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Original article

Feasibility of breaking up sitting time in mainstream and special schools with a cognitively challenging motor task

Emiliano Mazzoli [a,*], Harriet Koorts [b], Jo Salmon [b], Caterina Pesce [c], Tamara May [d], Wei-Peng Teo [b], Lisa Michele Barnett [a,b]

[a] *School of Health and Social Development, Faculty of Health, Deakin University, Geelong, VIC 3220, Australia*
[b] *Institute for Physical Activity and Nutrition, Faculty of Health, Deakin University, Geelong, VIC 3220, Australia*
[c] *Department of Movement, Human and Health Sciences, Italian University of Sport and Movement "Foro Italico", Rome, 00135, Italy*
[d] *School of Psychology, Faculty of Health, Deakin University, Geelong, VIC 3220, Australia*

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Abstract

Background: Children spend ≤70% of the school day sitting in class. Classroom-based active breaks can benefit children's physical health, but if the breaks are cognitively demanding (i.e., combine physical exertion and mental engagement), they may also improve focus and cognitive functions. Teachers and students play a crucial role in the successful implementation of active breaks, and their perspectives are critical to the feasibility of these strategies. The aim of this study was to assess the feasibility of implementing a cognitively challenging motor task as an active break in mainstream and special primary schools.
Methods: A total of 5 teachers in 2 mainstream schools and 7 teachers in 1 special school (attended by children with neurodevelopmental disorders) attended a 20-min training on how to implement a 4-min cognitively challenging active break, before conducting a feasibility trial (twice a day for 1 week). To understand individual perceptions, one-on-one semistructured interviews were conducted before and after the trial with teachers, and focus group interviews were conducted with typically developing children after the trial. Questions were based on a predefined framework for feasibility studies. All interviews were audio recorded, transcribed and analyzed in NVivo 11 using a framework approach. A total of 12 teachers (11 females; 7 between 20 and 34 years old) and 34 children (16 girls; 9.3 ± 1.7 years, mean ± SD) participated in the interviews.
Results: In mainstream schools, teachers viewed the cognitively challenging motor task as appropriate and potentially beneficial for children's health and focus. Children reported enjoying the active breaks. Teachers in special schools viewed the task as complex and potentially frustrating for children. In both school types, children's disruptive behavior and lack of time were seen as the main potential barriers to implementation. The use of music, videos, visual cards, and support staff were noted as potential facilitators.
Conclusