<tr>
<td>37</td>
<td>I am a cheerful, high-spirited person <em>(Positive emotions/affect)</em></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>I laugh easily <em>(Positive emotions/affect)</em> *</td>
<td></td>
</tr>
</tbody>
</table>

*Note.* *Reversed-scored item; *Sociability Facet; *Activity Facet; *Positive Affect Facet and Cronbach alpha in **bold.**
Based on his findings, Saucier (1998) called for the release of the NEO-FFI from the conceptual constraints of its forbearer by pointing out that, the NEO-FFI comprises a subset of items (60 as opposed to 240) with fewer measurable facets. Therefore, when used as a stand alone measure, the utility of the NEO-FFI lies in its ability to capture another level of description; a new level of complexity for describing personality for the NEO family of test instruments. Whilst it is plausible that individuals who score higher on the NEO-FFI extraversion scale could describe themselves in broader terms such as sociable, the internal consistency of these broader facets is somewhat inadequate. This maintains an impression of the NEO-FFI as unreliable.

Therefore, to investigate the lack of consistency in prior research evidence, all 12 items of the NEO-FFI extraversion scale in the current study will be subjected to two separate principal components analyses. The first will examine the variance accounted for in a forced one-component solution, interpreted as extraversion. The second principal components analysis will explore the data without imposing constraints on the solution for evidence in support of previous findings (e.g. Hull et al., 2010; Saucier, 1998). To adhere to the guidelines in the test manual (see Costa Jr. & McCrae, 1992), varimax rotation will be employed to aid in the interpretation of the results.

**Principal Components Analysis with a Forced One-Component Solution**

Using the 12 NEO-FFI extraversion items as data, the single-item measures were intercorrelated, and subjected to principal components analysis with a forced one-component solution. The Kaiser-Meyer-Olkin value was .839, exceeding the recommended values of .6 (Kaiser, 1970, 1974) and Bartlett’s Test of Sphericity (Bartlett, 1954) reached statistical significance, supporting the factorability of the correlation matrix. The results revealed a forced one-component solution accounted for 34% of the variance. Cronbach’s alpha for the 12 items is .81.

Table 14 below, shows the factor loadings of each of the items on the single component along with the communalities. The criterion for determining a loading on a component is set at .4. Communalities < .3 are of no utility as they indicate that the particular item does not fit well with the other items on its component (Pallant,
2007). As can be seen from Table 14, two of the 12 items failed to load on this one component. In addition, four of the 12 items achieved communalities < .3.

Table 14:
Principal components analysis with a forced one-component solution of the NEO-FFI 12-item extraversion scale.

<table>
<thead>
<tr>
<th>Item#:</th>
<th>Personality Measure (Facet Scale from the original NEO-PI-R)</th>
<th>Component Matrix</th>
<th>Communality</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>C1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Extraversion)</td>
<td></td>
</tr>
<tr>
<td>17:</td>
<td>I really enjoy talking to people (Warmth) *</td>
<td>.648</td>
<td>.420</td>
</tr>
<tr>
<td>2:</td>
<td>I like to have a lot of people around me (Gregariousness) *</td>
<td>.542</td>
<td>.294</td>
</tr>
<tr>
<td>27:</td>
<td>I usually prefer to do things alone* (Gregariousness) *</td>
<td>.383</td>
<td>.147</td>
</tr>
<tr>
<td>57:</td>
<td>I would rather go my own way than be a leader of others* (Assertiveness) *</td>
<td>.243</td>
<td>.059</td>
</tr>
<tr>
<td>22:</td>
<td>I like to be where the action is (Excitement-seeking) b</td>
<td>.573</td>
<td>.329</td>
</tr>
<tr>
<td>32:</td>
<td>I often feel as if I’m bursting with energy (Activity) b</td>
<td>.619</td>
<td>.383</td>
</tr>
<tr>
<td>47:</td>
<td>My life is fast-paced (Activity) b</td>
<td>.463</td>
<td>.214</td>
</tr>
<tr>
<td>52:</td>
<td>I am a very active person (Activity) b</td>
<td>.567</td>
<td>.322</td>
</tr>
<tr>
<td>42:</td>
<td>I am a cheerful optimist (Positive emotions) c</td>
<td>.750</td>
<td>.563</td>
</tr>
<tr>
<td>12:</td>
<td>I am very “light-hearted” (Positive emotions) c</td>
<td>.586</td>
<td>.344</td>
</tr>
<tr>
<td>37:</td>
<td>I am a cheerful, high-spirited person (Positive emotions) c</td>
<td>.816</td>
<td>.666</td>
</tr>
<tr>
<td>7:</td>
<td>I laugh easily (Positive emotions) c</td>
<td>.594</td>
<td>.353</td>
</tr>
</tbody>
</table>

Note. *Reversed-scored item; aSociability Facet; bActivity Facet; cPositive Emotions Facet and Cronbach alpha in **bold**.

It appears from these results that a one-component solution cannot adequately account for the variance in the 12 items of the NEO-FFI extraversion scale. Therefore, proceeding to test the relationship between extraversion and a circumplex model of core affect, from a composite measure of these 12 items, is not possible.

Unforced Principal Components Solution

Examining an unforced principal components solution, the results revealed the presence of three components with eigenvalues exceeding 1, accounting for
34.1%, 13.4%, and 10.3% respectively. This was further supported by the results of Parallel Analysis (Horn, 1965). As shown in Table 15, only three components exceeded those criterion values for a randomly generated data matrix of the same size (23 variables × 804 respondents).

Table 15:
*Total variance explained, initial eigenvalues, and eigenvalues generated from Parallel Analysis.*

<table>
<thead>
<tr>
<th>Initial Eigenvalues</th>
<th>% Variance of Accounted for</th>
<th>Cumulative %</th>
<th>Eigenvalues generated from Parallel Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.093</td>
<td>34.11</td>
<td>34.11</td>
<td>1.202</td>
</tr>
<tr>
<td>1.606</td>
<td>13.38</td>
<td>47.49</td>
<td>1.147</td>
</tr>
<tr>
<td>1.240</td>
<td>10.33</td>
<td>57.83</td>
<td>1.109</td>
</tr>
<tr>
<td>0.893</td>
<td>7.44</td>
<td>65.27</td>
<td>1.195</td>
</tr>
</tbody>
</table>

Note. Major loadings in bold show the first three eigenvalues in the PCA.

Together, the three-component solution accounted for a total of 57.8% of the variance, with component one (C1) contributing 34.11%, component two (C2) 13.38%, and component three (C3) 10.33%. The interpretation of the solution after varimax rotation is consistent with the NEO-FFI conception of *extraversion* given by Saucier (1998) as (C1) *positive affect*, (C2) *activity*, and (C3) *sociability*. However, based on the criterion set at .4 for determining a loading on a component, the rotated solution did not reveal the presence of simple structure (Thurstone, 1947). As shown in Table 16 below, the *warmth* item depicting *sociability* on C3 cross-loaded on C1 (i.e., *positive affect*), and the *excitement-seeking* item depicting *activity* on C2 cross-loaded on C3 (i.e., *sociability*). Whilst the *warmth* and *excitement-seeking* items were not included in the ‘problematic’ item-pool previously identified by Hull et al. (2010), both items along with many others in the study conducted by Saucier (1998) cross loaded (criterion set at >.3), on a non-corresponding component.
Table 16:
PCA of the NEO-FFI 12 item Extraversion Scale. Unrotated and rotated varimax solutions, and communalities.

<table>
<thead>
<tr>
<th>Personality Measure</th>
<th>Component Matrix</th>
<th>Component Matrix with Varimax Rotation</th>
<th>Communalities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C1</td>
<td>C2</td>
<td>C3</td>
</tr>
<tr>
<td><em>I really enjoy talking to people</em> (Warmth)</td>
<td>.648</td>
<td>.112</td>
<td>.242</td>
</tr>
<tr>
<td><em>I like to have a lot of people around me</em> (Gregariousness)</td>
<td>.542</td>
<td>.375</td>
<td>.293</td>
</tr>
<tr>
<td><em>I usually prefer to do things alone</em> (Gregariousness)</td>
<td>.383</td>
<td>.432</td>
<td>.397</td>
</tr>
<tr>
<td><em>I would rather go my own way than be a leader of others</em> (Assertiveness)</td>
<td>.243</td>
<td>.515</td>
<td>.316</td>
</tr>
<tr>
<td><em>I like to be where the action is</em> (Excitement-seeking)</td>
<td>.573</td>
<td>.381</td>
<td>-.056</td>
</tr>
<tr>
<td><em>I often feel as if I’m bursting with energy</em> (Activity)</td>
<td>.619</td>
<td>.033</td>
<td>-.513</td>
</tr>
<tr>
<td><em>My life is fast-paced</em> (Activity)</td>
<td>.463</td>
<td>.416</td>
<td>-.361</td>
</tr>
<tr>
<td><em>I am a very active person</em> (Activity)</td>
<td>.567</td>
<td>.098</td>
<td>-.598</td>
</tr>
<tr>
<td><em>I am a cheerful optimist</em> (Positive affect)</td>
<td>.750</td>
<td>-.330</td>
<td>.042</td>
</tr>
<tr>
<td><em>I am very “light-hearted”</em> (Positive affect)</td>
<td>.586</td>
<td>-.525</td>
<td>.173</td>
</tr>
<tr>
<td><em>I am a cheerful, high-spirited person</em> (Positive affect)</td>
<td>.816</td>
<td>-.275</td>
<td>.051</td>
</tr>
<tr>
<td><em>I laugh easily</em> (Positive affect)</td>
<td>.594</td>
<td>-.461</td>
<td>.228</td>
</tr>
</tbody>
</table>

Note: Major loadings are in bold. Reversed-scored item; *Sociability Facet; Activity Facet; Positive Affect Facet
In summary, the findings of both principal components analyses suggest a component structure for the NEO-FFI extraversion scale that is mainly commensurate with conceptualisations and empirical findings of Saucier (1998). Furthermore, these and the other findings reviewed (e.g. Hull et al., 2010) allude to the difficulty in obtaining simple structure from a personality measure such as the NEO-FFI. Ultimately, the findings do not provide sufficient evidence for a global factor of extraversion. A forced one-component solution produced a substantial reduction in total variance, to 34% as opposed to 58% for a three-component solution. Communalities for the forced solution were low with 4 of the 12 items attracting loadings of < .3, suggesting at least one third of the items did not belong on this one component.

While the problem of a lack of simple structure remains in representing extraversion as three broad facets, these latter findings replicate prior research and thus, can be used to build a more consistent research evidence base for an alternative conceptualisation of the extraversion superfactor. Therefore, the decision was made to adopt Saucier’s (1998) interpretation of the NEO-FFI extraversion scale as three broad facets: positive affect ($\alpha = .83$), activity ($\alpha = .71$), and sociability ($\alpha = .59$). Notably, Crobach’s alpha coefficients in the current study are more robust than those reported by Saucier (e.g. positive affect: $\alpha = .72$; activity: $\alpha = .52$; sociability: $\alpha = .57$). These measures along with general life satisfaction, subjective wellbeing, self esteem, and optimism will be related to a circumplex model of core affect in the upcoming cosine wave analysis.

Data cleaning

Less than 5% missing data were detected across all study variables and were dealt with by means of listwise deletion. To eliminate response sets inherent in measures concerning subjective evaluations of satisfaction with life, participants’ scores on SWB, self-esteem, and optimism were compared. It is highly likely that participants who achieve a maximum score of 100 on all three measures are demonstrating an acquiescent response style. In the current sample, 14 participants responded in this way and were therefore removed from the analysis. Univariate outliers were detected on the PWI and GLS. A closer inspection of the tails of the histograms and boxplots using the Explore option in SPSS revealed three participants.
had reported zero on all seven domains of the PWI. Hence, these individuals were removed from the data set. In the case of GLS, four extreme (zero) scores were detected. These univariate outliers were re-assigned a value one unit below the next extreme score in the distribution (Tabachnick & Fidell, 2007).

In order to detect multivariate outliers, separate standard multiple regressions were conducted. The IVs were the 23 single-item affect measures regressed against each of the DVs (i.e., GLS, PWI, RSE, LOT, NEO-FFI facets). An inspection of the standardised residuals, together with Mahalanobis and Cook’s distances, revealed four participants whose very low scores consistently increased all three indices across the analyses. These individuals were subsequently removed from the data set.

Statistical analyses

As all study variables were measured on a 0-10 point response scale, transformation onto a 0 to 100 point distribution was achieved by shifting the decimal point one step to the right. For example, a response of 5.0 on the 0 – 10 scale became 50 points. Table 17 presents the psychometric properties of the external variables in the study.

Table 17:
Psychometric properties of the external variables placed within the circumplex.

<table>
<thead>
<tr>
<th>Composite Variable</th>
<th>Variable</th>
<th>( M )</th>
<th>( SD )</th>
<th>( \text{Min} )</th>
<th>( \text{Max} )</th>
<th>( \text{Skew} )</th>
<th>( \alpha )</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Life Satisfaction (GLS)</td>
<td></td>
<td>75.58</td>
<td>16.71</td>
<td>10.00</td>
<td>100.00</td>
<td>-1.32</td>
<td>-</td>
</tr>
<tr>
<td>Personal Wellbeing Index (PWI)</td>
<td></td>
<td>74.84</td>
<td>13.78</td>
<td>21.43</td>
<td>98.57</td>
<td>-1.14</td>
<td>.86</td>
</tr>
<tr>
<td>Rosenberg Self-Esteem scale (RSE)</td>
<td></td>
<td>78.21</td>
<td>15.52</td>
<td>00.00</td>
<td>100.00</td>
<td>-1.26</td>
<td>.93</td>
</tr>
<tr>
<td>Life Orientation Test-Revised (LOT-R)</td>
<td></td>
<td>68.61</td>
<td>18.73</td>
<td>00.00</td>
<td>100.00</td>
<td>-0.89</td>
<td>.85</td>
</tr>
<tr>
<td>NEO Five Factor Inventory - (Positive Affect)</td>
<td></td>
<td>65.50</td>
<td>18.46</td>
<td>00.00</td>
<td>100.00</td>
<td>-0.58</td>
<td>.83</td>
</tr>
<tr>
<td>NEO Five Factor Inventory - (Activity)</td>
<td></td>
<td>53.26</td>
<td>18.44</td>
<td>00.00</td>
<td>100.00</td>
<td>-0.16</td>
<td>.71</td>
</tr>
<tr>
<td>NEO Five Factor Inventory - (Sociability)</td>
<td></td>
<td>54.97</td>
<td>16.03</td>
<td>05.00</td>
<td>97.50</td>
<td>-0.36</td>
<td>.59</td>
</tr>
</tbody>
</table>

Note: (GLS): Single-item measure of SWB, \( n = 975 \); (PWI): Composite measure of SWB, \( n = 941 \); (RSE) Composite measure of Self-Esteem, \( n = 970 \); (LOT-R): Composite measure of Optimism, \( n = 970 \); (NEO-FFI): Composite measures of Positive Affect, \( n = 958 \); Activity, \( n = 952 \); Sociability \( n = 833 \). Possible scores range from 0 to 100 for each composite measure.
Cosine wave analysis

The statistical software programme Statistica version 6 (Statsoft, 1984) was used to conduct the cosine wave analysis. The final data file contained eight variables. The first column in the data file was designated ‘X’ to represent pre-specified values for the 23 polar angles or segments obtained in the previous CIRCUM analysis from the 23 affects. The remaining columns represent zero-order correlations between each of the external trait variables (i.e., general life satisfaction, subjective wellbeing, self-esteem, optimism, positive emotions, sociability, and activity), and each segment of ‘X’. Via the ‘statistics’ module in the drop-down menu, advanced non-linear estimation modeling was chosen along with the option to employ a “user-specified regression function”. As previously outlined in section 1.3.5 of the literature review, the specific regression function to be estimated is:

\[ Y = a + b \cdot \cos(X + d) \]

where \( Y \) is the correlation between each segment of the circumplex model of affect and each external variable; \( X \) is the angle for the segment within the circumplex model. \( a, b, \) and \( d \) are constants to be estimated in the estimation procedure. In this formulation, \( a \) adjusts the values of \( Y \) to fit the cosine function; \( b \) indicates the amplitude of the cosine wave; \( d \) indicates the start value of \( X \) when it does not start at 0. As an example, to chart the relation between subjective wellbeing and the 23 segments of the circumplex model of affect the user specifies the following equation:

\[ SWB = a + b \cdot \cos(X + d) \]

The results of the cosine wave analysis for each external variable placed within a circumplex model of affect are presented in Table 18.
3.2. RESULTS

Table 18:

Placing external variables within a circumplex established from 23 single-item affect measures via the Cosine Wave Method.

<table>
<thead>
<tr>
<th>TRAIT SCALE</th>
<th>Cosine Method</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>â</td>
<td>$r_{max}$</td>
<td>VAF (%)</td>
</tr>
<tr>
<td>GLS – (General Life Satisfaction)</td>
<td>357º</td>
<td>.64</td>
<td>97</td>
</tr>
<tr>
<td>PWI – (Subjective Wellbeing)</td>
<td>356º</td>
<td>.65</td>
<td>98</td>
</tr>
<tr>
<td>RSE – (Self-esteem)</td>
<td>356º</td>
<td>.59</td>
<td>98</td>
</tr>
<tr>
<td>LOT-R – (Optimism)</td>
<td>354º</td>
<td>.55</td>
<td>98</td>
</tr>
<tr>
<td>NEO-FFI – (Positive Affect)</td>
<td>352º</td>
<td>.48</td>
<td>97</td>
</tr>
<tr>
<td>NEO-FFI – (Sociability)</td>
<td>11º</td>
<td>.21</td>
<td>89</td>
</tr>
<tr>
<td>NEO-FFI – (Activity)</td>
<td>28º</td>
<td>.44</td>
<td>95</td>
</tr>
</tbody>
</table>

Note: All values of VAF were significant at the $p < .01$ level.

The summary statistics are based on estimates for the constants a, b, and d and form the basis from which to estimate $\hat{\alpha}$ (a-hat) that indicates where within the circumplex the external variable falls. As shown in the table, $\hat{\alpha}$ has produced a polar angle for each external variable, the locations of which range between 352º and 28º on the circumplex. Next, an estimate of $r_{max}$ (rmax) indicates the maximum correlation between each external variable and a circumplex segment. Therefore, where the empirical estimates of $a$, $b$, and $d$, and $\hat{\alpha}$ are inserted in the equation:

$$r_{max} = a + b \cdot \cos (\hat{\alpha} + d)$$

Using the findings in Table 18 for subjective wellbeing, the equation yields the following finding. Participants who rated their subjective wellbeing had a strong tendency ($r_{max} = .65$) to report a specific type of core affect (pleasantness) that is best characterised by the peak of the fitted curve at ($\hat{\alpha} = 356º$) within the circumplex. The final statistic provided by the cosine wave analysis is the percentage of variance accounted for (VAF). $VAF$ can be considered the ‘fit’ of the obtained correlations to a cosine function. The results indicate that the ‘line of best-fit’ through the data reliably approximates a cosine curve for all variables in the study; the ‘data’ being...
the circumplex model of 23 affects with each external variable included separately as part of the model.

The significance levels of VAF and $r_{max}$, are determined by a Monte Carlo simulation study. This study was conducted by Yik et al. (2011) and was outlined in section 1.3.5 of the literature review. The outcome of this study sets alpha levels for significance at $p < .05$ for values of VAF $\geq 45.5\%$, and $p < .01$ for values $\geq 57.6\%$. Values of $r_{max}$ that are $< .15$ indicate that the external variable is unrelated to a circumplex model of affect. As shown in Table 18, VAF values for all external variables are significant at the $p < .01$ level, and $r_{max}$ values are well above the critical value of .15, indicating all variables are reliably and meaningfully related to a structure of core affect. Figure 20 below reveals the specific blend of Hedonic Valence and Arousal on the circumplex that is most strongly associated with these external measures. The strongest point of association found between all external variables and the circumplex model of core affect is located within a region of the circumplex ranging between 352° and 28° on the circumference of the circle.

**Figure 19:** The strongest point of association found between all of the listed external variables and a circumplex model of 23 affects.
In sum, the results of the cosine wave analysis have empirically defined a specific type of core affect accompanying these responses. This definition is commensurate with Cummins’ (2010, 2012) conceptualisation of HPMood as a ‘pleasant and mildly activated’ core state of affect. The analysis has also revealed the degree to which SWB, and major correlates of SWB, are affective in nature. Furthermore, Figure 20 below compares the observed locations of the composite affects used to create the circumplex model of affect in the first study, with the newly established empirical definition of HPMood. As can be seen, lay descriptions of HPMood (e.g. content, happy, excited, alert, active, energised) are commensurate with the new empirical definition of HPMood as a ‘mildly pleasant and activated’ core state of affect.

*Figure 20: Commensurability between laypersons’ description of HPMood and the newly established empirical definition of HPMood.*
3.3. DISCUSSION

The main aim of the current study was to validate the theoretical definition of HPmood as a pleasant and mildly activated ‘core’ state of affect on the circumplex, and to test previous findings, using linear models, that SWB and major correlates of SWB are mostly affective in nature. The procedure employed to investigate the affective core of SWB and major correlates, the circular way, is known as the Cosine Wave Method (Yik, 2009; Yik et al., 2011). This technique treated the affective circumplex model established in Study 1 Part A as an integration tool to chart a relation between the established structure of core affect and variables in the Homeostatic Model of SWB (Cummins, 2010; Cummins, 2013; Cummins & Nistico, 2002).

The guiding principle is that each variable in the Homeostatic Model that correlates with one affect within the circumplex will correlate with the remaining affects in a systematic way. The magnitude of that correlation will rise and fall in a cosine wave pattern as one moves around the circumference of the circumplex (Stern, 1970; Wiggins, 1979). The peak of a fitted cosine curve when each external variable is related to the model of core affect represents the strongest point of association between that variable and a structure of core affect. This locates HPmood on the circumplex, and reveals the degree to which SWB and major correlates of SWB are affective in nature. Until now, no study has validated the affective core of SWB called HPmood, using a structural model that best describes its specific blend of Hedonic Valence and Arousal.

Whereas Study 1 Part A took a largely inductive approach to investigating affective structure, the circular way with the CIRCUM procedure, Study 1 Part B has utilised the circumplex to make a number of predictions based on SWB Homeostasis theory with the Cosine Wave Method.

Hypothesis 1: The strongest point of association between the affective circumplex and any one of the external variables will elucidate where HPmood resides within the circumplex.

Justification for this prediction is based on the theoretical assumption that all of the listed external variables are infused with a form of core affect described as
'pleasant and mildly activated'. By relating these external variables to an entire structure of core affect established in the first study, it was possible to examine a specific blend of Hedonic Valence and Arousal underlying responses to these variables. An illustration of the designated range of 352° to 28° found for all listed external variables is given in Figure 19. Empirical locations have demarcated an area of the circumplex, which resembles the theoretical nature of HPMood as 'mildly pleasant and activated'. Therefore, the results provide a first approximation of HPMood on the circumplex, and support the first hypothesis.

More precisely, the estimated location of GLS is 357° with 97% VAF. SWB and self-esteem share identical locations at 356° with 98% VAF. This indicates, first, that almost all of the variance in the correlation pattern is accounted for by the cosine cure. Second, participants who rated their levels of GLS, SWB, and self-esteem tended to report a specific type of core affect best described as ‘pleasant’. The implication of this for theory building is that, in this instance of measurement, the nature of the set-point HPMood accompanying responses to these measures is more pleasant and less activated than theoretically described (Cummins, 2010, 2012). However, this is the first study to employ the Cosine Wave Method to chart a relation between an affective circumplex, and measures of SWB and self-esteem, and hence this is a first approximation of HPMood on the circumplex. It will be most interesting to observe, with replication, whether variables in the Homeostatic Model reliably predict a range within which HPMood can be normally described.

It is possible to observe this normal descriptive range with the trait measure of optimism. The first researchers to employ the Cosine Wave Method to chart a relation between optimism using the Life Orientation Test (Carver & Scheier, 1992) and a structure of core affect were Yik et al. (2011). In their analysis, optimism was located at 7° with 100% VAF to indicate that, participants who rated their levels of optimism tended to report a specific type of core affect best described as ‘mildly activated pleasure’. This description of HPMood is commensurate with Cummins’ (2010, 2012) theoretical definition. Yet in the current analysis, optimism is located at 354° with 98% VAF and thus, the description of HPMood is pleasant and slightly de-activated.
Comparing the current findings to those of Yik et al. (2011), the discrepancy between polar estimates (354° and 7°) is 13°. This falls within confidence limits of 20° set by Remington et al. (2000) for determining reliability in estimation across different studies. The $r_{max}$ values suggest that HPMood has a moderate effect on reported levels of optimism in the current analysis ($r_{max} = .55$) and in the analysis conducted by Yik et al. ($r_{max} = .46$). Taken together, either study is considered to be a reliable estimate of the affective core of optimism. This implies that HPMood could be described as always pleasant, yet it may vary in levels of arousal. However, this description is based on comparing cross-sectional studies, and must be interpreted with caution.

Turning now to the type of core affect accompanying the facets of extraversion, the results of the cosine wave analysis revealed that the NEO-FFI extraversion facets are variously located within a range of 352° to 28° on the circumplex. The positive affect facet is located at 352° with 97% VAF, sociability is located at 11° with 89% VAF, and activity is located at 28° with 95% VAF, with up to 36° of separation between them. These results suggest that participants who responded to the NEO-FFI extraversion items tended to report different core affective states, with the differentiation lying in the level of arousal.

This finding may explain why combining the facets to form a single measure of extraversion in a circumplex analysis, has produced many different correspondences to a structure of core affect (Yik, 2009; Yik et al., 2002; Yik et al., 2011). For example, the NEO-FFI extraversion scale has been variously located within a range of 357° to 33°. Indeed, this range resembles the suggested descriptive range for HPMood where all three facets of extraversion are located in the current analysis. Therefore, it would seem that HPMood characterises the affective core of trait extraversion.

Research evidence consistent with this claim suggests that, the central component of extraversion is positively affective in nature (Lucas, Diener, Grob, Suh, & Shao, 2000). The observed close proximity of positive affect to SWB is also consistent with Costa and McCrae’s (1992) assertion that this facet of the NEO-FFI extraversion is most strongly related to SWB. The current analysis shows that this relatedness is due to a shared correspondence with a structure of core affect, and
implies that the true irreducible essence of extraversion and SWB is HPMood. This finding on the circumplex could also explain why in linear modeling (Davern et al., 2007), HPMood represented as ‘happy’, ‘content’, and ‘excited’, accounts for almost all of the shared variance between the NEO-FFI extraversion and SWB.

Notably, the precision in estimating the type of core affect accompanying sociability must be interpreted with caution. This is due to a lack of internal consistency ($\alpha = .59$), when two of the four items cross-loaded in preliminary principle components analysis. The first item, depicting ‘warmth’ cross-loaded on positive affect. The second item, depicting ‘excitement-seeking’, cross-loaded on activity. Therefore, the weak magnitude of effect of HPMood (.04%) likely indicates systematic measurement error, and its attenuation of correlation coefficients in circumplex analyses (Browne, 1992).

These findings further add to an ongoing debate discussed in section 1.3.1 of the literature review, which surrounds identifying the basic dimensions of affect from dimensions of personality (Watson & Tellegen, 1985; Watson et al., 1999; Yik et al., 2002; Yik et al., 2011). The current findings support the aforementioned research evidence (e.g. Yik, 2009; Yik et al., 2002; Yik et al., 2011) to show that personality (i.e., extraversion) comes closer to Hedonic Valence than to ‘High Positive Affectivity’, according to Watson and Tellegen’s (1985; Watson et al., 1999) 45° thesis.

Hypothesis 2: The specific kind of core affect located on the circumplex, called HPMood, will support Cummins’ theoretical definition of HPMood as a ‘mildly pleasant and activated’ core state of affect.

Justification for the second prediction is based on the consistent finding in linear regression analyses (Blore et al., 2011; Davern et al., 2007) that only certain kinds of lay descriptors (happy, content, active, energised) uniquely predict scores on GLS, which is considered a proxy for the set-point HPMood. This alludes to the shared existence among these lay terms of a specific blend of Hedonic Valence and Arousal. Cummins (2010, 2012) has theorised, this blend is ‘pleasant and mildly activated’. As results supporting the first hypothesis show, by placing each external variable separately into the circumplex, a descriptive range for locating HPMood is
established on the circumplex. As a first approximation, this range supports Cummins’ (2010, 2012) theoretical definition of HPMood as *‘mildly pleasant and activated’*.

However, it is now possible to examine, post-test, the specific blend of HPMood accompanying each, separate variable. As was previously discussed, GLS is considered a proxy for the set-point (HPMood) (Cummins, 2010; Cummins et al., 2014). Therefore, the most valid empirical definition of HPMood, as a first approximation, is located at 357° on the circumplex to describe ‘pleasantness’. The ability to synthesise the findings from both studies (Study 1 Part A and Part B) is a most informative aspect of the current research design, as it provides multiple levels of complexity for describing the HPMood construct. This strengthens the construct validity of HPMood, and establishes convergent validity with prior replication studies to adopt linear methods (Blore et al., 2011; Davern et al., 2007; Lai & Cummins, 2013; Tomyn & Cummins, 2011).

For example, the circumplex has provided an analysis of those elementary components represented in the data (Guttman, 1954a), which has in turn, provided a fundamental level of description for HPMood as *‘mildly pleasant and activated’*. Superimposed over this newly established descriptive range for HPMood (352° to 28°), is a more peripheral level of analysis, one that lies in the language system of the respondents and is inextricably linked to the specifics of the local culture (Guttman, 1954a; Russell, 1991; Wierzbicka, 1986, 1994). In the language culture of normal Australians in the current analysis, the folk terms located within the descriptive range for HPMood are ‘happy’ (356°), ‘content’ (353°), ‘alert’ (18°), ‘excited’ (16°), and ‘active’ (27°). Indeed, these terms (along with the term ‘energised’) are most predictive of HPMood in linear models (Blore et al., 2011; Davern et al., 2007; Lai & Cummins, 2013; Tomyn & Cummins, 2011).

Furthermore, this first approximation for describing the set-point HPMood reveals there is one word Australians’ use that best describes the ‘pleasant’ affective core accompanying responses to SWB measures, and to self esteem (e.g. GLS at 357°; PWI at 356°; RSE at 356°). This word is *‘happy’* at 356°. This supports the well-established finding that happiness is synonymous with feeling both satisfied with the self and life in general (Campbell et al., 1976; Cummins, 2013; Cummins &
Nistico, 2002; Tatarkiewicz, 1976). This demonstrated commensurability between lay and empirical descriptions of HPMood is the most valid finding to date. The challenge for future research is to replicate the current findings in a new circumplex analysis. Therefore, in addition to establishing a 12-point circumplex model of momentary affect from composite scales in the next study, a future aim is to provide a comparative analysis of the reliability of the cosine wave technique to locate these various levels of description for HPMood on the circumplex.

_Hypothesis 3: A substantial association between a circumplex model of core affect, and all of the listed external variables will be evidenced, with the strongest magnitude of association evidenced by SWB measures._

Justification for the third prediction was based on a growing body of research (Blore et al., 2011; Davern et al., 2007; Lai & Cummins, 2013; Tomyn & Cummins, 2011) that indicates much of the shared variance between SWB measures and related variables, is accounted for by a small composite of affects (happy, content, alert/excited/active), with SWB measures (e.g. PWI and GLS) most dominated by these affects. The results revealed that when a series of correlations between the 23 circumplex affects and each external variable was fitted to a pre-defined cosine function in the cosine wave analysis, 89-98% of the variance was accounted for in the model, depending on the listed variable. This indicates that all of the listed external variables are reliably related ($p < .01$) to a structure of core affect.

Whilst the variance accounted for (VAF) value is necessary for indicating whether an external variable is related to a structure of core affect, it is not sufficient. The real value lies in $r_{max}$ because the greater the magnitude of the relation between an external variable and a structure of core affect, the more meaningful the results should be (Yik et al., 2011). Based on the criterion value set at $> .15$ in Monte Carlo testing as an effect size indicator (see Yik, 2009), the magnitude of the $r_{max}$ values in the current analysis indicate precision in estimation is highly meaningful. Maximum correlations for the listed variables ranged from .21 to .65, with GLS and SWB achieving the strongest magnitudes of association (.64 and .65, respectively). Thus, the third hypothesis is fully supported.
Elaborating on these findings, while SWB is found to be more affective in nature compared to the other listed variables, the analysis does not appear to support interpretations of previous findings, with linear models, that HPMood dominates these responses. Instead, HPMood predicts up to 42% of the variance depending on the listed variable. In specific relation to SWB, the cosine wave analysis has estimated that approximately 42.3% of the variance in scores is accounted for by HPMood. In previous linear multiple regression analyses (see Blore et al., 2011; Davern et al., 2007) a small composite of affects, which alludes to the nature of HPMood as a core affective construct, accounts for up to 64% of the variance.

One explanation for the reduced magnitude of effect in the current analysis is that circumplex structures are models of structural interdependence (see section 1.3.2 of the literature review for a detailed discussion). Therefore, they cannot partial out the effects of systematic (correlated) error variance. This form of non-random error attenuates correlation coefficients that are used for inferences of effect size (Browne, 1992). The implication of this is that the increased signal to noise ratio may have concealed HPMood’s true (error-free) magnitude of association. In sum, this test confirms SWB is more affective in nature than it major correlates. However, it does not conclusively support the claim that SWB is mostly affective in nature.

In conclusion, all listed external variables in the study are reliably and meaningfully related to a structure of core affect. SWB is also more affective in nature compared to self-esteem, optimism, and facets of extraversion. However, the results do not provide conclusive evidence that HPMood dominates these experiences. The normal descriptive range demarcated by all listed variables is commensurate with Cummins’ (2010, 2012) theoretical understanding of HPMood and with lay descriptions of HPMood in prior linear models (Blore et al., 2011; Davern et al., 2007; Lai & Cummins, 2013; Tomyn & Cummins, 2011). Therefore, HPMood as a core affective construct has been empirically validated, for the first time.
CHAPTER 4:
STUDY 2: Part A

THE CREATION OF A 12-POINT CIRCUMPLEX MODEL OF MOMENTARY AFFECT

The main aim of Study 2 Part A is to improve on the research design employed in Study 1 Part A. To briefly re-cap, participants in the first part of Study 1 completed a questionnaire asking them to indicate how each of 24 affect items described their feelings when they thought about their life in general. The overall aim was to integrate participants’ responses to these measures into one structure to create a measurement map of affective feelings on the circumplex. The findings in relation to examining the precise locations of affective states on the circumplex indicated that, the sample of affects chosen to represent an affective circumplex structure (n = 23) predicted the bottom half of the circle relatively well. However, the top half of the circle was not as well predicted.

These results support the notion that it is difficult to capture high activation in participants’ responses from semantic labels (M. Yik, personal communication, July 7th, 2012; Remington et al., 2000). Therefore, refining the item selection process, and increasing the number of affects sampled to capture more regions of the circumplex are design aims of the current study. The results of Study 1 Part A also supported the intuitive assumption that less activation was captured in the model due to the ‘life in general’ nature of the test question. If words alone are sufficient for distinguishing state from trait measures (Allen & Potkay, 1981), then it is possible that constructing a circumplex model from self-report ratings involving shorter time frames (i.e., momentary states), rather than longer time frames (i.e., trait judgements), will not only improve the overall fit of the model (see Remington et al.), it will likely capture more acute fluctuation in felt responses. It will also fulfil the ultimate study aim of Study 2 part A, that is, to replicate Yik’s (2009) 12-point Chinese circumplex model of momentary affect, in English.
AIMS AND PREDICTIONS

Following the empirical findings of Study 1 Part A, this Study 2 Part A aims to increase the affect sample from 24 single items to 48 single items to offer a 12-point circumplex model of momentary affect from composite scales. All aspects of study design and methodology will replicate Yik’s Chinese circumplex model of affect, (CCMA) (Yik, 2009), in English in the following ways:

1. Using 48 ipsatised affective descriptors as data, preliminary statistical analyses will explore the component structure of affect in relation to the circumplex using principal components analysis. The first two components of an unrotated solution are anticipated to reveal the two independent and bipolar dimensions of core affect in Hedonic Valence and Arousal. From here, a factor plot for the two bipolar dimensions will be generated to examine the pattern of interrelatedness among the response items for circularity.

2. In order to confirm that affective structure is bipolar, the research design must reflect an assumption of structural independence, so as not to impose bipolarity on the data (Yik et al., 1999). As such, unipolar response scales are employed at the questionnaire level for rating responses (see section 1.3.5 of the literature review for a detailed discussion of this design). At the confirmatory level of analysis, all manifest (observed) variables are thus treated as unipolar constructs. To replicate research design and methodology employed by Yik (2009), 12 unipolar scales represented by four items each will be constructed and hypothesised to slice the circumplex into segments spaced approximately 30° apart.

3. Extending on methodology employed in Study 1 Part A, Yik et al.’s (1999; Yik et al., 2002; Yik et al., 2011) confirmatory methods with linear modeling will be replicated. A measurement model will be established from 16 ipsatised affects in order to confirm a structure that represents the four (unipolar) cornerstone constructs of ‘Pleasant’, ‘Unpleasant’, ‘Activated’, and ‘Deactivated’ as bipolar continua in Hedonic Valence and Arousal. Estimation will proceed in the following manner:
a. The measurement model will estimate factor loadings for each manifest variable intended to represent each of the four cornerstone latent constructs in ‘Pleasant’, ‘Unpleasant’, ‘Activated’, and ‘Deactivated’. Error variance associated with each manifest variable and correlations between latent constructs will also be estimated.

b. The inter factor correlation matrix will be examined for bipolarity. This simple test of bipolarity must indicate structural interdependence (≥-.47) (Segura & Gonzalez-Roma, 2003) between unipolar dimensions theorised to be located 180° apart on the circumplex (e.g. ‘pleasant’-‘unpleasant’; ‘activated’-‘deactivated’). Correlations between unipolar dimensions theorised to be located 90° apart (e.g. ‘pleasant’-‘activated’; ‘pleasant-deactivated’; ‘unpleasant-‘activated’; ‘unpleasant-deactivated’) must indicate structural independence (< +/- .47).

4. Assuming the results confirm that the four cornerstone constructs can be represented as two independent and bipolar dimensions of Hedonic Valence and Arousal, a further measurement model will be established. Hedonic Valence will be indicated by eight ipsatised affects, describing ‘pleasant-unpleasant’, while Arousal will be indicated by eight ipsatised affects, describing ‘activated-deactivated’. The two axes will be submitted to structural equation modeling, treated as exogenous variables with their correlation fixed to .00, and used to predict each of the remaining eight constructs or segments of the 12-point circumplex model, treated as endogenous variables. Both the exploratory and confirmatory results with linear methods will be utilised as a measure of convergent validity for the final structural analysis with the CIRCUM procedure.

5. A 12-point circumplex structure will be tested using the CIRCUM procedure to examine the precise location of the 12 constructs within a two-dimensional space. It is anticipated that the creation of a circumplex model from composite scales will provide more reliable estimates for the 12 constructs within a circular ordering. Estimates in the form of polar angles (and 95% confidence intervals) will reveal how well the common space is described, and an
estimate of the minimum common score correlation at 180° will provide a more precise indicator, than the prior measurement model, of the degree to which affective space is bipolar. All aspects of Yik’s methodological approach for conducting CIRCUM analyses, adopted in Study 1 Part A, will be replicated. The creation of a circumplex model of momentary affect from composite scales is predicted to provide a more robust platform from which to replicate HPMood on the circumplex, in Study 2 Part B.

4.1. METHOD

Creation of a Circumplex Model of Momentary Affect from Composite Scales

As part of Study 2 Part A, participants completed a questionnaire asking them to indicate how each of 48 affect items described their feelings in the current moment. The aim was to replicate Yik’s (2009) 12-point Chinese circumplex model of affect (CCMA), in English.

Participants

Participants were 753 adults (359 men and 394 women), with an age range between 21 and 93 years ($M = 61.5$ years, $SD = 13.3$), who took part in the Australian Unity Wellbeing Index Longitudinal Project labelled as ARC24, with data collected over the period of October to December 2012.

Procedure

Ethics approval was obtained from the Deakin University Human Research Ethics Committee (DU-HREC). An external mail-house distributed questionnaire packs to both new recruits and to those who had participated in previous waves of data collection. The packs included introductory letters and plain language statements along with the written survey. Participants’ ability to provide informed consent, their right to confidentiality, and information on the storage and ownership of data were provided in the information packs. In total, 1,550 questionnaires were mailed and the first 753 questionnaires returned formed the current sample. These participants comprise approximately 30% new participants recruited from telephone Survey 27 (April, 2012), the remainder comprising continuing participants from previous waves of the written surveys.
**Measures**

Forty-eight affective descriptors were chosen to theoretically represent twelve $30^\circ$ segments of a circumplex model of momentary affect shown in Figure 21.

![Circumplex Model of Affect](image)

**Figure 21:** The forty-eight affect terms represent a circumplex model of momentary affect. Twelve segments, or vectors $30^\circ$ apart inside the circle, indicate theoretical locations of the chosen affect measures.

The item selection process was guided by English translations originally provided by a bilingual (Cantonese and English) translator, who was involved in the construction of the Chinese Circumplex Model of Affect (CCMA) (M. Yik, personal communication, September 17th, 2012). These English translations were used to communicate among the research team. They were not considered operational definitions. The challenge, therefore, was to provide operational definitions in English that were as close in definition to the original Cantonese descriptors, yet provide meaningful descriptions of feeling states for an Australian, English-speaking population. It was agreed that seven of the 48 items were either too complex (i.e., beyond a sixth-grade reading level), or were not used in everyday expression by Australians. For example, the terms vehement and vivacious were considered too complex, and were replaced with the terms intense and lively, respectively. Terms such as grey-hearted and at a high tide of feelings are not common expressions of
feeling states in Australian society, and so were replaced with the terms despondent and on an emotional high, respectively.

The order of presentation of affect items in the questionnaire was systematic and replicated Professor Yik’s research design. Using the analogy of the clock to represent each 12-point segment, the cornerstone constructs of ‘Pleasant (P)’, ‘Unpleasant (U)’, ‘Activated (A)’, and ‘Deactivated (D)’ are depicted at 3 o’clock, 9 o’clock, 12 o’clock, and 6 o’clock, respectively. The first item of each construct was positioned as the first four items in the questionnaire. For example, carefree (P), unhappy (U), stimulated (A), and still (D) were items 1 to 4. Next, came the first of four items to represent segments at 2 o’clock (AP), 8 o’clock (DD), 11 o’clock (UA), and 5 o’clock (PD) followed by the first of four items to represent segments at 1 o’clock (PA), 7 o’clock (UD), 10 o’clock (AD), and 4 o’clock (DP). The second, third, and fourth items of each construct (12×4=48) were allocated to each segment in the same manner to complete the ordering in the questionnaire.

The instructions for the affect items, adopted from Yik (Yik et al., 1999; Yik, 2009; Yik et al., 2011) were as follows:

“…Before you begin, please pause briefly, CLOSE YOUR EYES, and consider how you are feeling RIGHT NOW, AT THIS VERY MOMENT.

Let’s call it the “CLEAREST MOMENT”.

The FOLLOWING section concerns the feeling that you have just experienced in the “CLEAREST MOMENT”, not the feelings as they change over the course of filling out the questionnaire.

Now please circle the number that most closely describes your feelings experienced in the “CLEAREST MOMENT”.”

The specific wording of this preamble statement is the result of a collaborative exchange between Professor Yik and Myself.

Respondents rated their level of intensity in respect of each item using a 5-point unipolar response scale. Each response option was anchored with the following labels:
(1) “not at all” (2) “a little” (3) ‘moderately” (4) “quite a bit” (5) “extremely”.

Statistical analyses

Affect data were converted to Percentage of Scale Maximum scores (%SM) calculated by the following formula below:

\[
%SM = \frac{x - k_{Min}}{k_{Max} - k_{Min}} \times 100
\]

\(x\) = the score to be converted; where \(k_{Min}\) = the minimum score possible on the scale; where \(k_{Max}\) = the maximum score possible on the scale. This procedure transforms data onto a 0-100 scale.

Data cleaning

All study variables had more than 5% missing data. Given the large sample size and the requirement of the CIRCUM procedure to deal with missing data by means of listwise deletion, all missing data were dealt with in this manner. This reduced the sample size from 753 to 569 respondents. Data were examined for univariate outliers by z-score and multivariate outliers by Mahalanobis distance. Numerous outliers were detected. However, the removal of either univariate outliers (\(n = 16\)), and/or multivariate outliers (\(n = 17\)), did not improve statistical analyses. Therefore, the decision was made to retain the composition of the sample.

Principal components analysis

A principal components analysis was conducted to examine the distribution of 48 affect items on the circumference of an imaginary circle drawn around a two-component space. Replicating the research methodology of Study 1 Part A, the aim of this exploratory analysis is to reduce scores obtained from the 48 single-item measures to scores on a small set of linear composite variables, or principal components, whilst retaining as much information from the original variables as possible (Fabrigar et al., 1999). Each affect item was ipsatised in order to follow Yik’s methodological approach for conducting preliminary analyses of circumplex structure (see Study 1 Part A for a detailed discussion of ipsisation). Two-components are anticipated from the solution, interpreted as the bipolar dimensions of Hedonic Valence and Arousal. Once revealed, a component plot will be generated.
for these two dimensions in order to examine the pattern of interrelatedness among the measured variables for circumplexity. This is achieved by estimating the angular position for each item using its loadings on the two components. The results of this preliminary exploratory analysis will be used as a measure of convergent validity for later systematic structural analyses using the CIRCUM procedure.

### 4.2. RESULTS: EXPLORATORY ANALYSES

Using the 48 ipsatised affects as data, the measures were intercorrelated, and subjected to principal components analysis. The Kaiser-Meyer-Olkin value was .944, exceeding the recommended values of .6 (Kaiser, 1970, 1974) and Bartlett’s Test of Sphericity (Bartlett, 1954) reached statistical significance, supporting the factorability of the correlation matrix. Principal components analysis with ipsatised data revealed the presence of eleven components with eigenvalues exceeding 1. However, a Parallel Analysis (Horn, 1965), which involves comparing the size of the eigenvalues with those obtained from a randomly generated data matrix of the same size (48 variables × 569 respondents) indicated the contribution of these variables is best accounted for by a five-component solution. As shown in Table 19 below, only the first five eigenvalues obtained in the principal components analysis exceeded the values of the randomly generated results.

#### Table 19:

*Total variance accounted for, initial eigenvalues, and eigenvalues generated from Parallel Analysis.*

<table>
<thead>
<tr>
<th>Initial Eigenvalues</th>
<th>% of Variance Accounted for</th>
<th>Cumulative %</th>
<th>Eigenvalues generated from Parallel Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.535</td>
<td>24.03</td>
<td>24.03</td>
<td>1.611</td>
</tr>
<tr>
<td>5.788</td>
<td>9.98</td>
<td>34.01</td>
<td>1.549</td>
</tr>
<tr>
<td>2.106</td>
<td>4.39</td>
<td>38.39</td>
<td>1.502</td>
</tr>
<tr>
<td>1.763</td>
<td>3.67</td>
<td>42.07</td>
<td>1.461</td>
</tr>
<tr>
<td>1.506</td>
<td>3.14</td>
<td>45.20</td>
<td>1.428</td>
</tr>
<tr>
<td>1.308</td>
<td>2.73</td>
<td>47.93</td>
<td>1.395</td>
</tr>
<tr>
<td>1.182</td>
<td>2.46</td>
<td>50.39</td>
<td>1.365</td>
</tr>
<tr>
<td>1.145</td>
<td>2.39</td>
<td>52.78</td>
<td>1.337</td>
</tr>
</tbody>
</table>
Based on these results, it was decided to retain the five components for further investigation. Together they account for a total of 45.2% of the variance, with component one (C1) contributing 24.03%, component two (C2) 9.98%, component three (C3) 4.39%, component four (C4) 3.67%, and component five (C5) 3.14%. In line with Yik’s research methodology employed in Study 1 Part A, interpretation is based on an un-rotated solution. The criterion for determining a loading on a component is set at .4. Communalities less than .3 are of no utility as they indicate that the particular item does not fit well with the other items on its component (Pallant, 2007). Table 20 below, shows the unrotated loadings of each of the items on the five components along with the communalities. As can be seen from Table 20, all of the communalities exceed .3.

Table 20:

_PCA with an unrotated component solution of ipsatised affect items interpreted as Hedonic Valence (HV) and Arousal (A) in accordance with a Circumplex Model of Momentary Affect._

<table>
<thead>
<tr>
<th>Affect Measure</th>
<th>Component Matrix (HV)</th>
<th>Component Matrix (A)</th>
<th>Communalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Theoretical Angle)</td>
<td>C1</td>
<td>C2</td>
<td>C3</td>
</tr>
<tr>
<td>Carefree (P: 0°)</td>
<td>-.502</td>
<td>.022</td>
<td>-.023</td>
</tr>
<tr>
<td>Content (P: 0°)</td>
<td>-.602</td>
<td>-.154</td>
<td>.093</td>
</tr>
<tr>
<td>Satisfied (P: 0°)</td>
<td>-.585</td>
<td>-.094</td>
<td>.076</td>
</tr>
<tr>
<td>At ease (P: 0°)</td>
<td>-.640</td>
<td>-.366</td>
<td>.083</td>
</tr>
<tr>
<td>Overjoyed (AP: 30°)</td>
<td>-.484</td>
<td>.313</td>
<td>1.25</td>
</tr>
<tr>
<td>Vigorous (AP: 30°)</td>
<td>-.449</td>
<td>.469</td>
<td>-.104</td>
</tr>
<tr>
<td>Lively (AP: 30°)</td>
<td>-.510</td>
<td>.544</td>
<td>-.009</td>
</tr>
<tr>
<td>Peppy (AP: 30°)</td>
<td>-.547</td>
<td>.362</td>
<td>-.069</td>
</tr>
<tr>
<td>On an emotional high (PA: 60°)</td>
<td>-.442</td>
<td>.399</td>
<td>-.203</td>
</tr>
<tr>
<td>Affect Measure</td>
<td>Component Matrix</td>
<td>Communalities</td>
<td></td>
</tr>
<tr>
<td>----------------------------------------------------</td>
<td>------------------</td>
<td>---------------</td>
<td></td>
</tr>
<tr>
<td>(Theoretical Angle)</td>
<td>C1</td>
<td>C2</td>
<td>C3</td>
</tr>
<tr>
<td>Passionate (PA: 60°)</td>
<td>-0.396</td>
<td>0.515</td>
<td>-0.073</td>
</tr>
<tr>
<td>Encouraged (PA: 60°)</td>
<td>-0.539</td>
<td>0.202</td>
<td>-0.038</td>
</tr>
<tr>
<td>Bouncing with energy (PA: 60°)</td>
<td>-0.576</td>
<td>0.462</td>
<td>0.026</td>
</tr>
<tr>
<td>Stimulated (A: 90°)</td>
<td>-0.378</td>
<td>0.455</td>
<td>-0.157</td>
</tr>
<tr>
<td>Aroused (A: 90°)</td>
<td>-0.244</td>
<td>0.406</td>
<td>-0.123</td>
</tr>
<tr>
<td>Intense (A: 90°)</td>
<td>0.225</td>
<td>0.467</td>
<td>0.027</td>
</tr>
<tr>
<td>Awed (A: 90°)</td>
<td>-0.117</td>
<td>0.281</td>
<td>0.196</td>
</tr>
<tr>
<td>Quivering with rage (UA: 120°)</td>
<td>0.237</td>
<td>0.026</td>
<td>0.474</td>
</tr>
<tr>
<td>Stunned (UA: 120°)</td>
<td>0.264</td>
<td>0.071</td>
<td>0.600</td>
</tr>
<tr>
<td>Jittery (UA: 120°)</td>
<td>0.579</td>
<td>0.280</td>
<td>0.108</td>
</tr>
<tr>
<td>Shocked (UA: 120°)</td>
<td>0.226</td>
<td>0.159</td>
<td>0.623</td>
</tr>
<tr>
<td>Irritated (AD: 150°)</td>
<td>0.584</td>
<td>0.233</td>
<td>0.120</td>
</tr>
<tr>
<td>Uptight (AD: 150°)</td>
<td>0.655</td>
<td>0.309</td>
<td>-0.040</td>
</tr>
<tr>
<td>Tense (AD: 150°)</td>
<td>0.633</td>
<td>0.390</td>
<td>0.007</td>
</tr>
<tr>
<td>Painfully distressed (AD: 150°)</td>
<td>0.472</td>
<td>0.025</td>
<td>0.484</td>
</tr>
<tr>
<td>Unhappy (U: 180°)</td>
<td>0.689</td>
<td>0.123</td>
<td>0.135</td>
</tr>
<tr>
<td>Downhearted (U: 180°)</td>
<td>0.761</td>
<td>0.120</td>
<td>0.076</td>
</tr>
<tr>
<td>Feeling low (U: 180°)</td>
<td>0.779</td>
<td>0.029</td>
<td>0.007</td>
</tr>
<tr>
<td>Despondent (U: 180°)</td>
<td>0.752</td>
<td>0.028</td>
<td>0.055</td>
</tr>
<tr>
<td>Spiritless (DD: 210°)</td>
<td>0.542</td>
<td>-0.021</td>
<td>-0.170</td>
</tr>
<tr>
<td>Slothful (DD: 210°)</td>
<td>0.409</td>
<td>-0.270</td>
<td>-0.286</td>
</tr>
<tr>
<td>Lethargic (DD: 210°)</td>
<td>0.655</td>
<td>-0.285</td>
<td>-0.330</td>
</tr>
<tr>
<td>Lifeless (DD: 210°)</td>
<td>0.626</td>
<td>-0.138</td>
<td>-0.141</td>
</tr>
<tr>
<td>Half awake/half asleep (UD: 240°)</td>
<td>0.420</td>
<td>-0.158</td>
<td>-0.313</td>
</tr>
<tr>
<td>Sluggish (UD: 240°)</td>
<td>0.606</td>
<td>-0.230</td>
<td>-0.289</td>
</tr>
<tr>
<td>Drowsy (UD: 240°)</td>
<td>0.541</td>
<td>-0.244</td>
<td>-0.350</td>
</tr>
<tr>
<td>Immobile (UD: 240°)</td>
<td>0.312</td>
<td>-0.348</td>
<td>0.076</td>
</tr>
<tr>
<td>Still (D: 270°)</td>
<td>-0.125</td>
<td>-0.416</td>
<td>0.176</td>
</tr>
<tr>
<td>Calm (D: 270°)</td>
<td>-0.463</td>
<td>-0.402</td>
<td>0.056</td>
</tr>
<tr>
<td>Affect Measure</td>
<td>(Theoretical Angle)</td>
<td>Component Matrix</td>
<td>Communalities</td>
</tr>
<tr>
<td>--------------------------------------------</td>
<td>---------------------</td>
<td>------------------</td>
<td>---------------</td>
</tr>
<tr>
<td></td>
<td>C1</td>
<td>C2</td>
<td>C3</td>
</tr>
<tr>
<td>Unhurried (D: 270°)</td>
<td>-245</td>
<td>-385</td>
<td>.066</td>
</tr>
<tr>
<td>Emotionally detached (D: 270°)</td>
<td>.324</td>
<td>-.120</td>
<td>-.042</td>
</tr>
<tr>
<td>Serene (PD: 300°)</td>
<td>-.469</td>
<td>-.316</td>
<td>-.023</td>
</tr>
<tr>
<td>Quiet (PD: 300°)</td>
<td>.107</td>
<td>-.450</td>
<td>.038</td>
</tr>
<tr>
<td>Placid (PD: 300°)</td>
<td>-.254</td>
<td>-.506</td>
<td>.106</td>
</tr>
<tr>
<td>Tranquil (PD: 300°)</td>
<td>-.481</td>
<td>-.476</td>
<td>.073</td>
</tr>
<tr>
<td>Even-tempered (DP: 330°)</td>
<td>-.208</td>
<td>-.328</td>
<td>.128</td>
</tr>
<tr>
<td>Leisurly (DP: 330°)</td>
<td>-.358</td>
<td>-.204</td>
<td>-.130</td>
</tr>
<tr>
<td>Relaxed (DP: 330°)</td>
<td>-.581</td>
<td>-.397</td>
<td>.137</td>
</tr>
<tr>
<td>Emotionally stable (DP: 330°)</td>
<td>-.392</td>
<td>-.254</td>
<td>-.043</td>
</tr>
</tbody>
</table>


Component one (C1) is interpreted as the bipolar dimension of Hedonic Valence. Negative signs consistently indicate a range of pleasant states at one end of the dimensional continuum and positive signs indicate a range of unpleasant states at the other end. In addition, affects representing the purely activated (stimulated, aroused, intense, awed) and deactivated (still, unhurried, emotionally detached) ends of the Arousal dimension failed to load on C1, which is consistent with these items’ predicted orthogonality with the valence dimension. However, one of the deactivated states (calm) failed to demonstrate orthogonality. Instead, this affect attracted the strongest loadings on both the valence (C1) and arousal dimensions (C2). This finding supports the results of the CIRCUM analysis conducted in Study 1 Part A (see Chapter 2 section 2.3). In this confirmatory analysis of circumplex structure, calm was located at 330° on the circumplex to indicate that participants who rate their levels of calmness tend to report a specific type of core affect (i.e., Hedonic Valence and Arousal) best described as ‘deactivated pleasure’.
Some of the newly sampled descriptors theorised to capture various levels of Hedonic Valence appear to be poor representatives. These descriptors are outlined in Table 21 below.

Table 21:  
Newly sampled descriptors representing poor predictors of Hedonic Valence.

<table>
<thead>
<tr>
<th>Affect Measure</th>
<th>Component Matrix</th>
<th>Communalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Theoretical Angle)</td>
<td>HV:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A</td>
<td>C3</td>
</tr>
<tr>
<td>Quivering with rage (UA: 120°)</td>
<td>.237</td>
<td>.026</td>
</tr>
<tr>
<td>Stunned (UA: 120°)</td>
<td>.264</td>
<td>.071</td>
</tr>
<tr>
<td>Shocked (UA: 120°)</td>
<td>.226</td>
<td>.159</td>
</tr>
<tr>
<td>Painfully distressed (AD: 150°)</td>
<td>.472</td>
<td>.025</td>
</tr>
<tr>
<td>Immobile (UD: 240°)</td>
<td>.312</td>
<td>-.348</td>
</tr>
<tr>
<td>Quiet (PD: 300°)</td>
<td>.107</td>
<td>-.450</td>
</tr>
<tr>
<td>Placid (PD: 300°)</td>
<td>-.254</td>
<td>-.506</td>
</tr>
<tr>
<td>Even-tempered (DP: 330°)</td>
<td>-.208</td>
<td>-.328</td>
</tr>
<tr>
<td>Leisurely (DP: 330°)</td>
<td>-.358</td>
<td>-.204</td>
</tr>
<tr>
<td>Emotionally stable (DP: 330°)</td>
<td>-.392</td>
<td>-.254</td>
</tr>
</tbody>
</table>

As can be seen, *quivering with rage, stunned, and shocked* achieved their highest loadings on component three (C3) along with the complex item of *painfully distressed*. *Immobile, leisurely, and emotionally stable* failed to load on any one component in the solution, *quiet* and *placid* achieved their highest loadings on component two (C2), and *even-tempered* was the only term to load on component five (C5).

Returning to Table 20, component two (C2) is interpreted as the bipolar dimension of *Arousal*. Positive and negative signs indicate a range of activated states at one end of the dimensional continuum to deactivated states at the other end. In addition, affects representing the ‘Pleasant’ (*carefree, content, satisfied, at ease*) and ‘Unpleasant’ (*unhappy, downhearted, feeling low, despondent*) ends of the *Hedonic Valence* dimension failed to load on this component, which is consistent with these items’ predicted orthogonality with the *Arousal* dimension. However, many of the newly sampled descriptors theorised to capture various levels of arousal from
participants’ responses appear to be poor representatives. These descriptors are outlined in Table 22 below.

Table 22:
Newly sampled descriptors representing poor predictors of Arousal.

<table>
<thead>
<tr>
<th>Affect Measure</th>
<th>Component Matrix</th>
<th>Communalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Theoretical Angle)</td>
<td>HV</td>
<td>A</td>
</tr>
<tr>
<td>Peppy (AP: 30°)</td>
<td>-0.547</td>
<td>0.362</td>
</tr>
<tr>
<td>Overjoyed (AP: 30°)</td>
<td>-0.484</td>
<td>0.313</td>
</tr>
<tr>
<td>Encouraged (PA: 60°)</td>
<td>-0.539</td>
<td>0.202</td>
</tr>
<tr>
<td>Awed (A: 90°)</td>
<td>-0.117</td>
<td>0.281</td>
</tr>
<tr>
<td>Quivering with rage (UA: 120°)</td>
<td>0.237</td>
<td>0.026</td>
</tr>
<tr>
<td>Stunned (UA: 120°)</td>
<td>0.264</td>
<td>0.071</td>
</tr>
<tr>
<td>Shocked (UA: 120°)</td>
<td>0.226</td>
<td>0.159</td>
</tr>
<tr>
<td>Painfully distressed (AD: 150°)</td>
<td>0.472</td>
<td>0.025</td>
</tr>
<tr>
<td>Spiritless (DD: 210°)</td>
<td>0.542</td>
<td>-0.021</td>
</tr>
<tr>
<td>Slothful (DD: 210°)</td>
<td>0.409</td>
<td>-0.270</td>
</tr>
<tr>
<td>Lethargic (DD: 210°)</td>
<td>0.655</td>
<td>-0.285</td>
</tr>
<tr>
<td>Lifeless (DD: 210°)</td>
<td>0.626</td>
<td>-0.138</td>
</tr>
<tr>
<td>Half awake/half asleep (UD: 240°)</td>
<td>0.420</td>
<td>-0.158</td>
</tr>
<tr>
<td>Sluggish (UD: 240°)</td>
<td>0.606</td>
<td>-0.230</td>
</tr>
<tr>
<td>Drowsy (UD: 240°)</td>
<td>0.541</td>
<td>-0.244</td>
</tr>
<tr>
<td>Immobile (UD: 240°)</td>
<td>0.312</td>
<td>-0.348</td>
</tr>
<tr>
<td>Unhurried (D: 270°)</td>
<td>-0.245</td>
<td>-0.385</td>
</tr>
<tr>
<td>Emotionally detached (D: 270°)</td>
<td>0.324</td>
<td>-0.120</td>
</tr>
<tr>
<td>Serene (PD: 300°)</td>
<td>-0.469</td>
<td>-0.316</td>
</tr>
<tr>
<td>Even-tempered (DP: 330°)</td>
<td>-0.208</td>
<td>-0.328</td>
</tr>
<tr>
<td>Leisurely (DP: 330°)</td>
<td>-0.358</td>
<td>-0.204</td>
</tr>
<tr>
<td>Emotionally stable (DP: 330°)</td>
<td>-0.392</td>
<td>-0.254</td>
</tr>
</tbody>
</table>

As can be seen, negatively valenced descriptors designed to capture variation in the level of arousal (i.e., ‘unpleasant activation’ at 120°, ‘activated displeasure’ at 150°, ‘deactivated displeasure’ at 210° and ‘unpleasant deactivation’ 240°) along
with positively valenced-mildly activated (i.e., ‘activated pleasure’ at 30°) and deactivated (i.e., ‘deactivated pleasure’ at 330°) descriptors, comprise the majority of terms that poorly capture Arousal.

Notably, the terms *awed, immobile, unhurried, emotionally detached, leisurely*, and *emotionally stable* failed to load on any one component in the solution. This implies that either these items are not associated with affective experiences, or that participants did not know what these words mean. Furthermore, the terms *even-tempered, quivering with rage, stunned, shocked*, and the complex item of *painfully distressed* failed to adequately describe the two core affective dimensions of *Hedonic Valence* and *Arousal*. Assuming that these terms are ecologically valid, *quivering with rage, stunned, shocked, and painfully distressed* attracted the highest loadings on component three (C3), and thus could be interpreted as a kind of acute high-level intensity that is not normally experienced in everyday self-reports of affective experiences. It is not possible to interpret re-produced variance on components four (C4) and five (C5) as no item loaded >.4 on C4, and only one item, that of *even-tempered* loaded on C5.

Whilst conceptually it appears that the ipsatisation process has once again enabled the detection of circumplexity in the data, statistically, the combined contribution of Hedonic Valence and Arousal is relatively weak, accounting for only 34% of the total variance. This is in spite of widening the nomological net, and constructing responses with reference to current momentary affective experience. To explore a circular ordering of the 48 ipsatised affect items from the first two-unrotated components, interpreted as *Hedonic Valence* and *Arousal*, a factor-plot was generated by estimating the angular position for each item using its factor loadings. The factor plot produced is shown in Figure 22. It is important to note that in the associated principal components analysis (see Table 20), negative signs were allocated to pleasant states and positive signs were allocated to unpleasant states on C1 (*Hedonic Valence*). Therefore, plotting X (Hedonic Valence) and Y (Arousal) co-ordinates will generate a graphical display where the pleasant and unpleasant vectors of the Hedonic Valence dimension are reversed.
Figure 22: Factor plot generated from principal components analysis unrotated, two-component solution of forty-eight ipsatised affect items.

The solid lines represent the orthogonal and bipolar dimensions of hedonic valence and arousal. The blue dots approximate angular locations for the ipsatised items.

Figure 22 illustrates concentric circles extending from the centroid to the circumference. These represent incremental increases in communality indices (i.e., 0.2, 0.4, 0.6, 0.8, and 1.00). The blue dots approximate angular locations for the ipsatised items, and as can be seen none of the blue dots reach the circumference. This suggests that none of the variables are completely accounted for by a structure of core affect. However, as previously discussed in section 1.3.3 of the literature review, a circumplex that accounts for 100% of the variance in affective data is not a sufficient condition to establish circumplexity, because a simple structure could also show this property (Acton & Revelle, 2004).

Nevertheless, in accounting for the remaining variance, it is assumed that the ipsatisation process has eliminated non-substantive forms of systematic error variance such as acquiescence (Acton & Revelle, 2004; Di Blas, 2007; Yik, 2009;
Yik & Russell, 2003; Yik et al., 2011). Therefore, the percentage of variance unaccounted for may represent other systematic and substantive dimensions of affect beyond Hedonic Valence and Arousal that are involved in self-reported experiences. These dimensions are discussed in sections 1.1.4 and 1.3.3 of the literature review as cognitive appraisal (Smith & Ellsworth, 1985) and beliefs about the antecedents and consequences of affective experiences (Russell, 1978) that are associated with attention and memory (Barrett, 2009). On the other hand, the failure of a number of items to predict the two core affective dimensions may suggest issues related to translation. It may be that the original English translation of terms from Cantonese do not adequately operationalise feeling states in an Australian, English-speaking population.

In summary, preliminary results of circumplexity demonstrate a lack of simple structure as items fell at various angles throughout the two-dimensional space. The results also suggest that whilst the Hedonic Valence and Arousal dimensions are a part of the structure of self-reported affect, numerous terms failed to capture the ‘core’ of affect from self-report responses. This is particularly apparent for the Arousal dimension, which remains statistically weak relative to the Hedonic Valence dimension. The overall contribution of core affect is 34% in the current analysis, and this is less than the overall contribution of core affect in Study 1 Part A of 44% (see Chapter 2 section 2.2, Table 7). This may suggest more refinement is needed to operationalise the original English translation of terms to offer a 12-point circumplex model of momentary affect. Yet in spite of this, the contribution of arousal of 10% in the current analysis is greater than the contribution found in Study 1 Part A of 6.2%. This may further indicate that research design to capture momentary affective responses as opposed to in general, or trait responses, has improved the detection of arousal. A confirmatory factor analysis will now systematically confirm the underlying structure of the measures.

4.3. RESULTS: CONFIRMATORY ANALYSES

Confirming the four cornerstone constructs of core affect.

In accordance with Yik et al.’s (1999; Yik et al., 2002; Yik et al., 2011) methodological approach, the first step in confirming a 12-point structure of momentary affect according to the circumplex, is to examine the structure of the four

Based on the anomalous findings of the previous principal components analysis, two confirmatory factor analyses will be conducted. The first will establish a measurement model with the original affect items hypothesised to predict the four cornerstone constructs of Hedonic Valence and Arousal. These affects are presented on the left side of Table 23 below.

Table 23:

<table>
<thead>
<tr>
<th>Affect Measure</th>
<th>Affect Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Theoretical angle)</td>
<td>(Angle according to principal components analysis)</td>
</tr>
<tr>
<td>Carefree (Pleasant: 0°)</td>
<td>Carefree (Pleasant: 0°)</td>
</tr>
<tr>
<td>Content (Pleasant: 0°)</td>
<td>Content (Pleasant: 0°)</td>
</tr>
<tr>
<td>Satisfied (Pleasant: 0°)</td>
<td>Satisfied (Pleasant: 0°)</td>
</tr>
<tr>
<td>At ease (Pleasant: 0°)</td>
<td>At ease (Pleasant: 0°)</td>
</tr>
<tr>
<td>Unhappy (Unpleasant: 180°)</td>
<td>Unhappy (Unpleasant: 180°)</td>
</tr>
<tr>
<td>Downhearted (Unpleasant: 180°)</td>
<td>Downhearted (Unpleasant: 180°)</td>
</tr>
<tr>
<td>Feeling low (Unpleasant: 180°)</td>
<td>Feeling low (Unpleasant: 180°)</td>
</tr>
<tr>
<td>Despondent (Unpleasant: 180°)</td>
<td>Despondent (Unpleasant: 180°)</td>
</tr>
<tr>
<td>Stimulated (Activated: 90°)</td>
<td>Stimulated (Activated: 90°)</td>
</tr>
<tr>
<td>Aroused (Activated: 90°)</td>
<td>Aroused (Activated: 90°)</td>
</tr>
<tr>
<td>Intense (Activated: 90°)</td>
<td>Intense (Activated: 90°)</td>
</tr>
<tr>
<td>Awed (Activated: 90°)</td>
<td>-</td>
</tr>
<tr>
<td>Still (Deactivated: 270°)</td>
<td>Still (Deactivated: 270°)</td>
</tr>
<tr>
<td>Calm (Deactivated: 270°)</td>
<td>Quiet (Deactivated: 270°)</td>
</tr>
<tr>
<td>Unhurried (Deactivated: 270°)</td>
<td>Placid (Deactivated: 270°)</td>
</tr>
<tr>
<td>Emotionally detached (Deactivated: 270°)</td>
<td>-</td>
</tr>
</tbody>
</table>
A second confirmatory analysis will then establish a measurement model with affects found to represent the four cornerstone constructs in the previous principal components analysis, and these affects are presented on the right side of Table 23. The hypothesised angles of 0°, 90°, 180°, and 270° accompanying items on the right side of the table signify those items that loaded cleanly on their intended construct in the previous principal components analysis. As can be seen, the findings in relation to the purely activated end of the Arousal continuum at 90° demonstrated that awed failed to load on any one component in the solution, leaving the remaining three items of aroused, stimulated, and intense to capture pure activation. In relation to the purely deactivated end of the Arousal continuum at 270°, only one of the originally hypothesised items, that of still, loaded cleanly on Arousal. Two additional items, quiet and placid also loaded cleanly on Arousal to suggest these three affects may best capture pure deactivation at 270°. Whilst quiet and placid were not designed to predict deactivation in the current study, it is worth re-iterating that quiet was predicted, and found, to capture pure deactivation in Study 1 Part A. Both measurement models will be compared in terms of model fit, and the degree to which the factor structure underlying the measures demonstrates bipolarity. The best fitting model will then be used to examine whether the remaining eight segments of the circumplex can be accounted for by Hedonic Valence (pleasant-unpleasant) and Arousal (‘activated-deactivated’).

Data analysis

Correlation matrices for the manifest (observed) variables were submitted to confirmatory factor analysis in MPlus Version 7.2 (Muthén & Muthén, 2012). For each model, factor loadings for each item on its intended latent construct were estimated along with error variances for the manifest variables and correlations between the latent constructs. As with all prior systematic modeling of component structure, the chi-square statistic ($\chi^2$) and root mean squared error of approximation (RMSEA: Steiger & Lind, 1980) statistic were used to assess the best fitting model to affective data (see Chapter 1.3. for a detailed discussion of these fit indexes). In addition, the standardised root mean squared residual (SRMR: Bentler, 1990), and the comparative fit index (CFI: Bentler) were used to quantify the degree of fit. Like the RMSEA, the SRMR is an absolute fit index that assesses average residual error in the hypothesised model, or ‘badness’ of fit. Whereas the RMSEA compares the
hypothesised model to an assumed population matrix, the SRMR compares the hypothesised model to the actual observed variable matrix (Hu & Bentler, 1999) with the following formula:

$$
\frac{1}{\sqrt{q (q+1)}} \sqrt{\sum_{i=1}^{p} \sum_{j=1}^{i} \left[ \frac{(s_{ij} - \hat{o}_{ij})}{(s_{ii} - s_{jj})} \right]^2}
$$

where $s_{ij}$ is the square root of the sum of all the variables in the observed covariance matrix, minus $o_{ij}$, which is the implied covariance matrix, divided by $q$, the number of parameters to be estimated, and then converted into standardised units ($z$). Like the RMSEA, low values for the SRMR indicate best fit, with a recommended cut-off value close to .08 (Hu & Bentler).

The comparative fit index (CFI: Bentler, 1990) is an incremental normed-fit index that assesses the proportional improvement in fit by comparing the hypothesised model to a more restricted model. The restricted model is often referred to as a baseline, independence, or null model (Bentler & Bonett, 1980) where all manifest (observed) variables are assumed to be completely unrelated. The formula is as follows:

$$
1 - \frac{\chi^2_{\text{implied model (i.e., } \chi^2_{\text{implied}} - \text{df}_{\text{implied}})} - \chi^2_{\text{baseline model (i.e., } \chi^2_{\text{baseline}} - \text{df}_{\text{baseline}})}}{1 - \chi^2_{\text{baseline model}}}
$$

where $\tau$ compares the centrality of the chi square distribution, with greater non-centrality indicating greater misspecification of the hypothesised model relative to the baseline model. Possible values for the CFI range from 0 to 1, with a cut-off value for goodness of fit recommended at > .90 (Bentler; Hu & Bentler, 1999; Yik et al., 2011).

**Confirmatory factor analysis based on the original hypothesised model**

The fit indexes to establish a measurement model based on the original research design were $\chi^2$ (98, N = 569) = 429.99, RMSEA = .08, CI = .07-.09, SRMR = .08, and CFI = .88. Altogether, the fit indexes indicate the hypothesised model fit the data marginally well. Whilst the $\chi^2$ was significant, it was expected
due to the large sample size, and the RMSEA was comparatively lower than previous reports adopting this methodological approach (Yik et al., 1999; Yik et al., 2002; Yik et al., 2011). Table 24 presents factor loadings for the manifest (observed) variables on their intended constructs, standard errors, and the variance accounted for in the measurement model. As can be seen all items significantly loaded on their intended construct.

Table 24:
Standardised factor loadings ($\lambda$), standard errors (SE), and variance accounted for ($R^2$) in the original hypothesised model.

<table>
<thead>
<tr>
<th>Affect Measure</th>
<th>(Theoretical Angle)</th>
<th>$\lambda$</th>
<th>SE</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>P: ‘Pleasant’</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carefree (P: 0°)</td>
<td></td>
<td>.46**</td>
<td>.04</td>
<td>.21</td>
</tr>
<tr>
<td>Content (P: 0°)</td>
<td></td>
<td>.73**</td>
<td>.03</td>
<td>.53</td>
</tr>
<tr>
<td>Satisfied (P: 0°)</td>
<td></td>
<td>.68**</td>
<td>.03</td>
<td>.46</td>
</tr>
<tr>
<td>At ease (P: 0°)</td>
<td></td>
<td>.67**</td>
<td>.03</td>
<td>.45</td>
</tr>
<tr>
<td><strong>U: ‘Unpleasant’</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unhappy (U: 180°)</td>
<td></td>
<td>.72**</td>
<td>.02</td>
<td>.51</td>
</tr>
<tr>
<td>Downhearted (U: 180°)</td>
<td></td>
<td>.86**</td>
<td>.02</td>
<td>.73</td>
</tr>
<tr>
<td>Feeling low (U: 180°)</td>
<td></td>
<td>.83**</td>
<td>.02</td>
<td>.68</td>
</tr>
<tr>
<td>Despondent (U: 180°)</td>
<td></td>
<td>.76**</td>
<td>.02</td>
<td>.58</td>
</tr>
<tr>
<td><strong>A: ‘Activated’</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stimulated (A: 90°)</td>
<td></td>
<td>.56**</td>
<td>.05</td>
<td>.31</td>
</tr>
<tr>
<td>Aroused (A: 90°)</td>
<td></td>
<td>.55**</td>
<td>.05</td>
<td>.30</td>
</tr>
<tr>
<td>Intense (A: 90°)</td>
<td></td>
<td>.14*</td>
<td>.06</td>
<td>.02</td>
</tr>
<tr>
<td>Awed (A: 90°)</td>
<td></td>
<td>.27**</td>
<td>.05</td>
<td>.07</td>
</tr>
<tr>
<td><strong>D: ‘Deactivated’</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Still (D: 270°)</td>
<td></td>
<td>.25**</td>
<td>.05</td>
<td>.06</td>
</tr>
<tr>
<td>Calm (D: 270°)</td>
<td></td>
<td>.61**</td>
<td>.05</td>
<td>.37</td>
</tr>
<tr>
<td>Unhurried (D: 270°)</td>
<td></td>
<td>.34**</td>
<td>.05</td>
<td>.12</td>
</tr>
<tr>
<td>Emotionally detached (D: 270°)</td>
<td></td>
<td>-.25**</td>
<td>.05</td>
<td>.06</td>
</tr>
</tbody>
</table>

Note. $N = 569$. * $p < .01$ ** $p < .0005$. 
From Table 24, the following observations can be made. First, *emotionally detached* appears to be a poor representative of the model, as it negatively correlates with its intended factor of ‘deactivated’. In addition, $R^2$ values indicate that the intended factor structure accounts for less than 5% of the variance in the items *carefree, intense, awed, still, unhurried,* and *emotionally detached.*

In relation to the assumption of bipolarity, an inspection of the inter-factor correlation matrix in Table 25 indicates other structural anomalies.

Table 25:

*Inter-factor correlations among 'Pleasant', 'Unpleasant', 'Activated', and 'Deactivated'.*

<table>
<thead>
<tr>
<th></th>
<th>Pleasant: (0°)</th>
<th>Unpleasant: (180°)</th>
<th>Activated: (90°)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unpleasant: (180°)</td>
<td>-.87**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Activated: (90°)</td>
<td>.19*</td>
<td>-.47**</td>
<td></td>
</tr>
<tr>
<td>Deactivated (270°)</td>
<td>.84**</td>
<td>-.70**</td>
<td>-.16</td>
</tr>
</tbody>
</table>

*Note. N = 569. *p < .01 **p < .0005.*

Whilst the ‘pleasant-unpleasant’ axes representing the Hedonic Valence dimension are strongly bipolar correlating at -.87, the ‘activated-deactivated’ axes of the Arousal dimension are almost completely independent of one another correlating at -.16. This suggests that ‘pleasant’ and ‘unpleasant’ would be located approximately 180° apart from one another in circumplical space. However, ‘activated’ and ‘deactivated’ would be located approximately 90° apart from one another, and thus violating the assumption that activated and deactivated states can be represented along a bipolar continuum. Where orthogonality is assumed in the bipolar model, the unipolar dimensions of ‘pleasant’ and ‘activated’ support the assumption, correlating at .19. However, all other dimensions predicted to demonstrate orthogonality (e.g. ‘pleasant-deactivated’; ‘unpleasant-activated’; ‘unpleasant-deactivated’) fail to do so. In sum, items designed to measure the arousal dimension appear to be poor predictors, and the original design does not support the existence of two independent and bipolar dimensions in Hedonic Valence and Arousal according to circumplex theory (Guttman, 1954a; Russell, 1980; Yik et al., 1999).
Confirmatory factor analysis based on the findings of principal components analysis.

The findings of the previous principal components analysis revealed that the purely ‘activated’ and ‘deactivated’ axes of the Arousal dimension were each captured by three items, whereas the purely ‘pleasant’ and ‘unpleasant’ axes of the Hedonic Valence dimension were each captured by four items. In the light of this inequality, an arbitrary decision was made to represent each of the four cornerstone constructs in the upcoming confirmatory factor analysis with an equivalent number of three items each. The $R^2$ values in Table 24 from the previous confirmatory factor analysis were used to guide the decision-making process to eliminate one item from the pleasant axis and one item from the unpleasant axis. According to these values, the weakest representatives of Hedonic Valence were carefree and unhappy, and so these items were removed prior to testing. The fit indexes to establish a measurement model based on the findings of principal components and confirmatory factor analyses were $\chi^2 (48, N = 569) = 233.18$, RMSEA = .08, CI = .07-.09, SRMR = .09, and CFI = .91. Once again, the fit indexes indicate the newly hypothesised model fit the data marginally well. Table 26 compares fit indexes for both measurement models.

Table 26: Comparative fit indexes for both Confirmatory Factor Analyses.

<table>
<thead>
<tr>
<th>Model</th>
<th>$\chi^2$</th>
<th>df</th>
<th>RMSEA (90% CI)</th>
<th>SRMR</th>
<th>CFI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Four Cornerstone Constructs (according to research design)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypothesised Model:</td>
<td>429.99</td>
<td>98</td>
<td>.08</td>
<td>.08</td>
<td>.88</td>
</tr>
<tr>
<td>Baseline Model:</td>
<td>2785.66</td>
<td>120</td>
<td>(.07-.09)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Four Cornerstone Constructs (three items for each construct)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypothesised Model:</td>
<td>233.18</td>
<td>48</td>
<td>.08</td>
<td>.09</td>
<td>.91</td>
</tr>
<tr>
<td>Baseline Model:</td>
<td>2030.01</td>
<td>66</td>
<td>(.07-.09)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. $N = 569$. SRMR = Standardised Root Mean squared Residual; RMSEA = Root Mean Squared Error of Approximation with 90% Confidence Interval; CFI = Comparative Fit Index.
From Table 26, the following comparisons can be made. Whilst the $\chi^2$ value remains significant, it is substantially reduced, indicating the newly established model is an improvement on the original. This is supported by an increase in the CFI value from .88 to .91. However, the increased SRMR value of .08 to .09 indicates a slightly poorer fit to the data compared to the original model. Therefore, it is difficult to draw conclusions about the best fitting model based on these criteria alone. Table 27 provides additional information regarding the strength of the factor loadings for the manifest (observed) variables on their intended constructs, standard errors, and the variance accounted for in the newly established measurement model. As with the original model, all items significantly loaded on their intended construct.

Table 27:

<table>
<thead>
<tr>
<th>Affect Measure</th>
<th>(Theoretical Angle)</th>
<th>$\lambda$</th>
<th>$SE$</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>P: ‘Pleasant’</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Content (P: 0°)</td>
<td></td>
<td>.74**</td>
<td>.03</td>
<td>.55</td>
</tr>
<tr>
<td>Satisfied (P: 0°)</td>
<td></td>
<td>.71**</td>
<td>.03</td>
<td>.51</td>
</tr>
<tr>
<td>At ease (P: 0°)</td>
<td></td>
<td>.65**</td>
<td>.03</td>
<td>.42</td>
</tr>
<tr>
<td><strong>U: ‘Unpleasant’</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Downhearted (U: 180°)</td>
<td></td>
<td>.85**</td>
<td>.02</td>
<td>.72</td>
</tr>
<tr>
<td>Feeling low (U: 180°)</td>
<td></td>
<td>.82**</td>
<td>.02</td>
<td>.68</td>
</tr>
<tr>
<td>Despondent (U: 180°)</td>
<td></td>
<td>.77**</td>
<td>.02</td>
<td>.60</td>
</tr>
<tr>
<td><strong>A: ‘Activated’</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stimulated (A: 90°)</td>
<td></td>
<td>.60**</td>
<td>.05</td>
<td>.36</td>
</tr>
<tr>
<td>Aroused (A: 90°)</td>
<td></td>
<td>.53**</td>
<td>.05</td>
<td>.28</td>
</tr>
<tr>
<td>Intense (A: 90°)</td>
<td></td>
<td>.14*</td>
<td>.06</td>
<td>.02</td>
</tr>
<tr>
<td><strong>D: ‘Deactivated’</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Still (Deactivated: 270°)</td>
<td></td>
<td>.40**</td>
<td>.05</td>
<td>.16</td>
</tr>
<tr>
<td>Quiet (Deactivated: 270°)</td>
<td></td>
<td>.37**</td>
<td>.06</td>
<td>.14</td>
</tr>
<tr>
<td>Placid (Deactivated: 270°)</td>
<td></td>
<td>.61**</td>
<td>.06</td>
<td>.37</td>
</tr>
</tbody>
</table>

Note. $N = 569$. * $p < .01$ ** $p < .0005$. 
An additional 6.7% more variance has been accounted for in this newly established model. However, the ‘activated-deactivated’ axes remain relatively weak compared to the ‘pleasant-unpleasant’ axes. On average, 58% of the variance has been accounted for in Hedonic Valence as opposed to 22.7% of the variance in Arousal.

The final criterion for determining the best overall fit relates to the assumption of bipolarity. The inter-factor correlation matrix in Table 28 shows the structure of affect according to circumplex theory, is vastly improved with this selection of affective items.

Table 28: 

<table>
<thead>
<tr>
<th></th>
<th>Pleasant: (0°)</th>
<th>Unpleasant: (180°)</th>
<th>Activated: (90°)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unpleasant: (180°)</td>
<td>-.83** (.87**)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Activated: (90°)</td>
<td>.16* (.19*)</td>
<td>-.47** (.47**)</td>
<td></td>
</tr>
<tr>
<td>Deactivated (270°)</td>
<td>.25* (.84**)</td>
<td>-.28** (.70**)</td>
<td>-.61** (-.16)</td>
</tr>
</tbody>
</table>

Note. Inter-factor correlations in bold relate to the newly established model. Those in parentheses are based on the original design of the model. N = 569. * p < .01 **p < .0005.

Negative correlations of sizeable magnitude are now evident between both bipolar (180°) opposites of ‘pleasant-unpleasant’, correlating at -.83 and ‘activated-deactivated’, correlating at -.61. Where orthogonality is assumed in the bipolar model, inter-factor correlations between unipolar pairings spaced 90° apart from one another in circumplical space support the assumption with one exception. The significant relationship found between the ‘activated’ and ‘unpleasant’ axes at -.47 indicates structural interdependence as opposed to independence (orthogonality) (Segura et al., 2003). Whilst overall, there is an improvement in the current model these results are inconsistent with previous reports (Yik et al., 1999; Yik et al., 2002; Yik et al., 2011). In this earlier work, inter-factor correlations demonstrate almost complete independence for all unipolar pairings assumed to be located 90° apart.

In sum, comparing the results across both confirmatory factor analyses, it would seem that the newly established measurement model provides a better overall fit to the data than the original hypothesised model. However, the variables did not consistently represent a thoroughly bipolar model. In this sense, defining the four
cornerstone constructs as two bipolar continua in the upcoming structural analysis may reduce the predictive power of the measurement model.

4.4. STRUCTURAL ANALYSES

*Predicting the remaining segments of the circumplex from the two bipolar axes.*

Replicating Yik’s (2009; see also Yik et al., 1999; Yik et al., 2002; Yik et al., 2011) methodological approach, the next step in the structural modeling process is to examine whether the remaining segments of the 12-point circumplex design can be accounted for by Hedonic Valence (‘pleasant-pleasent’) and Arousal (‘activated-deactivated’), treated as two bipolar continua. The best-fitting measurement model established in the previous confirmatory factor analysis will be used to represent the two axes, treated as exogenous variables to predict each of the remaining eight constructs, treated as endogenous variables. As such, Hedonic Valence (HV) and Arousal (A) are indicated by six items each (HV: content, downhearted, satisfied, feeling low, at ease, despondent; A: aroused, quiet, stimulated, still, intense, placid). The correlation between the two latent constructs was fixed to zero. To maintain the decision to represent all constructs with an equivalent number of items, composite scales for each of the remaining eight constructs (endogenous variables) were constructed from three items each. The eliminated items were those that attracted the weakest loadings on Hedonic Valence and Arousal in the previous principal components analysis.

The correlation matrix for the manifest (observed) variables was submitted to structural equation modeling in MPlus Version 7.2 (Muthén & Muthén, 2014). The fit indexes for both measurement and structural models combined were $\chi^2 (134, N = 569) = 922.37$, RMSEA = .10, CI = .09 - .11, SRMR = .10, and CFI = .86. Altogether, the fit indexes indicate a marginal fit, and the RMSEA value is commensurate with values typically reported in the aforementioned cross-cultural studies conducted by Yik (e.g. Yik et al., 1999; Yik et al., 2002; Yik et al., 2011). The psychometric properties of the eight segments (constructs) predicted from the bipolar axes of Hedonic Valence and Arousal are presented in Table 29 below.
Table 29: Structural Equation Model: Predicting Eight Segments of the Circumplex From the Bipolar Axes of Hedonic Valence and Arousal.

<table>
<thead>
<tr>
<th>Segment</th>
<th>Hedonic Valence</th>
<th>Arousal</th>
<th>%VAF</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>β</td>
<td>SE</td>
<td>B</td>
</tr>
<tr>
<td>2 o’clock</td>
<td>.48**</td>
<td>.03</td>
<td>.65</td>
</tr>
<tr>
<td>1 o’clock</td>
<td>.47**</td>
<td>.03</td>
<td>.64</td>
</tr>
<tr>
<td>11 o’clock</td>
<td>-.24**</td>
<td>.04</td>
<td>-.18</td>
</tr>
<tr>
<td>10 o’clock</td>
<td>-.74**</td>
<td>.02</td>
<td>-.98</td>
</tr>
<tr>
<td>8 o’clock</td>
<td>-.60**</td>
<td>.03</td>
<td>-.72</td>
</tr>
<tr>
<td>7 o’clock</td>
<td>-.48**</td>
<td>.03</td>
<td>-.59</td>
</tr>
<tr>
<td>5 o’clock</td>
<td>.60**</td>
<td>.03</td>
<td>.70</td>
</tr>
<tr>
<td>4 o’clock</td>
<td>.64**</td>
<td>.03</td>
<td>.72</td>
</tr>
</tbody>
</table>

Note. %VAF = The percentage of variance accounted for in each segment (construct) by the two independent bipolar dimensions of hedonic valence and arousal. N = 569. * p < .05 ** p < .0005. Means are represented on a 0 to 100 point scale.
Overall, the model was able to account for up to 65% of the variance in the outcome variables. This is slightly lower than the previously cited studies (e.g. Yik, 2009; Yik et al., 1999; Yik et al., 2002; Yik et al., 2011), where an average of 73% of the variance is reported. In particular, quadrants representing pleasant-activated states (30°-60°) and pleasant-deactivated states (330°-330°) accounted for an average variance of 53% and 58%, respectively. Unpleasant-activated states (120°-150°) and unpleasant-deactivated states (210°-240°) accounted for substantially less, with both quadrants each accounting for an average variance of 36%. Analysis of the specific regression coefficients revealed that Hedonic Valence significantly predicted all eight segments of the circumplex as expected, whereas Arousal significantly predicted all but one segment, that of unpleasant activation (120°) at 11 o’clock (see Table 29 for full results).

These results only partially support the results of the previous exploratory principal components analysis. To re-iterate, the three items comprising the construct ‘unpleasant activation’ (120°) (*quivering with rage, stunned, and shocked*) failed to load on Hedonic Valence (C1) and Arousal (C2) in this exploratory analysis, and instead loaded on C3. It was speculated that C3 could represent a kind of acute high-level intensity that is not normally experienced in everyday self-reports of affective experiences. Commensurate with these findings, the arousal dimension in this structural analysis has also demonstrated an inability to predict the same three items now represented as a composite scale. However, contrary to the exploratory findings, Hedonic Valence significantly predicts unpleasant activation ($\beta = -.24$, $p< .0005$). This indicates that, as purely pleasurable states decrease, unpleasant-activated states increase. In summary, given the small, albeit significant amount of variance accounted for by the model (6%), and the significant non-normality evidenced in the scale (*skewness* = 3.51), the decision was made to eliminate this construct of ‘unpleasant activation’ from further inclusion in structural modeling.

### 4.5. CIRCUM ANALYSIS

The final step in the structural modeling process in Study 2 Part A, is to test the structure of momentary affect with the CIRCUM procedure (Browne, 1992). The aims of this analysis are twofold: The main aim is to replicate Yik’s (2009; Yik et al., 2011) 12-point Chinese Circumplex Model (CCMA), in English. However, findings
from the previous exploratory and confirmatory analyses revealed various structural anomalies that required changes to the original design of the model. As a result, the manifest variables submitted to a CIRCUM analysis will not fully replicate the intended 12-point circumplex structure. Instead, the manifest variables submitted to CIRCUM will be in the form of 11 composite scales comprising three items each. Appendix G presents the results of a CIRCUM analysis conducted post hoc of the original 12-point (48-item) design of the model.

Analysis at the item level in the previous principal components analysis revealed that items failed to show simple structure, and did not cluster at multiples of 45° according to Watson and Tellegen’s (1985) 45° hypothesis. Instead, items fell at various angles throughout the two-dimensional space. Replicating Yik’s (2009; Yik et al., 2011) research design, the current model is designed to slice the circumplex into finer segments spaced approximately 30° apart to provide a more descriptive structure of core affect. Therefore, the second aim of the upcoming CIRCUM analysis is to examine where each segment (construct) falls within a circular ordering. This analysis, at the scale level, will pinpoint the precise location of each segment (construct) in the form of a polar angle and provide a confidence interval for that angle. In this way, it will be possible to demonstrate the degree to which the various affective dimensions reliably conform to such arbitrary decisions regarding the descriptive structure of momentary affect.

As with all prior systematic tests of circumplexity, the manifest variables submitted to a CIRCUM analysis will be left free to fall at any location on the circumplex, in the form of composite scales. The model will be tested by specifying parameters one through five, and an assessment of which model provides the best overall fit will be made. All analyses conducted using the CIRCUM procedure are based on a pre-ordered correlation matrix of the original scores. The results of the CIRCUM analysis, using 11 composite scales as data, will now be presented.

Results of the CIRCUM procedure to establish an 11-point circumplex model of momentary affect

To test the circumplexity of the data, the pre-ordered correlation matrix for the manifest variables was submitted to structural equation modeling using the
circular stochastic process model with a Fourier series (CSPMF), or ‘CIRCUM’ (Browne, 1992).

The reference variable designated ‘Pleasant’ was fixed with its polar angle \( \theta \) at zero, relative to which the locations of the other composite variables were estimated. No other constraints were placed on the model. The analysis converged on a solution in 24 iterations. Three free parameters were specified in the correlation function equation; additional free parameters did not improve the model fit. The final model had a total of 35 free parameters and 31 degrees of freedom. The fit indices for the model were \( \chi^2 (31, N = 569) = 195.74 \), \( \text{RMSEA} = .10 \) (90% CI = .08 - .11), and \( \text{MCSC} = -.50 \). Values of \( \zeta \) ranged from .81 to .95. The results are given in Table 30, and a graphical display is presented in Figure 23.

Table 30:

<table>
<thead>
<tr>
<th>Affect Measure</th>
<th>Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Theoretical Angle)</td>
<td>( \theta )</td>
</tr>
<tr>
<td>Pleasant (0°)</td>
<td>0°</td>
</tr>
<tr>
<td>Activated Pleasure (30°)</td>
<td>53°</td>
</tr>
<tr>
<td>Pleasant Activation (60°)</td>
<td>55°</td>
</tr>
<tr>
<td>Activated (90°)</td>
<td>81°</td>
</tr>
<tr>
<td>Activated Displeasure (150°)</td>
<td>165°</td>
</tr>
<tr>
<td>Unpleasant (180°)</td>
<td>188°</td>
</tr>
<tr>
<td>Deactivated Displeasure (210°)</td>
<td>221°</td>
</tr>
<tr>
<td>Unpleasant Deactivation (240°)</td>
<td>226°</td>
</tr>
<tr>
<td>Deactivated (270°)</td>
<td>311°</td>
</tr>
<tr>
<td>Pleasant Deactivation (300°)</td>
<td>339°</td>
</tr>
<tr>
<td>Deactivated Pleasure (330°)</td>
<td>351°</td>
</tr>
</tbody>
</table>

Note: The circumplex model of momentary affect is constructed from 11 composite scales above and the hypothesised angles represent vectors spaced 30° apart. \( N = 569 \). The angle (\( \theta \)), the communality index (\( \zeta \)), and confidence intervals for both indices were computed in the CIRCUM analysis for all 11 affect scales. Possible scores range from 0 to 100 for each affective composite measure.
Figure 23: An 11-point Circumplex Model of Momentary Affect. Polar angles show $\theta$ (theta) along with confidence intervals. The length of the solid blue line from the centre shows the communalities $\zeta$ (zeta). $n = 569$. 
The results for the four cornerstone constructs indicate that, with ‘Pleasant’ fixed at 0°, ‘Unpleasant’ is located 188° away and close to the predicted value of 180°. Moreover, ‘Activated’ is located 81° away and close to the predicted value of 90°. However, ‘Deactivated’ failed to fall within a 20° confidence interval (Remington et al., 2000) either side of the predicted value of 270°. Instead this construct is located at 311°, and appears to best describe ‘Pleasant-Deactivation’. In summary, while the hypothesised polar opposites of ‘Pleasant-Unpleasant’ are located close to their predicted values, the polar opposites of ‘Activated-Deactivated’ failed to meet with theoretical predictions. Instead of being located approximately 180° away from one another, ‘Activated’ is 230° away from ‘Deactivated’.

Examining the precise location of each segment (construct), the results indicate that the polar estimates are quite precise. As can be seen in both Table 30 and Figure 23, 95% confidence intervals for each polar estimate are quite narrow ranging between 9° and 15°. More specifically, ‘Pleasant-Deactivation’ and ‘Deactivated-Pleasure’, located at 339° and 351° respectively, are the most precise estimates of the common space, whereas ‘Activated’ and ‘Unpleasant-Deactivation’, located at 81° and 226° respectively, provide the least reliable polar estimates for the model. The $\chi^2$ was once again significant, and this was expected due to the large sample size. The RMSEA value indicates a model that fits the data marginally well (Browne & Cudeck, 1992). The communalities indicate that between 66% and 86% of the variance ($M = 76\%$) in each 11-point segment (construct) is accounted for by a structure of core affect, and the minimum common score correlation at 180° of -.50 suggests that this affective space is bipolar (Russell, 1979). Altogether, the fit indexes in the current analysis are an improvement on the original 12-point Chinese circumplex model (CCMA) produced by Yik (2009, p.421).

Given the precision in estimation provided by the CIRCUM procedure, the results further indicate that the 11 affective dimensions do not demonstrate simple structure and do not cluster at multiples of 45° according to Watson and Tellegen’s (1985) 45° hypothesis. However, the 11 affective dimensions also do not slice the circumplex into segments spaced approximately 30° apart according to Yik’s (2009; Yik et al., 2011) hypothesis. Moreover, no affective dimension comes close to describing the ‘Activated-Pleasant’ region of the circumplex at 30° (2 o’clock), or
the purely ‘Deactivated’ region at 270° (6 o’clock). The ‘Activated-Unpleasant’ region of the circumplex at 120° remains undescribed because this segment (11 o’clock) could not be adequately operationalised from the current sample of affective descriptors.

In summary, this 11-point circumplex structure does not reliably conform to arbitrary decisions regarding how best to describe the underlying dimensional structure of affect. Whilst dimensions were not located at multiples of 45° (Watson & Tellegen, 1985) or 30° (Yik, 2009), they did provide a well-defined description of core affective space, a space that is lacking simple structure and which is indicative of bipolarity.

4.6. DISCUSSION

The main aim of Study 2 Part A was to improve on the research design employed in Study 1 Part A. The number of affects sampled was increased from 24 to 48 items to provide a more robust platform from which to replicate HPMood on the circumplex in the next study. In addition, self-report ratings were designed to elicit momentary feeling states rather than trait judgements to capture more fluctuation in responses. These new refinements relied upon refining the item selection process, which lead to a collaboration between myself and Professor Michelle Yik (M. Yik, personal communication, September 19th, 2012), and the decision to replicate the design of Yik’s (2009) 12-point Chinese circumplex model of momentary affect (CCMA), in English.

As a result of this replication in research design, all aspects of Yik’s (2009; Yik et al., 1999; Yik et al., 2002; Yik et al., 2011) methodology for statistically modeling affective structure were also replicated. Therefore, modeling to establish an underlying structure best described by the two independent and bipolar dimensions of Hedonic Valence and Arousal commenced with an initial exploratory phase using principal components analysis, and progressed through two confirmatory phases. The first phase confirmed a structure of core affect with structural equation modeling under assumptions of linearity (Muthén & Muthén, 2014), and the second phase confirmed a core affective structure under assumptions of circumplexity (Browne,
Altogether, the results conducted under divergent theoretical and statistical assumptions converge to suggest a core affective structure that lacks simple structure and is bipolar in nature. However, convergence among the methods also reveals structural anomalies associated with the Arousal dimension, where findings consistently demonstrate an inability to reliably describe highly activated and deactivated states, and levels of unpleasant activation. An elaborated discussion of convergence among the findings will now be presented.

**Elaborating on the findings to validate a core affective space.**

In the exploratory phase of circumplex modeling, principal components analysis with ipsative data revealed the presence of eleven components with eigenvalues exceeding 1. However, Parallel Analysis (Horn, 1965) indicated the contribution of these variables was best accounted for by a five-component solution. The first two components accounted for 34% of the total variance. Component one (C1: 24.03%) was interpreted as Pleasure versus Displeasure (*Hedonic Valence*), and component two (C2: 9.98%) as Activation versus Deactivation (*Arousal*).

However, there were a number of items that appeared to poorly represent the two core affective dimensions. Of most concern were those descriptors designed to capture ‘unpleasant-activation’, or the 11 o’clock segment of the circumplex (i.e., *quivering with rage, stunned, shocked, jittery*). With the exception of *jittery*, all items demonstrated complete orthogonality with Hedonic Valence and Arousal by loading on a separate component (C3: 4.39%). This lack of association with a core affective structure was also indicated by extreme low scores ($M = 4.61, SD = 10.86$) and significant absolute skew (3.51) when the items were used to form a composite scale. Linear structural equation modeling confirmed that ‘unpleasant-activation’ is not significantly predicted by arousal, and the contribution of core affect in responses on this dimension is minimal (6%). Assuming the descriptors are ecological valid, altogether the findings suggest that this dimension represents a kind of unpleasantness that is not normally experienced in everyday momentary affective responses. Interpreting components four (C4: 3.67%) and five (C5: 3.14%) was not possible, as no item loaded >.4 on C4, and only one item loaded on C5.
In relation to the two core affective dimensions, these findings are similar to Yik’s (2009) exploratory modeling of circumplexity. In her study to establish a 12-point Chinese circumplex model of momentary affect (CCMA), a principal components analysis revealed the presence of four components with eigenvalues exceeding 1. The first two components accounted for 38% of the total variance, with C1 interpreted as Hedonic Valence (27.79%), and C2 as Arousal (10.04%). Yik did not provide an interpretation of components three (C3: 4.96%) and four (C4: 3.13%).

Comparing the findings of Yik’s (2009) study and this current replication of her design, it is interesting to note that the difference in total variance accounted for by core affect, of 4%, is largely attributable to Hedonic Valence. At first blush, it appears that this is due to the fact that Yik’s analysis was conducted with 113 ipsatised items as opposed to 48 ipsatised items in the current analysis. Her sample comprised those descriptors represented in her 12-point Chinese circumplex model of momentary affect (CCMA) along with additional items used to describe a common two-dimensional space in earlier work (Russell & Yik, 2003).

What is most interesting is that this substantial widening of the nomological net in Yik’s (2009) study has made a minimal, additional contribution to capturing variance in only one of the two core affective dimensions. The degree to which arousal captures variance remains almost unchanged in both studies, at approximately 10%. Moreover, the overall contribution of core affect in the previous Study 1 Part A of 44% was achieved with only 23 items. This far exceeds the overall contribution of core affect in the current analysis (34%), with 48 items, and Yik’s analysis (38%) with 113 items. This suggests that more semantic labels are not necessarily best for providing a robust descriptive map of affective experiences on the circumplex.

One reason for this points to a confounding effect discussed in section 1.3.5 of the literature review, which concerns the use of ‘ambiguous’ semantic terms to describe the structure of affect. The research evidence (Clore et al., 1987; Ortony et al., 1987) attempts to discriminate between a more specific language of moods and emotions, or ‘affect-focal’ terms, and a broader, ‘ambiguous’ language of affect. According to Ortony et al. (p.343), ambiguous language refers to words that have been used in the affect literature to label any valenced judgement or condition.
Comparing their taxonomy of ambiguous semantic terms to those commonly employed in circumplex analyses, the most consistent ambiguity lies in descriptions of highly activated and deactivated states.

Comparing this evidence to the exploratory findings, 11 out of 48 items in the current design failed to load on C1 and C2, and thus did not capture the ‘core’ of affect from self-report responses. Subsequent confirmatory factor analyses exposed difficulties in operationalising pure activation and deactivation. Together, these results produced a narrowing of the nomological net from 48 to 33 items, and a revised 11-point circumplex model from composites scales of 3 items each. Whether, as Ortony et al. (1987) suggest, the anomalous items reflect a lack of understanding among participants to associate words such as quivering with rage, or even tempered with specific instances of moods and emotions, is moot. As was previously argued in section 1.3.5, in the event that a participant experiences high activation or deactivation at a given moment, research design must describe all regions of the circumplex in the event the participant requires a label to describe that experience.

However, if some of this response language has indeed confounded its function, which is to bring momentary feelings into existence as the ‘core’ of affect is categorised during perception (Lindquist et al., 2006), then this may have influenced how the entire common space is understood. Following this line of reasoning, the difficulties found in operationalising pure activation and deactivation, would explain why the Arousal dimension failed to predict ‘unpleasant activation’, in linear structural equation modeling, and the subsequent exclusion of this dimension from the CIRCUM analysis.

A previously mentioned and related line of reasoning is that, the response language utilised in the current research design is an English translation of the original Cantonese description of a 12-point circumplex (Yik, 2009). It is possible that the translation of terms from Cantonese to English, which was conducted by a bilingual Cantonese translator, does not reflect specific instances of moods and emotions under normal operating conditions, in an Australian English-speaking population. This combined reasoning therefore suggests that, the sampled affects have not realised ‘activated pleasure’ (2 o’clock), ‘unpleasant activation’ (11
o’clock), and pure ‘deactivation’ (6 o’clock), as part of momentary feeling states under normal operation conditions, in the current CIRCUM analysis.

An alternative viewpoint requires discussion to be focused on those areas of the circumplex that have been realised, and a specific examination of the polar estimates in the current CIRCUM analysis. The discrepancy between the hypothesised and actual locations of each polar angle ranges from as little as 5° (‘pleasant activation’ at 1 o’clock), to as much as 41° (‘deactivation’ at 6 o’clock). An inspection of the discrepancy between the hypothesised and actual locations of each polar angle in Yik’s (2009) Chinese circumplex model of momentary affect (CCMA) reveals a range of 1° to 8°. As previously stated, these findings suggest that this 11-point circumplex structure does not reliably conform to arbitrary decisions regarding how best to describe the underlying dimensional structure of affect.

The most precise indicators of reliability, however, are the 95% confidence intervals for each polar angle provided by CIRCUM. In the current analysis these ranged between 9° and 15°. These intervals suggest that, based on this sample of participants’ responses, the actual locations are indeed precise estimates of the kinds of core affect represented in each 11-point segment. As previously cited throughout this thesis, Remington et al. (2000) suggest a confidence interval of within 20° as a cut-off for precision in estimation. It is not possible to examine the reliability of the polar estimates in Yik’s (2009) model, as 95% confidence intervals for the polar estimates were not reported.

Whilst the model produced in the current CIRCUM analysis does not slice the circumplex neatly into segments spaced 30° as predicted by Yik’s (2009) thesis, the current findings closely replicate the kind of structure established when various external affective dimensions are integrated within the 12-point CCMA space (see Yik et al., p. 722). This kind of structural analysis is conducted with the Cosine Wave method, and demonstrates that the most difficult regions of the circumplex to reliably predict are pure ‘deactivation’ (6 o’clock), ‘unpleasant activation’ (11 o’clock), ‘unpleasant deactivation’ (7 o’clock), and ‘pleasant activation’ (1 o’clock). With the exceptions of ‘pleasant activation’ (1 o’clock) and ‘unpleasant deactivation’ (7 o’clock), these regions along with ‘activated pleasure’ (2 o’clock) were the most poorly predicted in the current model.
Two possible explanations are offered for these findings. The first relates to methods artifacts (Remington et al., 2000). The second explanation speaks to the relationship between Hedonic Valence and Arousal in subjective experience (Kuppens, Tuerlinckx, Russell, & Barrett, 2013; Barrett et al., 2004). Explaining the findings in relation to methods artifacts requires returning to the exploratory findings of both Yik (2009) and this current replication, and to the topic of arousal. It appears that the degree to which the Arousal dimension captures variance remains almost unchanged across both studies, at approximately 10%. This consistency in variance accounted for is irrespective of the number of affects sampled, and is greater than the contribution found in Study 1 Part A of 6.2%.

To explain the greater contribution in variance accounted for, it may be that the current research design to capture momentary affective responses improves the detection of arousal. This aspect of design supports Russell’s (1980, 2003, 2009) contention that core affect is most clearly represented in momentary feeling states, elicited from questions about how one feels, ‘right now’. It further supports the intuitive assumption posited in Study 1 Part A, that less activation was captured in the model due to the ‘in general’ nature of the test question. This aspect of research design in Study 1 Part A was a replication of Davern’s (2004; Davern et al., 2007) research methodology for modeling circumplexity.

A potentially greater contribution of arousal, as a function of research design, also supports Remington et al.’s (2000) review findings. This is that circumplex models established from self-report ratings involving shorter time frames (i.e., momentary states), rather than longer time frames (i.e., trait judgements), improve interpretations of overall model fit. However, comparing the fit indices provided by CIRCUM, it appears that the two models established in this thesis do not support this research evidence. On the contrary, a circumplex model established from trait (not state) judgements provides a better overall fit to the data. Table 31 compares the fit of both models and those study characteristics built into the design of each model.
Table 31:
*A comparison of research design characteristics and overall fit of circumplex models produced in the current thesis.*

<table>
<thead>
<tr>
<th></th>
<th>Study 1: Part A</th>
<th>Study 2: Part A</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Overall Model Fit:</strong></td>
<td>RMSEA: .09 (90% CI: .08-.09)</td>
<td>RMSEA: .10 (90% CI: .08-.11)</td>
</tr>
<tr>
<td></td>
<td>MCSC: -.53</td>
<td>MCSC: -.50</td>
</tr>
<tr>
<td><strong>Study Characteristics:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longer Time Frames (i.e., trait judgments)</td>
<td></td>
<td>Shorter Time Frames (i.e., momentary judgements)</td>
</tr>
<tr>
<td>Intensity Ratings</td>
<td></td>
<td>Intensity Ratings</td>
</tr>
<tr>
<td>Single Items</td>
<td></td>
<td>Composite Scales</td>
</tr>
<tr>
<td>Unipolar Response Scales –</td>
<td></td>
<td>Unipolar Response Scales –</td>
</tr>
<tr>
<td>(0) ‘No contentment at all to (10) Extremely</td>
<td></td>
<td>(1) Not at all to (5) Extremely (standardised onto a 0-100 scale)</td>
</tr>
<tr>
<td>Nomological Net (n=23)</td>
<td></td>
<td>Nomological Net (n=48)</td>
</tr>
<tr>
<td>Consideration of ‘Affect-focal’ terms</td>
<td></td>
<td>Consideration of previous 12-point research design</td>
</tr>
</tbody>
</table>

Whilst both models are quite similar in terms of fit, fit indices in the table indicate the model established in this Study 2 Part A is a slightly poorer fitting model than the model established in Study 1 Part A. Most interesting is the wider confidence interval, which may suggest that current research design is not as rigorous in controlling for the combined confounding effects of study characteristics listed in the table. For example, the combined effect of state judgements involving an intensity rating is demonstrated to impede reliable interpretations of fit indices in circumplex analyses (Remington et al., 2000; see section 1.3.5 for a detailed discussion). Moreover, the aforementioned challenge associated with the item selection process and English translation of terms may have reduced the signal-to-noise ratio. The construction of composite scales from these potentially confounded items may have further impeded a more precise overall interpretation of model fit in Study 2 Part A.

A second possible explanation for why some areas of the circumplex are more difficult to predict than others draws on recent research by Kuppens et al. (2013; Kuppens, 2008) which investigates how Hedonic Valence and Arousal are
related to one another on a moment-to-moment basis. This work on the subjective experience of core affect extends on previous research (see Feldman, 1995b; Barrett, 2004; Barrett et al., 2006) by comparing this relationship at the individual level (i.e., idiographic), and at the level of the population (i.e., nomothetic). It is the nomothetic level that is pertinent to the current discussion given research design in this thesis is cross-sectional, and that this replicates much of the available evidence on the subjective experience of core affect.

The study conducted by Kuppens et al. (2013) examines six possible relationships between Hedonic Valence and Arousal (core affect), one of which includes the independence view (Mehrabian & Russell, 1974; Russell, 1980; Yik et al., 1999) adhered to in this thesis. Their specific aim is to control for methods and contextual artifacts in order to look for converging evidence for a particular relation in affective data. The data are therefore obtained in different settings (i.e., lab versus experience sampling) from various stimuli (i.e., facial images, modern art paintings, remembered affects, momentary affect) and from different methods built into their study design (i.e., multiple response scale formats, and emotion terms).

At the nomothetic level, Kuppens et al. (2013) argue it is indeed possible that perceived internal cues produce the affective feeling of arousal. As such, the relation between Hedonic Valence and Arousal in subjective experience would be modelled according to the independence view illustrated in Figure 24a.

![Figure 24a: Independence](image1)
![Figure 24b: Hypothesised asymmetry](image2)
![Figure 24c: Actual asymmetry](image3)

However, they also argue it is plausible that activation, as a proxy for arousal, is related to valence in a way that serves an adaptive function for the organism. This specific relationship is expressed as an asymmetric V-shape and includes two types
of asymmetry illustrated in Figure 24b. The vector on the right side of the circle indicates the first type of asymmetry. This is called positivity offset to signal the adaptive function of positive valence that is mildly activated to motivate the organism to approach and explore the environment. In accordance with the independence view (Yik, 2009; Yik et al., 2011) and this current replication study, mildly activated pleasure is hypothesised at 30° (2 o’clock) on the circumplex. The vector on the left side of the circle is the second type of asymmetry, and is called negativity bias. This suggests that negative valence is more highly activated (reactive) than positive valence because unpleasant activation is required by the organism to respond immediately to threat in the environment (Kuppens et al., 2013). The independence view models unpleasant activation on the circumplex at 120° (11 o’clock).

The specific hypothesis, that positive and negative valence covary differently as a function of their respective levels of activation, was put to the test in a regression model. The results supported a very weak V-shaped relation with arousal as a function of valence ($R^2 = .06$ for momentary affect). However, contrary to expectations, high activation was not a function of negative valence (i.e., no negativity bias). Furthermore, the asymmetry involved in the positive valence relationship indicated a positivity bias, and not a positivity offset, as hypothesised. The actual asymmetric V-shaped relationship found in Kuppens et al.’s analysis is illustrated in Figure 24c.

The authors conclude that due to very low $R$ squared values obtained at the nomothetic level, and the large degree of variability observed at the idiographic level, their results do not support the thesis that arousal is merely the intensity of positive and negative valence (Diener et al., 1985). Instead, the results indicate that an arousal dimension independent of valence is needed to describe qualities above and beyond the intensity involved in self-reported arousal experiences. They make a further claim that speaks to the issue of bipolarity. This is that the consistently observed asymmetric relationship between valence and arousal indicates that arousal does not covary with valence in a uniform way. This may explain why some instances of a relation between arousal and positive and negative valence in
subjective experience are separable and have bivariate rather than bipolar properties (Kuppens et al., 2013, p.934).

Returning to the independence view, the kind of asymmetry found in Kuppens et al. (2013) study can be graphically observed in the current circumplex model illustrated in Figure 23. Slicing the circumplex in half, horizontally, the top half of the circle represents ‘activation’ comprising a range of states that *vary in valence*. The most reliably predicted region of the circumplex in this current replication of momentary affect, is found at 60° (1 o’clock) on the circumplex. This vector is conceptualised as *pleasant activation* and corresponds with Kuppens et al.’s unexpected finding of a positivity bias. The hypothesised positivity offset that was not supported in their findings corresponds to a region of the circumplex conceptualised as *activated pleasure* at 30° (2 o’clock). This was one of the most poorly predicted regions of the currently established circumplex model. The most poorly predicted region is *unpleasant activation* hypothesised at 120° (11 o’clock). It was not possible to operationalise (and therefore predict) this region of the circumplex from momentary responses. *Unpleasant activation* corresponds with Kuppens et al.’s unexpected finding of no negativity bias. Hence, Kuppens et al.’s (2013) study provides additional convergent validity for the current findings in this thesis.

However, the assertion by Kuppens et al. (2013) that, an arousal dimension independent of valence, is needed to describe self-reported arousal experiences is also supported by study findings in this thesis. Comparing both currently established circumplex models shows that an average of 78% (Study 1 Part A) and 77% (Study 2 Part A) of the variance is accounted for in the models by the two independent dimensions of Hedonic Valence and Arousal. In addition, the circumplex model established from trait judgements in Study 1 Part A, failed to capture high levels of activation and so does not support Kuppens et al.’s (2013) hypothesis of a negativity bias, or the actual finding of a positivity bias. Yet this model captures a range of mildly activated states and highly deactivated states that vary in valence. This supports the need to describe the ‘core’ of affect according to the independence view (Russell, 1980; Yik, 2009; Yik et al., 2011). It is concluded that the failure to capture
highly activated states in the trait model is likely a consequence of research design to establish a model from feelings about life in general.

The circumplex model established from momentary states in this Study 2 Part A also failed to demonstrate a negativity bias. However, it has captured purely activated and highly activated-pleasant states, and thus supports a positivity bias. Unlike the trait-based model, this current model of momentary affect failed to capture pure deactivation. Slicing the circumplex illustrated in Figure 23 in half, vertically, the right half of the circle is interpreted as ‘positive affect’ and the left half as ‘negative affect’. Interpreting affective structure in this way reveals the asymmetry found by Kuppens et al. (2013) as well as the multidimensional nature of affect (Russell & Carroll, 1999), as a range of valenced states varying in the level of arousal are captured in this momentary model.

It is therefore concluded that the failure to capture pure deactivation (6 o’clock) in the current model, and unpleasant activation (11 o’clock) in both models, is due to difficulty in operationalising these constructs. This has confounded the more fundamental inquiry as to whether these regions of the circumplex actually describe the experience of ordinary everyday moods and emotions. The subsequent failure to capture activated pleasure (2 o’clock) in the current model may be a further consequence of research design to create a measurement map of momentary feelings. Comparing trait (Study 1 Part A) and state (Study 2 Part A) models, the novel aspect of the state model is the presence of acute fluctuation in positive arousal. This suggests that people’s aggregated self-reports of momentary experience incorporate more pleasant activation (1 o’clock), as opposed to mildly activated pleasure (2 o’clock) found in aggregated trait-based responses.

Mildly activated pleasure is the newly established empirical definition for HPMood on the circumplex. This trait mood affect dominates responses to subjective wellbeing (SWB) and variables in the homeostatic model, under normal operating conditions. However, according to Cummins (2010; Cummins et al., 2012), acute fluctuations in response to moment-to-moment subjective experiences will likely see a reduced presence of the affective experience of HPMood, as the positive mood associated with SWB is re-directed to the dominating emotions synonymous with the experience. Given the currently established momentary model fails to capture mildly

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activated pleasure at 30° (2 o’clock), it will be most interesting to observe the presence of a relation between core affect and variables in the homeostatic model, and more specifically, any reduction in the magnitude of this association.

Finally, in utilising the model as a means to empirically question whether affective experience conforms to the semantic hypothesis of bipolarity, the most reliable indicator of bipolarity in this thesis is the minimum common score correlation (MCSC) at 180° provided by the CIRCUM procedure. The values obtained for Study 1 Part A and Study 2 Part A are -.53 and -.50, respectively. Whilst Yik (2009) does not report the MCSC at 180° for her Chinese circumplex model of affect (CCMA), the median value across 47 correlation matrices submitted to a CIRCUM analysis by Remington et al. (2000) is -.66. The difficulty in capturing purely activated and deactivated states from semantic labels has likely confounded empirical testing of the bipolarity thesis by attenuating MCSC values in both studies. However, given the lack of constraints placed on the modeling procedure, it is concluded that these similar results provide a well-defined description of core affective space, a space that is lacking simple structure and which is indicative of bipolarity.
In this fourth and final study, the circumplex model of core affect established from composite measures of momentary experiences in Study 2: Part A is utilised as a platform from which to verify the construct validity of HPMood. The study will also provide a further test of the degree to which SWB and related variables are affective in nature, on the circumplex.

AIMS AND PREDICTIONS

The main aim of the study is to test the reliability of HPMood’s character, and its magnitude of association with SWB and its major correlates, using a momentary model of core affect. The Cosine Wave Method (Yik, 2009; Yik et al., 2011) will once again be used to verify HPMood on the circumplex in the following way:

- Measures of SWB and major correlates of SWB will be treated as external variables. These variables will be placed within the circumplex in the upcoming cosine wave analysis, one at a time, to examine the presence of a relation between each external variable and the circumplex model of core affect established in the previous study. The strongest point of association between that variable and a core affective structure will map out a range for where HPMood resides within the circumplex.

- The measures employed in Study 1 Part B will be utilised again in the cosine wave analysis. These include measures of SWB (e.g. PWI and GLS) and related variables in the homeostatic model of self-esteem and optimism. Trait extraversion will not be included in the upcoming analysis, as the focus of this study is to provide a more fine-grained description of HPMood’s constant structure.

In Study 1 Part B, variables in the Homeostatic Model of SWB (i.e., SWB, self-esteem, and optimism) together mapped a narrow bandwidth for describing
HPMood, that ranged between 354° and 357° on the circumplex. This implies that SWB, self-esteem, and optimism comprise almost an identical kind of core affect. The affective core of SWB was pinpointed precisely at 357° and was best described as ‘Pleasant’. This polar estimate captured the descriptive essence of the set-point HPMood from the single-item measure of SWB, general life satisfaction (GLS).

Importantly, GLS and the listed external variables were related to a circumplex model of core affect comprised of 23 single-item responses to feelings about life in general. In the upcoming cosine wave analysis, these same variables will be related to an affective circumplex of a different design; one that has been constructed from composite measures of momentary feeling states.

- Therefore, the summary statistics obtained in the upcoming cosine wave analysis will be compared with those obtained in Study 1 Part B, post-test. The aim is to observe whether a change in research design, from a ‘trait’ to ‘state’ model of core affect, influences the description of HPMood, and the degree to which SWB and related variables are affective in nature.

Based on SWB Homeostasis theory (Cummins, 2010, 2012; Cummins et al., 2012) and the empirical findings of Study 1 Part B, the circumplex will be utilised to make the following predictions:

The first hypothesis is that all listed external variables will be reliably related to a structure of core affect, and share a similar correspondence on the circumplex. Justification for this prediction is based on the results of the cosine wave analysis in Study 1 Part B. Not only were SWB, self-esteem, and optimism reliably related to a structure of core affect (mean variance accounted for: VAF: $M = 97.75\%$, $p < .01$), they shared an almost identical correspondence to a core affective structure, with only 3° of separation between them.

The second hypothesis is that SWB will be more affective in nature compared to the other listed external variables. Justification for this prediction is based on previous findings with linear methods (Blore et al., 2011; Davern et al., 2007; Lai & Cummins, 2013; Tomyn & Cummins, 2011), and the results of the cosine wave analysis in Study 1 Part B. Effect sizes in the form of $r_{max}$ values in the cosine wave analysis indicated SWB is more affective in nature than self-esteem, optimism, and
extraversion. However, the findings of the first cosine wave analysis did not conclusively support interpretations of the previous linear findings, that HPMood dominates the content of these variables. With replication to follow, it will be possible to obtain a further ‘glimpse’ of the descriptive essence of the affective core of SWB and related variables, and HPMood’s magnitude of association.

5.1. METHOD

External Measures

The participants (N = 569) registered responses to the following measures, which formed part of the Australian Unity Wellbeing Index Longitudinal Project labelled as ARC24. The entire survey contained 96 items, and included the 48 single-item affect measures used to replicate Yik’s (2009) Chinese circumplex model of momentary affect (CCMA), in English, reported in the previous study. Table 32 presents the external measures used in the current analysis to replicate HPMood on the circumplex.

Table 32: External variables used to replicate HPMood on the circumplex.

<table>
<thead>
<tr>
<th>Scale</th>
<th>Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Life Satisfaction (GLS)</td>
<td>Single-item measure of SWB</td>
</tr>
<tr>
<td>Personal Wellbeing Index (PWI)</td>
<td>Composite measure of SWB</td>
</tr>
<tr>
<td>Rosenberg Self-Esteem Scale (RSES)</td>
<td>Self Esteem</td>
</tr>
<tr>
<td>Life Orientation Test - Revised (LOT-R)</td>
<td>Optimism</td>
</tr>
</tbody>
</table>

Replicating the research design of Study 1 Part B, the respondents used an 11-point end-defined unipolar response scale for all rating measures in the study.

General Life Satisfaction (GLS)

The single item “Thinking about your own life and personal circumstances, how satisfied are you with your life as a whole?” was used to measure GLS with responses anchored by ‘Not at all satisfied’ (0) and ‘Completely satisfied’ (10).
**Subjective Wellbeing**

Subjective wellbeing (SWB) is measured with the Personal Wellbeing Index (PWI; International Wellbeing Group, 2013). The scale comprises seven items measuring important aspects of life that contribute, positively or negatively, to SWB. Questions are directed at satisfaction with ‘standard of living’, ‘health’, ‘achieving in life’, ‘relationships’, ‘safety’, ‘community-connectedness’, and ‘future security’ with responses anchored by ‘Not at all satisfied’ (0) and ‘Completely satisfied’ (10).

Comparing the internal consistency and component structure of the PWI in Study 1 Part B with this current replication study, a single component accounted for 54% of the variance in Study 1 Part B. Cronbach’s alpha coefficient for the seven items was .86 and item-total correlations ranged between .52 and .71. In the current study, a single component accounts for 52% of the variance. Cronbach’s alpha for the seven items is .84 and item-total correlations range between .45 and .69.

To test the assumption that the PWI is considered a domain-level representation of GLS, a multiple regression was conducted (see Study 2 Part B and the PWI test manual for an elaboration on this assumption). The seven domains regressed against GLS accounted for 62% of the variance. However, the domains of ‘Health’, ‘Safety’ and ‘Future Security’ failed to make unique contributions to the prediction of GLS. Interestingly, the regression analysis conducted in Study 1 Part B accounted for almost the same amount of total variance, at 64%. In this analysis, ‘Safety’ and ‘Community’ failed to contribute unique variance. While these findings challenge the theoretical underpinnings of the PWI as a domain-level representation of GLS, all items have been retained in order to generalise the results to normative populations in Australia and overseas.

**Self-Esteem**

Self-esteem is measured by the five positively worded items of the Rosenberg Self-Esteem scale (RSE) (Rosenberg, 1965) with responses anchored by ‘Do not agree at all’ (0) and ‘Agree completely’ (10). In Study 1 Part B, a single component accounted for 78% of the variance and Cronbach’s alpha for the five items was .93. In the current study, a single component accounts for 76% of the variance and Cronbach’s alpha is .92.
Optimism

Optimism is measured by the three positively worded items of the Life Orientation Test-Revised (LOT-R) (Scheier, Carver, & Bridges, 1994) with responses anchored by ‘Do not agree at all’ (0) and ‘Agree completely’ (10). In Study 1 Part B, a single component accounted for 76% of the variance and Cronbach’s alpha for the three items was .85. In the current study, a single component accounts for 80% of the variance and Cronbach’s alpha is .87.

Items pertaining to each trait variable were aggregated and averaged to form composite measures of SWB, self-esteem, and optimism.

Statistical analyses

All study variables were transformed onto a 0 to 100 point distribution. This was achieved by shifting the decimal point one step to the right. For example, a response of 5.0 on the 0-10 scale became 50 points.

Data cleaning

To briefly reiterate, all missing data were dealt with by means of listwise deletion prior to the commencement of Study 1 Part A, and the removal of univariate and multivariate did not improve statistical analyses. Therefore, the decision was made to retain the original composition of the sample. Prior to the commencement of Study 1 Part A, additional data cleaning relevant to the current analysis was performed. This involved eliminating response sets inherent in measures concerning subjective evaluations of satisfaction with life. As such, participants’ scores on SWB, self-esteem, and optimism were compared. Participants who achieve a maximum score of 100 on all three measures are considered to be demonstrating an acquiescent response style. In the current sample, 3 participants responded in this way and were removed from the analysis. Table 33 presents the psychometric properties of the external variables in the study.
Table 33:

*Psychometric properties of the external variables placed within the circumplex.*

<table>
<thead>
<tr>
<th>Composite Variable</th>
<th>Variable</th>
<th>M</th>
<th>SD</th>
<th>Min</th>
<th>Max</th>
<th>Skew</th>
<th>α</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Life Satisfaction (GLS)</td>
<td></td>
<td>71.28</td>
<td>18.66</td>
<td>00.00</td>
<td>100.00</td>
<td>-1.34</td>
<td>-</td>
</tr>
<tr>
<td>Personal Wellbeing Index (PWI)</td>
<td></td>
<td>71.73</td>
<td>15.20</td>
<td>20.00</td>
<td>100.00</td>
<td>-0.88</td>
<td>.84</td>
</tr>
<tr>
<td>Rosenberg Self-Esteem scale (RSE)</td>
<td></td>
<td>76.97</td>
<td>16.16</td>
<td>00.00</td>
<td>100.00</td>
<td>-1.35</td>
<td>.92</td>
</tr>
<tr>
<td>Life Orientation Test-Revised (LOT-R)</td>
<td></td>
<td>68.04</td>
<td>19.45</td>
<td>00.00</td>
<td>100.00</td>
<td>-0.80</td>
<td>.87</td>
</tr>
</tbody>
</table>

Note: (GLS): Single-item measure of SWB; (PWI): Composite measure of SWB; (RSE) Composite measure of Self-Esteem; (LOT-R): Composite measure of Optimism. Possible scores range from 0 to 100 for each composite measure.

There is a noticeable difference in the mean scores obtained for GLS and the PWI when compared to normative data generated from the Australian Unity Wellbeing Index. To re-iterate, normative data for both of these measures represent survey mean scores accumulated from 30 random samples, each of approximately 2,000 Australians taken biannually since 2001. Over all surveys conducted for the past 13 years, the survey means for GLS and the PWI have varied by just 4.1 and 3.1 percentage points, respectively. For GLS they range between 75.2 and 79.1, and between 73.2 and 76.3 for the PWI.

As can be seen in Table 33, the survey means for GLS and the PWI representing the 569 Australians in the current study are comparatively lower. They are also lower than the means scores obtained in the previous Study 1 Part B. To examine significant differences in mean scores, two independent samples t-tests were conducted with GLS and the PWI each as dependent variables and survey number (ARC21 and ARC24) as the independent or grouping variable. The results for GLS revealed a significant mean difference of 4.30 % (95% CI = 2.44 – 6.16) between scores in the current study ($M = 71.28$, $SD = 18.66$) and Study 1 Part B ($M = 75.58$, $SD = 16.71$), $t(1086) = 4.53$, $p < .0005$. A significant mean difference of 3.10% (95% CI = 1.57 – 4.63) was also found between scores on the PWI in the current study ($M = 71.73$, $SD = 15.20$) and Study 1 Part B ($M = 74.84$, $SD = 13.78$), $t(1108) = 3.98$, $p < .0005$. The possible implications of these differences will be discussed. The results of the cosine wave analysis will now be presented.
Cosine wave analysis

The final Statistica (Statsoft, 1984) data file contained five variables. The first column in the data file was designated ‘X’ to represent pre-specified values for the 11 polar angles obtained in the previous CIRCUM analysis from the 11 composite scales. The remaining columns represent zero-order correlations between each of the external trait variables (i.e., general life satisfaction, subjective wellbeing, self-esteem, and optimism), and each segment of ‘X’. Replicating the procedure in Study 1 Part B, advanced non-linear estimation modeling was chosen via the ‘statistics’ module in the drop-down menu along with the option to employ a “user-specified regression function”. The specific regression function to be estimated is:

\[ Y = a + b \times \cos(X + d) \]

To re-cap, \( Y \) is the correlation between each segment of the circumplex model of core affect and each external variable; \( X \) is the angle for the segment within the circumplex model. \( a, b, \) and \( d \) are constants to be estimated in the estimation procedure. In this formulation, \( a \) adjusts the values of \( Y \) to fit the cosine function; \( b \) indicates the amplitude of the cosine wave; \( d \) indicates the start value of \( X \) when it does not start at 0. As an example, to chart the relation between general life satisfaction and the 11 segments of the circumplex model of momentary core affect the user specifies the following equation:

\[ GLS = a + b \times \cos(X + d) \]

The results of the cosine wave analysis for each external variable placed within an 11-point circumplex model of momentary affect are presented in Table 34.
Table 34:
Placing external variables within an 11-point Circumplex Model of Momentary Affect via the Cosine Wave Method.

<table>
<thead>
<tr>
<th>TRAIT SCALE</th>
<th>( \hat{a} )</th>
<th>( r_{\text{max}} )</th>
<th>VAF (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GLS – (General Life Satisfaction)</td>
<td>9º</td>
<td>.52</td>
<td>98</td>
</tr>
<tr>
<td>PWI – (Subjective Wellbeing)</td>
<td>9º</td>
<td>.49</td>
<td>99</td>
</tr>
<tr>
<td>RSE – (Self-esteem)</td>
<td>8º</td>
<td>.46</td>
<td>99</td>
</tr>
<tr>
<td>LOT-R – (Optimism)</td>
<td>13º</td>
<td>.45</td>
<td>99</td>
</tr>
</tbody>
</table>

Note: All values of VAF were significant at the \( p < .01 \) level.

The summary statistics are based on estimates for the constants \( a \), \( b \), and \( d \) and form the basis from which to estimate \( \hat{a} \) (\( \hat{a} \)-hat) that indicates where within the circumplex the external variable falls. As shown in the table, \( \hat{a} \) has produced a polar angle for each external variable, the locations of which range between 8º and 13º on the circumplex. Next, an estimate of \( r_{\text{max}} \) (\( r_{\text{max}} \)) indicates the maximum correlation between each external variable and a circumplex segment. Therefore, where the empirical estimates of \( a \), \( b \), and \( d \), and \( \hat{a} \) are inserted in the equation:

\[
r_{\text{max}} = a + b \times \cos (\hat{a} + d)
\]

Using the findings in Table 34 for general life satisfaction, the equation yields the following finding. Participants who rated their overall life satisfaction had a moderate tendency (\( r_{\text{max}} = .52 \)) to report a specific type of core affect (mildly activated pleasure) that is best characterised by the peak of the fitted curve at (\( \hat{a} = 9º \)) within the circumplex.

The final statistic provided by the cosine wave analysis is the percentage of variance accounted for (VAF). To re-cap, VAF signals the ‘fit’ of the pattern of correlations to a cosine function. The results indicate that the ‘line of best-fit’ through the data reliably approximates a cosine curve for all variables in the study; the ‘data’ being the 11 segments of the circumplex model of momentary affect with each external variable included separately as part of the model. Monte Carlo testing (see Yik et al., 2011) sets alpha levels for significance at \( p < .05 \) for values of VAF \( \geq 45.5\% \), and \( p < .01 \) for values \( \geq 57.6\% \). Values of \( r_{\text{max}} \) that are < .15 indicate that the
external variable is unrelated to a circumplex model of affect. As shown in Table 34, $VAF$ values for all external variables are significant at the $p < .01$ level, and $r_{max}$ values are well above the critical value of .15, indicating all variables are reliably and meaningfully related to a structure of core affect. Table 35 compares the summary statistics for both studies in this thesis.

Table 35:
Replication of the precise locations, effect sizes and fit of a cosine curve to data in this thesis.

<table>
<thead>
<tr>
<th>Trait Scale</th>
<th>$\hat{\theta}$</th>
<th>$r_{max}$</th>
<th>VAF (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GLS – (General Life Satisfaction)</td>
<td>357°</td>
<td>.64</td>
<td>97</td>
</tr>
<tr>
<td>PWI – (Subjective Wellbeing)</td>
<td>356°</td>
<td>.65</td>
<td>98</td>
</tr>
<tr>
<td>RSE – (Self-esteem)</td>
<td>356°</td>
<td>.59</td>
<td>98</td>
</tr>
<tr>
<td>LOT-R – (Optimism)</td>
<td>354°</td>
<td>.55</td>
<td>98</td>
</tr>
</tbody>
</table>

Note: (S1): Study 1 Part B. The data comprise 23 single-item trait responses with each external trait variable included separately as part of the model; (S2): Study 2 Part B. The data comprise 11 composite scales representing momentary responses with each external trait variable included separately as part of the model. All values of VAF are significant at the $p < .01$ level.

The $VAF$ (%) values consistently indicate that all listed trait variables remain reliably related to a structure of core affect. Examining the polar angles ($\hat{\theta}$) for each study separately, it appears that the kind of core affect accompanying responses to all listed variables is very similar. In Study 1 Part B, participants who rated their GLS, SWB, self-esteem, and optimism tended to report pleasantness best characterised within a range of 354° - 357° on the circumplex. In Study 2 Part B, it is mildly activated pleasure located within a range of 8° - 13°, which best describes the affective core of these trait variables.

All together, it appears that the strongest point of association found between GLS, SWB, self-esteem, optimism, and an affective circumplex is located within a region of the circumplex ranging between 354° and 13° on the circumference of the circle. Using confidence limits of 20° set by Remington et al. (2000) as a further indicator for determining reliability in estimation across different studies, this
indicates that the polar estimates are quite precise. The most reliable estimates are found for GLS (S1: 357°; S2: 9°) and self-esteem (S1: 356°; S2: 8°). The discrepancy between polar angles across the two studies is 12°. The least reliable estimates are found for optimism. The discrepancy between polar angles across the studies is 19° (S1: 354°; S2: 13°). Finally, the magnitude of association ($r_{max}$) between all listed trait variables and a structure of core affect, is greater for the affective circumplex model constructed from single-item trait responses (S1) as opposed to composite measures of momentary responses (S2).

Figure 25 below illustrates the specific blend of Hedonic Valence and Arousal now replicated on the circumplex that is most strongly associated with these external measures.

Figure 25: The strongest point of association found between the listed external variables and an entire structure of core affect across two studies.

In sum, the results of the Cosine Wave analysis, across two studies, have empirically defined a specific type of core affect accompanying responses to the listed external variables. This definition is commensurate with Cummins’ (2010, 2012) conceptualisation of HPMood as a ‘pleasant and mildly activated’ core state of
affect. Replicating the analysis has revealed variation in the degree to which SWB and major correlates appear affective in nature.

5.3. DISCUSSION

In the current study, the cosine wave analysis (Yik, 2009; Yik et al., 2011) treated the 11-point circumplex model of momentary affect established in Study 2 Part A as an integration tool, to chart a relation between a structure of core affect and variables in the Homeostatic Model of SWB (Cummins et al., 2012). The aim was to confirm the construct validity of HPMood using a momentary model of core affect, and to provide a further test of HPMood’s magnitude of effect.

Pinpointing the precise location of HPMood within the circumplex is governed by the guiding principle of this methodology. To re-iterate, each variable in the homeostatic model that correlates with one vector (11-point segment) within the circumplex will correlate with the remaining segments in a systematic way. The magnitude of that correlation will rise and fall in a cosine wave pattern as one moves around the circumference of the circumplex (Stern, 1970; Wiggins, 1979). Therefore, the peak of a fitted cosine curve, when each listed variable is related to a structure of core affect, will represent the strongest point of association between that variable and the entire structure of core affect. This pinpoints where HPMood resides within the circumplex and reveals the degree to which each variable is affective in nature.

In addition to testing the reliability of HPMood’s character, it was possible to observe post-test whether a change in research design, from a ‘trait’ to ‘state’ model, influences the description of HPMood, and the degree to which SWB and related variables appear affective in nature. Therefore, based on theory (Cummins, 2010, 2012; Cummins et al., 2012) and newly established convergence between past (Blore et al., 2011; Davern et al., 2007; Lai & Cummins, 2013; Tomyn & Cummins, 2011) and present empirical findings in this thesis, two predictions were made.

Hypothesis 1: All listed external variables will demonstrate a reliable degree of relatedness to a structure of core affect, and share a similar correspondence on the circumplex.
Justification for the first hypothesis is based on the results of the previous cosine wave analysis conducted in Study 1 Part B. These findings indicated that SWB, self-esteem, and optimism were reliably related to a structure of core affect (variance accounted for: VAF: $M = 97.75\%, p < .01$). Furthermore, all listed variables shared similar correspondences to a core affective structure with only $3^\circ$ of separation between them. This implies that SWB, self-esteem, and optimism comprise almost an identical type of core affect. The results of the current study (variance accounted for: VAF: $M = 98.75\%, p < .01$) replicate this high degree of reliability. Furthermore, SWB, self-esteem, and optimism continue to share a similar correspondence on the circumplex with only $5^\circ$ of separation between them. Thus, the results fully support the first hypothesis.

Elaborating on the current findings, the region on the circumplex that captures the affective core of SWB and major correlates is located between $8^\circ$ and $13^\circ$. The affective core of SWB is pinpointed precisely at $9^\circ$ (VAF: 98%) and now confirms Cummins’ (2010, 2012) theoretical definition of HPMood as a mildly pleasant and activated ‘core’ state of affect. Comparing the construct validity of HPMood across both studies in this thesis, it appears that the composition of HPMood varies in the level of arousal. In the first cosine wave analysis (Study 1 Part B), the affective core of SWB was pinpointed at $357^\circ$ and was best described as ‘pleasant’. In the current study the descriptive essence of the set-point HPMood is located $12^\circ$ away, at $9^\circ$ on the circumplex, and describes ‘mildly activated pleasure’.

One possible explanation for this finding is that, the variation in arousal that appears to alter the composition of HPMood, may represent variation within normal functioning of homeostatic set-points reported in levels of SWB (Cummins, 2010, 2013 in press, Cummins et al., 2014). Therefore, this replication study has made a valuable contribution to establishing a narrow ‘descriptive bandwidth’ of the normal range of stability in SWB. A second possible explanation is that a change in research design, from a ‘trait’ to ‘state’ model, influences how HPMood is best described. To re-iterate, the trait-based model of core affect used to validate HPMood in the first study, was not able to capture high activation from responses. However, the state-based model of core affect used to test the reliability of HPMood’s nature in the current analysis did capture high activation particularly in pleasant states. An
implication of capturing acute fluctuation in the current core affective model is that, the findings of this cosine wave analysis may reflect a closer approximation to the true descriptive essence of HPMood as it is experienced on a moment-to-moment basis. This is in contrast to a more basic valuation generated from trait (in general) judgements.

This notion supports the findings of Yik et al. (2011) in relation to trait optimism, and may improve the interpretation herein of reduced reliability in estimating the affective core of optimism. To re-iterate, Yik et al. charted a relation between optimism using the Life Orientation Test (Carver & Scheier, 1992) and a 12-point affective circumplex (12-PAC) model of momentary affect (state-based model). In their cosine wave analysis, the affective core of optimism was pinpointed at 7° on the circumplex. Across two studies in this thesis, with different research designs, the discrepancy between the polar estimates predicting the affective core of optimism is 19° (S1: 354°; S2: 13°). Comparing Yik et al.’s findings to those in the current analysis of the same research design, the affective core of optimism is more reliably described within a narrower bandwidth between 7° and 13° on the circumplex, and comes closer to the theoretical definition of HPMood (Cummins, 2010, 2012).

Hypothesis 2: SWB will be most affective in nature compared to the other listed external variables.

Justification for this prediction is based on the results of the cosine wave analysis in Study 1 Part B. Effect sizes in the form of $r_{max}$ values in the cosine wave analysis indicated SWB is more affective in nature than its major correlates. The results of the current analysis replicate these findings. The $r_{max}$ values ranged from .45 to .52 to indicate their maximum strength of association with an 11-point structure of core affect. Based on the criterion value set in Monte Carlo testing (Yik, 2009) for $r_{max}$ of >.15 as an effect size indicator, the results imply that these estimates of the affective nature of the listed variables are highly meaningful. GLS and SWB achieved the strongest magnitudes of association with a structure of core affect (.52 and .49, respectively), and thus support the second hypothesis.
However, replication shows (see $r_{\text{max}}$ values in Table 35) the effect sizes are somewhat lower than those obtained in the previous cosine wave analysis. Taken together, the findings do not support previous findings conducted with linear methods (Blore et al., 2011; Davern et al., 2007; Lai & Cummins, 2013; Tomyn & Cummins, 2011) that, HPMood dominates the content of these variables. In the case of SWB, the current cosine wave analysis estimates approximately 27% of the variance, is accounted for by HPMood. In the previous analysis, approximately 42.3% of the variance is attributed to HPMood. In fact, maximum correlations ($r_{\text{max}}$) for all listed trait variables are greater for the affective circumplex model constructed from single-item trait responses in Study 1 Part A as opposed to composite measures of momentary responses in Study 2 Part A. Therefore, a change in research design from a ‘trait’ to ‘state’ model may influence the degree to which SWB and related variables appear affective in nature.

This latter notion is supported in Yik et al. (2011), and their comparison of effect sizes ($r_{\text{max}}$) for external variables measured as either ‘states’ or ‘traits’. They used a 12-point affective circumplex (12-PAC) model of momentary affect (state-based model) as a measurement map to chart a relation between a structure of core affect and a number of external variables. The results revealed lower $r_{\text{max}}$ values for external variables measured as traits, and higher $r_{\text{max}}$ values for variables measured as states. An implication of these findings is that words such as ‘in general’, ‘overall’, and ‘right now, in the current moment’ can indeed distinguish state from trait measures of psychological phenomena such as affect and personality.

The issue of whether wording alone, can provide a valid assessment of a construct is debated in the literature (see Allen & Potkay, 1981; Zuckerman, 1983), and was highlighted in section 1.2.2 of the literature review. In short, Allen and Potkay consider the state/trait distinction to be arbitrary, and hence the use of words is commonly considered sufficient for distinguishing state from trait measures (Diener & Iran-Nejad, 1986; Robinson & Clore, 2002; Watson, Clark, & Tellegen, 1988). However, Zuckerman argues that a valid assessment of whether measures capture ‘states’ or ‘traits’ relies on the specific examination of test-retest reliability along with the internal consistency of the measures. This can only be done when
research employs a within-subjects design and the constructs of interest are measured in the form of composite scales.

Following Zuckerman’s (1983) line of reasoning, the assumption that the affective circumplex model established in Study 1 Part A is a trait-based model, is not a valid one as it is based on wording alone and uses single-items, each eliciting an *in general* response. Indeed, the assumption that the affective circumplex model established in Study 2 Part A is a state-based model is somewhat arbitrary. This is due to the utilisation of the ARC longitudinal project as a cross-sectional data source, which prevents the examination of test re-test reliability. In spite of this proposed limitation and in line with Yik et al.’s (2011) findings, replication with the cosine wave analysis provides new insight into the state/trait distinction using the $r_{max}$ indicator. It shows the most meaningful relationships occur when the affect model and externally related variables are treated similarly as ‘trait-like’, or similarly ‘state-like’. The most meaningful relationships for all externally listed variables in this thesis measured as traits, occurred when they were related to an affective circumplex model constructed from *in general* responses, as opposed to *momentary* responses.

An additional and unique finding of the current replication study, which may explain the lower $r_{max}$ values and weaker overall contribution of HPMood, relates to the mean scores obtained on both measures of SWB (PWI: $M = 71.73$, $SD = 15.20$; GLS: $M = 71.28$, $SD = 18.66$). These are lower than normative data, and significantly lower than mean scores obtained in the previous Study 1 Part B. While it is not possible to determine what has contributed to this reduction, research conducted within SWB Homeostasis theory (Cummins, 2003, 2010; Cummins et al., 2012; Cummins et al., 2014) suggests that these scores indicate participants are holding the line just above the threshold for depression risk ($M \leq 70.00$). If this is indeed the case, then qualities associated with adversity such as thoughts (i.e., sadness), behaviour (i.e., loss of appetite), and motives (i.e., social withdrawal) may be dominating responses. This could account for a reduced presence of HPMood in participants’ ratings of SWB, as the predominant stable positive mood associated with SWB is re-directed to the dominating emotions synonymous with the challenge.

In summary, all listed external variables in the Homeostatic Model continue to demonstrate a high degree of reliability to a structure of core affect. SWB is also
more affective in nature compared to self-esteem, optimism, and extraversion. However, with replication, it cannot be shown that HPMood dominates these experiences. The bandwidth for describing HPMood is narrowly defined within a range of 354° to 13° on the circumplex. The normal descriptive range demarcated by the external variables remains commensurate with Cummins’ (2010, 2012) theoretical definition of HPMood as a *mildly pleasant and activated core state of affect*. Furthermore, all external variables are more meaningfully related to an affective circumplex model constructed from single-item trait responses as opposed to a model constructed from composite measures of momentary feeling states. Finally, with replication it has been possible to observe the descriptive essence of the set-point HPMood. Each glimpse shows HPMood as *positively pleasant, and mildly activated*. 
CHAPTER 6: EXECUTIVE DISCUSSION

This thesis has concerned verifying the nature of Homeostatically Protected Mood (HPMood), as a core affective construct. It has also attempted to determine HPMood’s degree of association with subjective wellbeing (SWB) and its major correlates, on the circumplex. The investigation was conducted across four studies using the best known methodology (Browne, 1992; Yik, 2009; Yik et al., 2011) to capture HPMood’s specific blend of Hedonic Valence and Arousal. The findings show that, the specific type of core affect infusing the content of SWB and related variables of self-esteem, optimism, and facets of extraversion is always pleasant and mildly activated. The results also reveal that, SWB is more affective in nature compared to the other included variables. However, HPMood’s degree of association with SWB varies between moderate to strong depending on the design of the core affective model. Overall, this character of HPMood is largely consistent with predictions based on SWB Homeostasis theory (Cummins, 2010, 2012; Cummins et al., 2012). However, the findings do not conclusively support previous interpretations of linear findings (Blore et al., 2011; Davern et al., 2007; Lai & Cummins, 2013; Tomyn & Cummins, 2011), that HPMood dominates the content of these responses. The basis of this work and implications of the findings are as follows.

Rationale and Aims

While there is general agreement that SWB comprises both cognitive and affective components, a growing body of research (Blore et al., 2011; Davern et al., 2007; Lai & Cummins, 2013; Tomyn & Cummins, 2011) suggests that SWB is mostly affective in nature. Moreover, with the recent claim that set-points for SWB have been demonstrated (Cummins et al., 2014), the precise nature of this affect becomes a central concern for researchers in this area.

In order to understand the type of affect dominating responses to SWB, researchers working within the theory of SWB Homeostasis have turned to the circumplex model of affect (Russell, 1980) for defining and measuring the affect-life satisfaction relationship.
The first of these researchers to investigate affect according to the circumplex was Melanie Davern (Davern, 2004; Davern et al., 2007). The methodological approach taken by Davern in her examination of circumplex structure involved a self-report questionnaire comprising 32 single-item affect measures rated according to feelings about life. The specific instructions for the affect items were “please indicate how each of the following describes your feelings when you think about your life in general”. This instruction preceded the list of affect terms.

According to Davern, the specific wording of this test question was designed to capture the affective component of SWB from each response. This implied that the established circumplex structure was a representation of the form of core affect proposed to underlie responses to SWB called Homeostatically Protected Mood (HPMood) (Cummins, 2010, 2012). However, Davern’s circumplex structure demonstrated poor substantive validity (Gurtman, 1997), in that the observed order of the variables did not array in a manner consistent with theory and Davern’s predictions, nor did it correspond to other established structures (Remington et al., 2000; Yik, 2009; Yik et al., 1999; Yik et al., 2011). The circumplex also failed to predict the activated and deactivated vectors of the Arousal dimension. Davern concluded that, study characteristics such as the types of affects sampled likely contributed to the erroneous findings. She also used her results to raise the question as to whether Arousal is a part of the subjective experience of affect. Subsequently, research in this area (Blore et al., 2011; Davern et al., 2007; Lai & Cummins, 2013; Tomyn & Cummins, 2011) has utilised Davern’s established circumplex structure to inform the item selection process in linear validation procedures to determine HPMood’s character.

A primary aim of this thesis was to improve upon research designs in this area to investigate the affective core of SWB. It was proposed that, a more valid way to represent HPMood on the circumplex is to examine the degree to which an external variable, theorised to be dominated by HPMood, relates to a circumplex structure of core affect. An external variable is one not used to define a previously established core affective structure. In accordance with the theoretical model of SWB Homeostasis (Cummins, 2010; Cummins et al., 2012; Davern et al., 2007; Lai & Cummins, 2013), variables dominated by HPMood are SWB and major correlates of
SWB such as extraversion, optimism, self-esteem, and perceived control. By relating these external variables to the circumplex, it is possible to locate the specific blend of Hedonic Valence and Arousal accompanying responses to these variables, and to examine the degree to which these variables are affective in nature. It is this specific kind of core affect that identifies HPMood, as a core affective construct, on the circumplex.

The methodological approach employed to pinpoint HPMood on the circumplex, and examine HPMood’s magnitude of association with variables like SWB, is known as the Cosine Wave Method (Yik, 2009; Yik et al., 2011). This methodology is an extension of the CIRCUM procedure (Browne, 1992) employed by Davern (2004; Davern et al., 2007). The Cosine Wave Method was able to address important limitations in research design and methodology currently employed by researchers working within the theory of SWB Homeostasis, with specific regard to the construct validity of HPMood.

With this improvement in research design and methodology, two central aspects of SWB Homeostasis theory were tested. The first concerned validating the theoretical nature of HPMood, as a pleasant and mildly activated ‘core’ state of affect (Cummins, 2010, 2012). The second aspect concerned verifying HPMood’s perfusion of SWB and its major correlates, in linear models (Blore et al., 2011; Davern et al., 2007; Lai & Cummins, 2013; Tomyn & Cummins, 2011), on the circumplex.

The investigation began by re-examining an affective circumplex structure within the context of SWB Homeostasis theory (Cummins, 2010; Cummins et al., 2012). Davern’s original research design was extended to incorporate Yik’s (2009; Yik et al., 2011) methodology and procedural approach for conducting circumplex analyses. The intention was to improve upon Davern’s original results, and to distinguish between an entire structure of core affect, and the specific form of core affect (HPMood) that accompanies responses to SWB and its major correlates. Therefore, the suggestion that the specific design of the test question, to elicit feelings about life in general, produces an entire circumplex structure of HPMood was not assumed herein. Instead, it was proposed that the in general nature of the test question would produce a circumplex structure of core affect from trait responses.
The established structure was then used as a measurement map, in a cosine wave analysis (Yik, 2009; Yik et al., 2011), to test the two central aspect of SWB Homeostasis theory.

1. **Verifying the nature of HP\textit{M}ood**

   According to theory (Cummins, 2010, 2012), HP\textit{M}ood is conceptualised as a pleasant and mildly activated ‘core’ state of affect that is always present and providing a background sense of SWB. However, until now, no study has empirically validated HP\textit{M}ood with a structural model that best describes its specific blend of Hedonic Valence and Arousal. Instead, researchers working within the theory of SWB Homeostasis (Blore et al., 2011; Davern et al., 2007; Lai & Cummins, 2013; Tomyn & Cummins, 2011) refer to the affective circumplex to inform the item selection process in linear multiple regression analysis, to determine HP\textit{M}ood’s character. By simultaneously regressing multiple independent affect items onto the single-item dependent measure of SWB (i.e., General Life Satisfaction (GLS)), these studies examine which of the chosen affects significantly and uniquely predict scores on GLS. The rationale for this methodological approach is that the abstract and personal nature of the GLS question, “How satisfied are you with your life as a whole?” captures the essence, or affective ‘core’ of SWB. Thus, responses to this single-item measure will be dominated by HP\textit{M}ood (Cummins, 2010).

   While the use of a linear model to verify a non-linear state of core affect underlying responses to SWB undermines Cummins’ (2010, 2012) theorising about HP\textit{M}ood’s character, these findings consistently show that only certain kinds of affects (e.g. content, happy, active, energised) predict GLS, which is considered a proxy for the set-point HP\textit{M}ood. This alludes to the shared existence among these lay terms of a specific blend of Hedonic Valence and Arousal that is pleasant and mildly activated. Therefore, based on these findings, it was hypothesised that, the specific type of core affect located on the circumplex by GLS would support Cummins’ theoretical definition of HP\textit{M}ood as a ‘pleasant and mildly activated’ ‘core’ state of affect.
2. **HPMood’s magnitude of association with SWB and its major correlates**

The second aspect of SWB Homeostasis theory to be tested concerned a growing body of evidence derived from linear methods (Blore et al., 2011; Davern et al., 2007; Lai & Cummins, 2013; Tomyn & Cummins, 2011), that a small composite of affects dominates the content of SWB and major correlates of SWB such as self-esteem, optimism, perceived control, and extraversion. In these study designs, HPMood is presumed to be best operationalised as *happy, content, alert/excited/active*. The HPMood composite variable is then treated as a mediator (Lai & Cummins, 2013), or determinant (Blore et al., 2011; Davern et al., 2007; Tomyn & Cummins, 2011), in linear structural modeling to test the assumption that HPMood explains or drives the relationship between SWB its and major correlates.

The findings of these studies indicate that much of the shared variance between SWB measures, and related variables, is accounted for by the HPMood composite, with SWB measures (GLS and PWI) most dominated by affect. These findings have led to the interpretation that SWB is mostly affective in nature, and that SWB and its major correlates are perfused with a similar form of core affect theorised as *mildly positive/pleasant and activated*. To test these assumptions on the circumplex, it was hypothesised that, the specific type of core affect located on the circumplex by *any one* of the externally listed variables in the investigation (e.g. SWB, GLS, self-esteem, optimism, and extraversion), would elucidate where HPMood resides within the two-dimensional circumplex space. It was also hypothesised that a substantial association between a circumplex structure of core affect and all of the listed external variables would be evidenced, with the strongest magnitude of association evidenced by SWB measures.

The final aim of the investigation was based on the assertion that the level of SWB is normally maintained within a restricted range (Cummins, 2010; Cummins et al., 2014). Therefore, it is argued HPMood as the affective core of SWB, is regulated for constancy by homeostatic mechanisms. The implication of this for construct validation is that HPMood must demonstrate a constant structure. Therefore, the second study aimed to, first, validate a more robust model of core affect from composite scales and momentary experiences based on Yik’s (2009) research design.
Second, to examine how reliably HPMood is described, and its magnitude of association with SWB and its major correlates, on the circumplex.

**Methodology**

The entire investigation was conducted across four studies, and involved participants who responded to Surveys 21 ($n=790$) and 24 ($n=569$) of the Australian Unity Wellbeing Index Longitudinal Project, over the years 2011-2012.

Two studies tested the circumplexity of affective data using the Circular Stochastic Process Model with a Fourier Series (CSPMF), commonly known as CIRCUM (Browne, 1992). The first study validated a circumplex model of core affect from 23 single-item measures of feelings about life in general. The second study validated a new core affective model from 11 composite measures (3 items per scale) of momentary feeling states. An additional two studies utilised each established model of core affect to investigate the psychological nature of HPMood, and its magnitude of association with SWB and its major correlates, on the circumplex, using the Cosine Wave Method (Yik, 2009; Yik et al., 2011).

6.1. **Results and Implications**

*Validating a circumplex structure of core affect from trait responses*

The findings of the first study confirmed a circumplex structure of core affect from 23 single-item measures of feelings about life in general. The substantive validity of the model (Gurtman, 1997) is an improvement on Davern’s (2004; Davern et al., 2007) original findings, in that variables array on the circumplex in a meaningful way, and correspond with previously established structures (e.g. Remington et al., 2000; Yik et al., 2011). The indicators of model fit (RMSEA = .09, CI: .08-.09; MCSC = -.53) support the structural integrity of the model (Gurtman) to suggest that, this affective space is bipolar in nature and lacking in simple structure (Russell, 1980; Russell & Carroll, 1999; Segura & Gonzalez-Roma, 2003). The entire structure of core affect established from single-item trait responses is presented in Figure 26.
The findings in relation to the locations of affective states indicate that, the sample of affects predict the bottom half of the circle relatively well. However, the top half of the circle was not as well predicted. An inspection of the confidence intervals for each polar estimate indicates that all reported angles are precise estimates of the common space. This implies that more affects are needed to capture all regions of the circumplex most particularly high activation. An additional suggestion to account for the relative absence of high activation is the use of a test question to elicit trait judgements of feelings about life in general. For example, asking how ‘aroused’ one generally feels will likely capture less acute fluctuation in responses than asking how ‘aroused’ one feels right now, in the current moment. Therefore, empirically, trait responses will capture less variance in the arousal dimension than momentary responses. Alternatively, this question may lose its relevance when the response is tied to feelings about life in general. This reasoning along with increasing the nomological net to capture all regions of the circumplex lead to the decision to replicate Yik’s (2009) 48 item (12-point) Chinese circumplex model of momentary affect (CCMA), in English.
Validating a circumplex structure of core affect from momentary responses

The item selection process involved in the construction of this new circumplex structure of core affect was guided by English translations. These were originally provided by a bilingual (Cantonese and English) translator, who was involved in the construction of the Chinese Circumplex Model of Affect (CCMA) (M. Yik, personal communication, September 17th, 2012).

When these translations were examined it was evident that seven of the 48 items were either too complex (i.e., beyond a sixth-grade reading level), or were not used in everyday expression by Australians. For example, the terms *vehement* and *vivacious* were considered too complex, and were replaced with the terms *intense* and *lively*, respectively. Terms such as *grey-hearted* and *at a high tide of feelings* are not common expressions of feeling states in Australian society, and so were replaced with the terms *despondent* and *on an emotional high*, respectively.

However, exploratory findings with principal components analysis revealed 11 out of 48 items in the current design failed to load on the first two components interpreted as Hedonic Valence (C1) and Arousal (C2), and thus did not capture the ‘core’ of affect from self-report responses. Subsequent confirmatory factor analyses also exposed difficulties in operationalising pure activation and deactivation. Of most concern, however, were those descriptors designed to capture ‘unpleasant-activation’, or the 11 o’clock segment of the circumplex (i.e., *quivering with rage, stunned, shocked, jittery*). This affective dimension demonstrated a lack of association with a core affective structure in both exploratory and confirmatory analyses. Altogether, these results produced a narrowing of the nomological net from 48 to 33 items, and a revised 11-point circumplex model from composites scales of 3 items each. The validated model is presented in Figure 27.
The indicators of model fit (RMSEA = .10, CI: .08-.11; MCSC = -.50) are somewhat marginal. Nonetheless, they are an improvement on the original 12-point CCMA produced by Yik (2009, p.421). While the model did not slice the circumplex neatly into segments spaced 30° as predicted by Yik’s (2009) thesis, it closely replicates the kind of structure established when various external affective dimensions are integrated within the 12-point CCMA space, using a cosine wave analysis (see Yik et al., 2011, p. 722). This demonstrated substantive validity has a number of implications.

First, the translation of terms from Cantonese to English is a unique aspect of the current analysis that may have confounded the ability of response language to bring certain feelings into existence, as the ‘core’ of affect is categorised during perception (Lindquist et al., 2006). If some of the translated terms did not reflect specific instances of moods and emotions under normal operating conditions, in an Australian English-speaking population, then this may have influenced how the entire common space is understood. This would explain why ‘pure deactivation’ and
‘mildly activated pleasure’ were difficult to predict in this analysis, yet were well predicted in the previous circumplex analysis.

However, the current findings are also consistent with previous studies (Remington et al., 2000; Kuppens et al., 2013; Yik et al., 2011) in that they fail to capture highly activated-unpleasant states, purely deactivated states, and mildly activated pleasure from momentary subjective experiences. Kuppens et al., argues this speaks to the issue of bipolarity, in that some instances of a relation between arousal and positive and negative valence in momentary experiences are separable and have bivariate rather than bipolar properties (Kuppens et al., p. 934).

Consistent with the findings of Kuppens et al.’s (2013), instances where arousal does not covary with valence in a uniform way are found in momentary states that vary in the level of activation. This could explain why the circumplex structure of core affect from momentary responses, as opposed to trait responses, captured more acute fluctuation in pleasant-activation. A wider implication of this is that HPMood’s nature as a mildly pleasant and activated ‘core’ state of affect may depend on the design of the core affective model. This is indeed what was found and is discussed in the sections to follow.

*Locating HPMood on the circumplex*

According to SWB Homeostasis theory (Cummins, 2010, 2012), HPMood is conceptualised as a pleasant and mildly activated ‘core’ state of affect that is always present and providing a background sense of SWB. HPMood is further proposed as the basic steady mood-state that homeostatic mechanisms seek to defend. It approximates each individual’s set-point for SWB because SWB is found to be highly saturated with affect in linear models (Blore et al., 2011; Davern et al., 2007; Lai & Cummins, 2013; Tomyn & Cummins, 2011). HPMood, as a core affective construct, is also proposed to pervade conscious experience, and is most strongly perceived in all semi-abstract self-perceptions.

*Cognitive ‘buffers’*

Three of these self-perceptions are discussed. Each one reflects a positive sense of value and worth as self-esteem (Rosenberg, 1979), a perceived ability to change the environment according to one’s desires as control (Folkman &
Moskowitz, 2000), and a sense of optimism for the future (Peterson, 2000). Together, they act as ‘internal cognitive buffers’ for maintaining the most abstracted self-perceptions (i.e., SWB). All are in constant interaction with momentary experience, and all are strongly related to positive-activated mood (HPMood), which is delivered at the set-point (Cummins, 2013). Their role is to re-frame adverse life events in such a way as to minimise negativity and maximise advantage to the self. All of this allows the maintenance of the perceived self as positive, leading to ‘self satisfaction’ (Cummins & Nistico, 2002), and feeling satisfied with life as a whole (Diener & Diener, 1995).

**Personality**

The proposition that HPMood pervades all conscious experience carries an additional assumption that, HPMood is also perceived in all higher process. This includes personality. Extraversion is an aspect of personality that is highly related to SWB (Costa & McCrae, 1980, 1992; Headey & Wearing, 1989, 1992). Furthermore, there is evidence to suggest that the central component of extraversion is positively affective in nature (Costa & McCrae, 1980; Lucas et al., 2000). Researchers working within the theory of SWB Homeostasis (Blore et al., 2011; Davern et al., 2007; Tomyn & Cummins, 2011), propose a more fundamental level of description for the positive affective component of extraversion. This is based on findings to indicate that a small composite of affects (e.g. happy, content, excited/alert/active), alluding to HPMood’s nature as a core affective construct, accounts for almost all of the shared variance between extraversion and SWB.

**External variables**

Informed by this understanding of HPMood’s nature and its perfusion of SWB, personality, and cognition, the measures of SWB (GLS and PWI), self-esteem, optimism, perceived control, and the personality trait of extraversion, were treated as external variables to locate HPMood’s character, on the circumplex.

Due to the restricted space allocated to the survey questionnaire in the second study (ARC 24), it was not possible to include perceived control to locate HPMood’s nature on the circumplex. Therefore, to maintain consistency throughout, the decision was made to exclude this homeostatic variable from both investigations.
In relation to extraversion, consistent with the findings of Saucier (1998), principal components analyses revealed that the 12-item NEO-FFI extraversion scale (Costa & McCrae, 1992) was best depicted as three broad facets of extraversion (positive affect, sociability, and activity), as opposed to one global factor. This provided a new level of complexity for describing extraversion and the type of core affect infusing these facets.

The nature of HPMood in Study 1

The findings of the first cosine wave analysis revealed that SWB, self-esteem, optimism, and the three facets of extraversion (i.e., positive affect, sociability, and activity) demarcated an area of the circumplex that describes HPMood as mildly pleasant and activated. This newly established empirical definition for HPMood is consistent with Cummins' (2010, 2012) theorising about HPMood’s nature. An illustration of the designated 36 degree range from 352° to 28° found for all external variables is given in Figure 28.

![Diagram showing the strongest point of association found between all of the listed external variables and a circumplex model of core affect (Study 1).](image)

*Figure 28:* The strongest point of association found between all of the listed external variables and a circumplex model of core affect (Study 1).
As can be seen from Figure 28, the facets of extraversion created the boundaries for describing HPMood according to theory, with the activity and sociability facets comprising more activation than the positive affect facet, and thus defining HPMood’s nature according to theory. Interestingly, the central component of extraversion (positive affect) (Lucas et al., 2000) and variables in the Homeostatic Model of SWB (GLS and PWI, self-esteem, optimism) share an almost identical correspondence to a structure of core affect with only 5° of separation between them, from 352 to 357 degrees. This implies that the precise nature of HPMood underlying responses to these variables is ‘pleasant’ and less activated than theoretically described (Cummins, 2010, 2012). The observed close proximity of positive affect to SWB is consistent with Costa and McCrae’s (1992) assertion that this facet of the NEO-FFI extraversion is most strongly related to SWB. The analysis shows that this relatedness is due to a shared correspondence with a structure of core affect. This finding on the circumplex explains why in linear modeling (Davern et al., 2007), HPMood represented as ‘happy’, ‘content’, and ‘excited’, accounts for almost all of the shared variance between the NEO-FFI extraversion and SWB.

Convergent validity between linear and non-linear methods for describing HPMood

Further demonstration of a similar type of core affect infusing the content of these variables is illustrated in Figure 29. The figure shows the new descriptive range for HPMood (mildly pleasant and activated) located within the entire core affective space by the external variables, in the first cosine wave analysis.
Figure 29: Commensurability between laypersons’ description of HPMood and the newly established empirical definition of HPMood.

As can be seen, the single-item affects used to establish the entire structure of core affect estimated within this designated descriptive range for HPMood, are content, happy, pleased, excited, alert, active, and aroused. With the exception of ‘aroused’, all of these terms are also found to be most predictive of HPMood in linear models (Blore et al., 2011; Davern et al., 2007; Lai & Cummins, 2013; Tomyn & Cummins, 2011). ‘Energised’ is also found to predict HPMood (Davern et al.) in linear models, but falls just outside of this descriptive range in the cosine wave analysis.

However, two affects as ‘content’ at 353°, ‘happy’ at 356° came closest to describing the affective core of the positive affect facet of extraversion and variables in the Homeostatic Model of SWB, on the circumplex. Moreover, the affect term ‘happy’ at 356° precisely describes the affective core of SWB and self-esteem (e.g. GLS at 357°; PWI at 356°; RSE at 356°). This finding is consistent with the well-established claim that happiness is synonymous with feeling both satisfied with the self and life in general (Campbell et al., 1976; Cummins, 2013; Cummins & Nistico, 2002; Tatarkiewicz, 1976).
All of this implies that the affective core of SWB, and the homeostatic variables of self-esteem and optimism, and central affective component of extraversion (Lucas et al., 2000) comprise almost an identical form of core affect that is best described as pleasant. The wider implication is that these findings may indicate a constant structure for the HPMood construct that is less activated than theoretically described (Cummins, 2010, 2012).

The nature of HPMood in Study 2

As the first study was a first approximation of HPMood’s nature on the circumplex, the aim of the second study was to replicate HPMood’s constant structure using only the variables in the Homeostatic Model of SWB. The findings of the second cosine wave analysis replicated the first in that GLS, SWB, self-esteem, and optimism continued to share an almost identical correspondence to an entire structure of core affect with only 5° of separation between them from 8 to 13 degrees. While this time the nature of HPMood is ‘pleasant and mildly activated’, and is commensurate with theory (Cummins, 2010, 2012), replication across ‘general’ and ‘momentary’ instructions to locate HPMood shows HPMood is always pleasant, yet it may vary in levels of mild activation.

Whilst this interpretation is tentative given the cross-sectional nature of research design, it appears valid given that each separate analysis is highly reliable ($p < .01$). Furthermore, the discrepancy in estimating the specific type of core affect accompanying any one of these external variables, across the two studies, falls within confidence limits of 20° set by Remington et al. (2000) for determining reliability in estimation in cross-sectional samples. Figure 30 illustrates the descriptive range for the specific type of core affect accompanying variables in the Homeostatic Model of SWB, across the entire investigation.
Figure 30: The strongest point of association found between the listed external variables and an entire structure of core affect across two studies.

The two values alongside each listed external variable pinpoint the nature of HPMood accompanying each measure in Study 1 and Study 2, respectively. The most reliable estimates of HPMood’s character are found with GLS and self-esteem, with a discrepancy in estimation across the two studies of 12 degrees.

The descriptive essence of the set-point for SWB

That GLS provides the most reliable estimate of HPMood’s nature is consistent with the rationale offered within SWB Homeostasis theory. This is that, the abstract and personal nature of the GLS question, “How satisfied are you with your life as a whole?” captures the essence, or affective ‘core’ of SWB. Therefore, GLS as the proxy for the set-point HPMood (Cummins, 2010; Cummins et al., 2014) provides the most valid description of HPMood’s character yet produced. In the first study, GLS is located at 357° on the circumplex, and hence the descriptive essence of the set-point HPMood is ‘pleasant.’ In the second study, GLS is located 12° away, at 9° on the circumplex. The descriptive essence of the set-point HPMood is now ‘mildly activated pleasure.’ It is therefore concluded that HPMood’s character is
reliably captured in aggregated response data, and appears as always *pleasant and varying in levels of mild activation*.

That self-esteem is just as reliable as GLS for describing HPMood’s character supports the strong predictive association found between self-esteem and SWB (Cummins & Nistico, 2002), and the recent finding that self-esteem is the most robust of all the homeostatic variables for maintaining stability for the SWB management system (Lai & Cummins, 2013). The aspect of self-esteem that may describe HPMood in line with GLS represents motivation to maintain unity regarding beliefs about the self, or ‘self consistency’ (Stevens, 1992).

A wider implication is that the observed variation in levels of arousal may represent variation within normal functioning of homeostatic set-points recently reported in levels of SWB (Cummins et al., 2014). Therefore, these findings are a first step to providing a glimpse of a ‘descriptive bandwidth’ of the normal range of stability in SWB. The next step is to verify this claim using a within-subjects design.

An additional suggestion to explain the observed variation in levels of arousal refers to the two core affective models established from different study designs. The first model was based on Davern’s (2004; Davern et al.’s, 2007) original design of feelings about *life in general*. This model of core affect has been referred to throughout the thesis as the ‘trait model’. All study designs within the theory of SWB Homeostasis (e.g. Blore et al., 2011; Lai & Cummins, 2013; Tomyn & Cummins, 2011) replicate the design of this test question to operationalise HPMood’s character, in linear models. Given the model of core affect in the first study is constructed from this test question, the essence of HPMood’s character is ‘*pleasant*’ (GLS: 357°). So HPMood is not best described in terms of a specific blend of the two core affective dimensions of Hedonic Valence and Arousal.

The wider implication for researchers in this area is that, when statistical models are operationalised in this way, HPMood is not a form of core affect. Rather, HPMood is a more basic ‘valuation’ (good/pleasant vs. bad/unpleasant). According to Feldman Barrett (2006), this basic form of meaning making captures the *invariant core* of core affect from self-report responses. While this understanding fulfills the requirement of SWB Homeostasis theory to account for the property of stability.
when discussing HPMood in terms of an individual difference variable, it does not agree with the theoretical understanding of HPMood, as a core affective construct.

The second model however, does agree with how HPMood is understood. This model has been referred to throughout as the ‘momentary or state model’, and was based on Yik’s (2009; Yik et al., 2011) original design of feelings *right now, in the current moment*. According to Yik (see also Russell and Feldman Barrett, 1999), this test question is designed to capture core affective states. Based on this design, HPMood’s character is indeed core affective in nature and meets with the theoretical prediction of HPMood as a *pleasant and mildly activated* ‘core’ state of affect. The wider implication for future research designs in this area is that, momentary affect models could provide a closer approximation of the descriptive essence of HPMood.

**HPMood’s magnitude of association from momentary responses**

While HPMood’s nature, as a core affective construct, is most accurately described from momentary responses, a momentary model indicates that only a moderate amount of HPMood (‘mildly activated pleasure’) accompanies variables in the Homeostatic Model of SWB. In specific relation to SWB, HPMood accounts for up to 27% of the variance in responses to SWB and GLS. These findings are consistent with Cummins’ (2010; Cummins et al., 2012) proposal that acute fluctuations in response to moment-to-moment subjective experiences will likely see a reduced presence of the affective experience of HPMood, as the positive stable mood associated with SWB is re-directed to the dominating emotions synonymous with the experience.

While this suggestion for HPMood’s reduced presence is plausible, it requires that response data used to construct the momentary model of core affect reflect some global event that has caused HPMood’s recession into the background of conscious experience. As life events were not included in the research design, it is not possible to extrapolate from the findings whether such an event has influenced HPMood’s strength of association with variables in the Homeostatic Model of SWB.

**HPMood’s magnitude of association from trait responses**

When the model of core affect is derived from trait responses, HPMood’s magnitude of association with SWB and its major correlates strengthens. Therefore,
with the exception of the sociability facet of extraversion, which was interpreted as unreliable \((\alpha = .59)\), effect sizes derived from the trait model are more meaningful than those derived from the momentary model. This finding supports previous research designs (Blore et al., 2011; Davern et al., 2007; Lai & Cummins, 2013; Tomyn & Cummins, 2011) that capture substantial variance in SWB and related variables from trait responses, in linear modeling. In specific relation to SWB, HPMood’s magnitude of association is strong, and accounts for up to 42.3% of the variance. However, given that 57.7% of the variance in SWB is not attributable to HPMood, modeling this association on the circumplex does not conclusively support the previous linear findings that, SWB is mostly affective in nature.

6.2. Limitations

One limitation that undermines the current investigation, in specific regard to determining HPMood’s magnitude of association with SWB and related variables, is the inability of a circumplex analysis to partial out the effects of non-random measurement error. As a result, statistical indicators that rely on the correlation coefficient for interpretations of effect size \((r_{max})\) and the nature of the underlying affect structure (MCSC at 180°) will likely reflect the attenuating effects of this form of error. Therefore, findings that question whether affective space is bipolar, and the degree to which HPMood infuses the content of SWB and related variables, must be interpreted with caution. Moreover, the findings of the current investigation may not generalise beyond an Australian, English-speaking population.

A further limitation is that the trait versus state distinction between models is based on words alone, (i.e., ‘in general’ and ‘right now’). While this is a justified practice (Allen & Potkay, 1981), a more valid assessment of whether measures are capturing state or trait responses relies on replication and the specific examination of test-retest reliability along with the internal consistency of the measures (Zuckerman, 1983). This can only be done with a within-subjects research design and the use of composite scales. The importance of this for future research design is that providing a more valid representation of trait and state affect measures will provide a more valid determination of HPMood’s nature as a prolonged state of core affect.
Finally, while replication shows variables in the homeostatic model share an almost identical kind of core affect, the inference that HPMood has a constant structure is limited by the cross-sectional nature of the research design.

6.3. Future Directions

One aim of future research design may be to employ experience-sampling methods to capture moment-to-moment subjective experiences within subjects, over time. Following the procedure of previous studies (Feldman-Barrett, 1995b, 2004; Feldman-Barrett & Bliss-Moreau, 2009), participants would be prompted several times randomly throughout a number of consecutive days (e.g. 20 to 30 days), and asked to complete a questionnaire. The questionnaire would comprise affect items according to how one feels right now, in the current moment, and measures of SWB and related variables (i.e., self-esteem, optimism, perceived control, personality). The selection of affect terms would require further refinement to better describe emotional life according to the specifics of the local Australian language culture. The questionnaire could be designed in the form of an application and delivered via a smartphone device (B. Richardson, personal communication, September, 15th, 2014). The ultimate aim is to aggregate each individual’s moment-to-moment responses in order to generate data that represent how that individual felt during a moderate time period (Russell and Barrett, 1999). In this sense, mood as a prolonged experience of core affect is measured, and used to establish an affective circumplex structure for each individual. SWB and related variables would then be used to locate HPMood’s constant structure on the circumplex.

6.4. Conclusion

In summary, these four studies together provide an empirical definition of HPMood with research methodology that can best describe its specific blend of Hedonic Valence and Arousal. The specific blend infusing the content of SWB, self-esteem, optimism, and facets of extraversion is always pleasant, and mildly activated. This is the most valid understanding of HPMood yet produced. While the investigation has not conclusively shown that SWB is mostly affective in nature, it does show that SWB is more affective in nature compared to its major correlates. This finding is consistent across studies, and does not depend on the design of the
core affective model. The wider implication is that discussion of SWB’s composition must no longer be limited to cognitive evaluations of life satisfaction, and emotional reactions to life events (Diener, 1984; Diener et al., 1999). As the evidence increases to verify that HPMood is a major component of SWB, the SWB literature must account for the crucial role this fundamental kind of affect plays in determining our subjective sense of wellbeing.
References


APPENDIX A: Study 1 Part A and Part B. Ethics approval document

Memorandum

To: Prof Robert Cummins
School of Psychology

From: Deakin University Human Research Ethics Committee (DUHREC)

Date: 11 May, 2011
Subject: 2005-266
The Australian Unity Wellbeing Index

Please quote this project number in all future communications

The modification to this project, submitted on 28/04/2011, has been approved by the committee executive on 11/05/2011.

Approval has been given for Prof Robert Cummins, School of Psychology, to continue this project as modified to 31/03/2013.

The approval given by the Deakin University Human Research Ethics Committee is given only for the project and for the period as stated in the approval. It is your responsibility to contact the Human Research Ethics Unit immediately should any of the following occur:

- Serious or unexpected adverse effects on the participants
- Any proposed changes in the protocol, including extensions of time.
- Any events which might affect the continuing ethical acceptability of the project.
- The project is discontinued before the expected date of completion.
- Modifications are requested by other HRECs.

In addition you will be required to report on the progress of your project at least once every year and at the conclusion of the project. Failure to report as required will result in suspension of your approval to proceed with the project.

DUHREC may need to audit this project as part of the requirements for monitoring set out in the National Statement on Ethical Conduct in Human Research (2007).

Human Research Ethics Unit
research-ethics@deakin.edu.au
Telephone: 03 9251 7123
APPENDIX B: Study 1 Part A and Part B. Plain language statements

DEAKIN UNIVERSITY HUMAN RESEARCH ETHICS COMMITTEE
PLAIN LANGUAGE STATEMENT FOR PEOPLE RECRUITED FROM THE TELEPHONE SURVEY

Dear Friend of the Australian Centre on Quality of Life

Some months ago you participated in the Australian Unity Wellbeing project that is conducted by telephone in conjunction with Deakin University. At that time, you indicated that you would be willing to be involved in future surveys of this kind. Thank you. We are writing to you now because we are conducting a longitudinal study of the well-being of Australians, to identify the beliefs that maintain wellbeing. We now invite you to be part of this study.

The research team involved is Professor Bob Cummins, Linda Hartley-Clark, and Trish Ayers from Deakin University. Australian Unity is a partner in the project. Linda will use part of this project for the purposes of her PhD thesis, and Trish will use part of this project for the purposes of her Honours thesis.

In the hope you will agree to be involved, we enclose a questionnaire package. One questionnaire asks for some basic demographic details, and the other some questions about yourself such as:

- How satisfied are you with life as a whole?
- How satisfied are you with your health?

Other questions will ask your level of agreement with various statements, on topics such as:

- How you have been feeling this past week.
- What kind of person you are.
- How well you cope with life events.

In total, the questionnaire should take you about 25 minutes to complete. Also enclosed is a reply paid envelope to return the completed questionnaire to Deakin University, and when you return the questionnaire we will assume you are doing so willingly. Your questionnaire will be given a code and your answers will be entered into a database for collation. The research team will not be able to identify you or your personal responses. The database will be securely stored electronically at Deakin University for ten years and used only for academic research purposes.

You are quite free to participate or not to any extent, or withdraw at any time from the study. However, as we will not be able to identify your responses if you withdraw after mailing your questionnaire, such responses will be used in the overall analysis.

If for any reason you feel distressed by anything asked in the survey, we suggest that you contact Lifeline on 13 1114.

For further details of the study, please contact Professor Bob Cummins on 03 9244 6845 or Linda Hartley-Clark on 0400 301 053.

Should you have any concerns about the conduct of this research project (ID 2006-266), please contact the Manager, Research Integrity, Research Services, Deakin University, 221 Burwood Highway, BURWOOD VIC 3125. Tel (03) 9251 7129 (International +61 3 9251 7129).
Dear Friend of the Australian Centre on Quality of Life

Last year you participated in our ongoing Australian Unity Wellbeing longitudinal project that is conducted in conjunction with Deakin University. At that time, you indicated that you would be willing to continue your involvement. We are most grateful – thank you. We are now conducting another follow-up study of the wellbeing of Australians, to identify the beliefs that maintain wellbeing. We invite you to again be part of this study.

The research team involved is Professor Bob Cummins, Linda Hartley-Clark, and Trish Ayers from Deakin University. Australian Unity is a partner in the project. Linda will use part of this project for the purposes of her PhD thesis, and Trish will use part of this project for the purpose of her Honours thesis.

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- How satisfied are you with your health?

Other questions ask your level of agreement with various statements, on topics such as:

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- What kind of person you are.
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APPENDIX C: Study 1 Part A and Part B. Survey questionnaire
### SECTION C  HOW YOU GENERALLY FEEL

Please indicate how each of the following describes your feelings when you think about your life in general.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Not at all</th>
<th>A little</th>
<th>Moderately</th>
<th>Very much</th>
<th>Extremely</th>
</tr>
</thead>
<tbody>
<tr>
<td>17 Thinking about my life in general</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>18 Calm</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>19 Anxious</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>20 AR rackety</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>21 Relaxed</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>22 Oblivious</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>23 Terrified</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>24 Overwhelmed</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>25 Stressed</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>26 Nervous</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>27 Terrified</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>28 Scared</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>29 Painful</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>30 Dis InvalidArgumentException</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

### SECTION E  COPING WITH LIFE

How much do you agree or disagree with the following statements? Do not agree at all: Agree strongly

<table>
<thead>
<tr>
<th>Statement</th>
<th>Do not agree at all</th>
<th>Agree strongly</th>
</tr>
</thead>
<tbody>
<tr>
<td>40 I feel I have too many responsibilities</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>41 I am not very happy with my life</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>42 I feel I am not coping well with what is happening</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>43 I feel I am not coping well with what is happening</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>44 I feel I am not coping well with what is happening</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>45 I feel I am not coping well with what is happening</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>46 I feel I am not coping well with what is happening</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

### SECTION F  MOVING ABOUT YOURSELF

How much do you agree with the following statements? Do not agree at all: Agree strongly

<table>
<thead>
<tr>
<th>Statement</th>
<th>Do not agree at all</th>
<th>Agree strongly</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 I feel I have too many responsibilities</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>51 I feel I have too many responsibilities</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>52 I feel I have too many responsibilities</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>53 I feel I have too many responsibilities</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>54 I feel I have too many responsibilities</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>55 I feel I have too many responsibilities</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

### SECTION G  WHAT YOU EXPECT TO HAPPEN

How much do you agree with the following statements? Do not agree at all: Agree strongly

<table>
<thead>
<tr>
<th>Statement</th>
<th>Do not agree at all</th>
<th>Agree strongly</th>
</tr>
</thead>
<tbody>
<tr>
<td>60 I expect things to happen</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>61 I expect things to happen</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>62 I expect things to happen</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>63 I expect things to happen</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>64 I expect things to happen</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>65 I expect things to happen</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

### SECTION D  OVER THE LAST WEEK

How much did these statements apply to you over the last week? Not at all: Extremely

<table>
<thead>
<tr>
<th>Statement</th>
<th>Not at all</th>
<th>A little</th>
<th>Moderately</th>
<th>Very much</th>
<th>Extremely</th>
</tr>
</thead>
<tbody>
<tr>
<td>31 I found it difficult to get going</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>32 I felt I had nothing to look forward to</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>33 I felt I had nothing to look forward to</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>34 I felt I had nothing to look forward to</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>35 I felt I had nothing to look forward to</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>36 I felt I had nothing to look forward to</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>37 I felt I had nothing to look forward to</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>38 I felt I had nothing to look forward to</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

---

**Note:** The table above contains a series of statements and options for rating the extent to which each statement applies to the respondent, ranging from "Not at all" to "Extremely." The statements are designed to assess various emotional and situational states over a specified period (over the last week).
Dear Friend of the Australian Centre on Quality of Life

Below you will find some questions that refer to your life circumstances. We know you have completed a similar set in the past, and we have these data on file, but we would appreciate confirmation of your current situation.

1. Your Gender
   - Male
   - Female

2. Your age

3. Your postcode

4. Please indicate from the list who lives with you. (Tick whichever boxes apply)
   - No one: you live by yourself
   - One or more children
   - Your partner
   - One or both of your parents
   - One or more adults who are neither your partner nor your parent

5. Please indicate how many children (aged less than 19 years) live with you.
   - 0
   - 1
   - 2
   - 3
   - 4
   - 5
   - 6 or more

6. Please indicate which of the following categories apply to you at the present time:
   - Never married
   - Separated but not divorced
   - Divorced
   - De facto or living together
   - Married
   - Widowed

7. Please indicate which of the following categories best applies to you at the present time. Are you in:
   - Full-time paid employment
   - Full-time home or family care
   - Full-time study
   - Semi-retired
   - Full-time volunteer
   - Unemployed

8. Please indicate whether any of the following part-time categories apply to you at the present time. Are you:
   - In part-time paid employment
   - A part-time volunteer
   - In part-time study
   - In casual employment

9. Please indicate your household’s total annual income before tax.
   - Less than $15,000
   - $15,000 to $30,000
   - $31,000 to $50,000
   - $51,000 to $100,000
   - $101,000 to $150,000
   - $151,000 to $250,000
   - More than $250,000

10. Please indicate your height and weight:
    - cm
    - kg
    or
    - feet
    - inches
    - stone
    - pounds

11. Which day of the week is it today?

12. Today’s date is

13. I completed the questionnaire at
    - am/pm
APPENDIX D: Study 2 Part A and Part B. Ethics approval document

Memorandum

To: Prof Robert Cummins
   School of Psychology

From: Deakin University Human Research Ethics Committee (DUHREC)

Date: 26 September, 2012

Subject: 2006-266
   The Australian Unity Wellbeing Index

Please quote this project number in all future communications.

The modification to this project, submitted on 26/09/2012 has been approved by the committee executive on 28/09/2012.

Approval has been given for Prof Robert Cummins, School of Psychology, to continue this project as modified to 31/03/2015.

The approval given by the Deakin University Human Research Ethics Committee is given only for the project and for the period as stated in the approval. It is your responsibility to contact the Human Research Ethics Unit immediately should any of the following occur:
   - Serious or unexpected adverse effects on the participants
   - Any proposed changes in the protocol, including extensions of time
   - Any events which might affect the continuing ethical acceptability of the project.

   The project is discontinued before the expected date of completion.

   Modifications are requested by other HRECs.

In addition you will be required to report on the progress of your project at least once every year and at the conclusion of the project. Failure to report as required will result in suspension of your approval to proceed with the project.

DUHREC may need to audit this project as part of the requirements for monitoring set out in the National Statement on Ethical Conduct in Human Research (2007).

Human Research Ethics Unit
research-ethics@deakin.edu.au
Telephone: 03 9251 7123
DEAKIN UNIVERSITY HUMAN RESEARCH ETHICS COMMITTEE
PLAIN LANGUAGE STATEMENT FOR PEOPLE RECRUITED FROM THE TELEPHONE SURVEY

Dear

Some months ago you participated in the Australian Unity Wellbeing project that is conducted by telephone in conjunction with Deakin University. At that time, you indicated that you would be willing to be involved in future surveys of this kind. Thank you. We are writing to you now because we are conducting a longitudinal study of the wellbeing of Australians, to identify the beliefs that maintain wellbeing. We now invite you to be part of this study.

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- How satisfied are you with your life as a whole?
- How satisfied are you with your health?

Other questions will ask your level of agreement with various statements, on topics such as:

- How you feel about yourself and your feelings in general.
- What kind of person you are.

In total, the questionnaire should take you about 25 minutes to complete. Also enclosed is a reply paid envelope to return the completed questionnaire to Deakin University, and when you return the questionnaire we will assume you are doing so willingly. Your questionnaire will be given a code and your answers will be entered into a database for collation. The research team will not be able to identify you or your personal responses. The database will be securely stored electronically at Deakin University for ten years and used only for academic research purposes.

You are quite free to participate or not to any extent, or withdraw at any time from the study. However, as we will not be able to identify your responses if you withdraw after mailing your questionnaire, such responses will be used in the overall analysis.

If for any reason you feel distressed by anything asked in the survey, we suggest that you contact Lifeline on 13 1114.

For further details of the study, please contact Professor Bob Cannings on 03 92446845 or Linda Hartley-Clark on 03 92517439.

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Should you have any concerns about the conduct of this research project (ID 2006-266), please contact the Secretary, Ethics Committee, Research Services, Deakin University, 221 Burwood Highway, EURLWOOD VIC 3125. Tel (03) 9251 7123 (International +61 3 9251 7123).
Dear

Last year you participated in our ongoing Australian Unity Wellbeing longitudinal project that is conducted in conjunction with Deakin University. At that time, you indicated that you would be willing to continue your involvement. We are most grateful – thank you. We are now conducting another follow-up study of the well-being of Australians, to identify the beliefs that maintain wellbeing. We invite you to again be part of this study.

The research team involved is Professor Bob Cummins and Linda Hartley-Clark from Deakin University. Australian Unity is a partner in the project. Linda will use part of this project for the purposes of her PhD thesis.

One enclosed questionnaire asks for some basic demographic details, and the other some questions about yourself such as:

- How satisfied are you with your life as a whole?
- How satisfied are you with your health?

Other questions ask your level of agreement with various statements, on topics such as:

- How you feel about yourself and your feelings in general.
- What kind of person you are.

In total, the questionnaire should take about 25 minutes to complete. Also enclosed is a reply paid envelope to return the completed questionnaire to Deakin University, and when you return the questionnaire we will assume you are doing so willingly. Your questionnaire will be given a code and your answers will be entered into a database for collation. The research team will not be able to identify you or your personal responses. The database will be securely stored electronically at Deakin University for ten years and used for academic research purposes only.

You are quite free to participate or not, to any extent, or withdraw at any time from the study. However, as we will not be able to identify your responses if you withdraw after mailing your questionnaire, such responses will be used in the overall analysis.

If for any reason you feel distressed by anything asked in the survey, we suggest that you contact Lifeline on 13 1114

For further details of the study, please contact Professor Bob Cummins on 03 92446845 or Linda Hartley-Clark on 03 92517439.

Should you have any concerns about the conduct of this research project (E2 2006-256), please contact the Secretary, Ethics Committee, Research Services, Deakin University, 221 Burwood Highway, BURWOOD VIC 3125. Tel (03) 9251 7123 (International +61 3 9251 7123).
APPENDIX F: Study 2 Part A and Part B. Survey questionnaire
Dear Friend of the Australian Centre on Quality of Life

Below you will find some questions that refer to your life circumstances. We know you have completed a similar set in the past, and we have these data on file, but would appreciate confirmation of your current situation:

1. Your Gender
   - [ ] Male
   - [ ] Female

2. Your age

3. Your postcode

4. Please indicate from the list who lives with you. (tick whichever boxes apply)
   - [ ] No one you live by yourself
   - [ ] One or more children
   - [ ] Your partner
   - [ ] One or more adults who are neither your partner nor your parent

5. Is there a person living with you who is elderly or disabled and requires your care?
   - [ ] Yes (go to item 5a)
   - [ ] No (go to item 5)

5a. Please indicate from the list who is being cared for:
   - [ ] Spouse
   - [ ] Parent
   - [ ] Child
   - [ ] Other

6. How many children (aged less than 16 years) live with you?
   - [ ] 0
   - [ ] 1
   - [ ] 2
   - [ ] 3
   - [ ] 4
   - [ ] 5
   - [ ] 6 or more

7. Which of the following categories apply to you at the present time?
   - [ ] Married
   - [ ] De facto or living together
   - [ ] Separated but not divorced
   - [ ] Widowed
   - [ ] Divorced
   - [ ] Never married

8. Which of the following categories best applies to you at the present time? Are you in...
   - [ ] Full-time paid employment
   - [ ] Full-time home or family care
   - [ ] Full-time retired
   - [ ] Semi-retired
   - [ ] Unemployed
   - [ ] Full-time volunteer

9. Please indicate whether any of the following part-time categories applies to you at the present time. Are you...
   - [ ] In part-time paid employment
   - [ ] As a part-time volunteer
   - [ ] In part-time study
   - [ ] In casual employment

10. What is your household’s total annual income before tax?
    - [ ] Less than $15,000
    - [ ] $15,000 to $30,000
    - [ ] $31,000 to $60,000
    - [ ] $61,000 to $100,000
    - [ ] $101,000 to $150,000
    - [ ] $151,000 to $250,000
    - [ ] $251,000 to $500,000
    - [ ] More than $500,000

11. Please indicate your height and weight.
    - [ ] cm
    - [ ] kg
    - [ ] Feet
    - [ ] Inches
    - [ ] Stone
    - [ ] Pounds

12. Today’s date is

13. I completed the questionnaire at
    - [ ] am/pm
APPENDIX G: Study 2 Part A. Results of the 12-point circumplex model of momentary affect.

The results of the CIRCUM analysis based on the original design of 48 items are presented below. The analysis using 12 composite (4-item) scales as data converged on a solution in 15 iterations. Three free parameters were specified in the correlation function equation; additional free parameters did not improve the model fit. The final model had a total of 38 free parameters and 40 degrees of freedom. The fit indices for the model were $\chi^2(40, N = 569) = 215.95$, RMSEA = .09 (90% CI = .08 -.10), and MCSC = -.47. Values of $\zeta$ ranged from .75 to .94. The results are given in Table 36, and a graphical display is presented in Figure 31.

Table 36.

<table>
<thead>
<tr>
<th>Affect Measure</th>
<th>(Hypothesised Angle)</th>
<th>$\theta$</th>
<th>CI</th>
<th>$\zeta$</th>
<th>CI</th>
<th>$\zeta$</th>
<th>CI</th>
<th>M</th>
<th>SD</th>
<th>Skew</th>
<th>$\alpha$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pleasant (0°)</td>
<td>0°</td>
<td>-</td>
<td>.91</td>
<td>.88-.93</td>
<td>57.86</td>
<td>20.60</td>
<td>.03</td>
<td>.85</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pleasant Activated (30°)</td>
<td>50°</td>
<td>44-56°</td>
<td>.92</td>
<td>.90-.94</td>
<td>30.84</td>
<td>21.51</td>
<td>0.33</td>
<td>.84</td>
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<td></td>
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<tr>
<td>Activated Pleasant (60°)</td>
<td>48°</td>
<td>43-54°</td>
<td>.94</td>
<td>.92-.95</td>
<td>34.15</td>
<td>21.56</td>
<td>0.30</td>
<td>.80</td>
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<tr>
<td>Activated (90°)</td>
<td>81°</td>
<td>75-88°</td>
<td>.89</td>
<td>.81-.94</td>
<td>23.65</td>
<td>15.76</td>
<td>0.52</td>
<td>.62</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Activated Unpleasant (120°)</td>
<td>151°</td>
<td>143-158°</td>
<td>.76</td>
<td>.71-.80</td>
<td>5.34</td>
<td>10.89</td>
<td>2.99</td>
<td>.71</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Unpleasant Activated (150°)</td>
<td>158°</td>
<td>152-164°</td>
<td>.93</td>
<td>.90-.95</td>
<td>12.65</td>
<td>16.55</td>
<td>1.80</td>
<td>.81</td>
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<td></td>
</tr>
<tr>
<td>Unpleasant (180°)</td>
<td>179°</td>
<td>173-184°</td>
<td>.87</td>
<td>.85-.90</td>
<td>14.36</td>
<td>18.43</td>
<td>1.74</td>
<td>.90</td>
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<td></td>
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<tr>
<td>Unpleasant Deactivated (210°)</td>
<td>211°</td>
<td>204-217°</td>
<td>.90</td>
<td>.86-.92</td>
<td>16.18</td>
<td>16.72</td>
<td>1.20</td>
<td>.75</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Deactivated Unpleasant (240°)</td>
<td>219°</td>
<td>212-227°</td>
<td>.82</td>
<td>.78-.86</td>
<td>18.45</td>
<td>18.09</td>
<td>1.17</td>
<td>.75</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deactivated (270°)</td>
<td>315°</td>
<td>308-323°</td>
<td>.75</td>
<td>.69-.80</td>
<td>45.33</td>
<td>16.32</td>
<td>0.10</td>
<td>.48</td>
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<tr>
<td>Deactivated Pleasant (300°)</td>
<td>322°</td>
<td>316-328°</td>
<td>.83</td>
<td>.79-.87</td>
<td>50.22</td>
<td>19.77</td>
<td>-0.17</td>
<td>.78</td>
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<tr>
<td>Pleasant Deactivated (330°)</td>
<td>341°</td>
<td>336-345°</td>
<td>.87</td>
<td>.84-.90</td>
<td>60.09</td>
<td>18.63</td>
<td>-0.42</td>
<td>.72</td>
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</tr>
</tbody>
</table>

Note: The circumplex model of momentary affect is constructed from 12 composite scales above and the hypothesised angles represent vectors spaced 30° apart. N = 569. The angle ($\theta$), the communality index ($\zeta$), and confidence intervals for both indices were computed in the CIRCUM analysis for all 12 affect scales. Possible scores range from 0 to 100 for each affect item measure.
Figure 31: A 12-point Circumplex Model of Momentary Affect. Polar angles show $\theta$ (theta) along with confidence intervals. The length of the solid blue line from the centre shows the communalties $\zeta$ (zeta). $n = 569$. 
The fit indices of this analysis are very similar to the 11-point circumplex structure validated in Study 2 Part A. Therefore, changes made to the original design have not significantly improved the structural integrity of the model. However, this 12-point structure has not captured as much variance in the Hedonic Valence and Arousal dimensions (\( \zeta \) ranged from .75 to .94) as the 11-point design (\( \zeta \) ranged from .81 to .95). The 12-point structure is also not as substantively valid as the 11-point design, in that variables have not arrayed in a meaningful way, nor are they consistent with Yik’s previously established model (Yik, 2009), of the same design. As can be seen in Figure 31, ‘mildly-activated pleasure’ (2 o’clock segment at 30°) predicts a more activated region of the circumplex than ‘pleasant-activation’ (1 o’clock segment at 60°). Furthermore, the inclusion of ‘unpleasant-activation’ (11 o’clock segment at 120°) in the 12-point design does not improve the inability to capture this region of the circumplex. This model also provides a less reliable prediction of pure deactivation (6 o’clock segment at 270°). Based on these findings, the decision was made to proceed with further testing using the 11-point established structure of core affect presented in Study 2 Part A (see Chapter 4 section 4.6.1).
**APPENDIX H: Pre-ordered correlation matrix submitted to CIRCUM (Study 1: Part A)**

```
PROG AUFIT MODE=CORR DISCREP=ML MAXITER=500 CONVERGE=0.0001;
VARIANACES = PLEASED HAPPY ENERGIZE LIVELY EXCITED ALERT ACTIVE
ARGUSED IRRIT ANNOYED UPSET DISTRESS MISERAD SAD BORED SLOUGISH
TIRED SLEEPY STILL QUIET CALM RELAXED CONTENT;
NCASES = 790;
TITLE = ARC 21 Theoretical Circumplex 23 Affects: Nest-3;
SCORR =

```

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<td>0.697</td>
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<td>1.000</td>
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<td>0.622</td>
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<td>1.000</td>
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<tr>
<td>0.641</td>
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</tbody>
</table>
```

```
APPENDIX I: Pre-ordered correlation matrix submitted to CIRCUM (Study 2: Part A)

```
PROG AUFIT MODE=CORR DISCREP=ML MAXITER=500 CONVERGE=0.0001;
VARNAMES = P PA AP A UA UP UD DU D DP PD ;
NCASES = 569 ;
TITLE = LINDA 3-ITEM 11-point CMA ARC24 TRILINGUAL: Nbet=3;
SCORR =
   1.000
 0.485 1.000
 0.481 0.816 1.000
 0.232 0.607 0.639 1.000
-0.561 -0.136 -0.111 0.168 1.000
-0.599 -0.271 -0.248 -0.040 0.725 1.000
-0.370 -0.332 -0.297 -0.131 0.488 0.630 1.000
-0.336 -0.334 -0.323 -0.143 0.432 0.535 0.789 1.000
 0.432 0.083 0.086 0.010 -0.223 -0.115 0.014 0.063 1.000
 0.743 0.372 0.368 0.153 -0.502 -0.432 -0.235 -0.200 0.650 1.000
 0.754 0.432 0.441 0.187 -0.503 -0.465 -0.256 -0.241 0.531 0.741
 1.000 ;
```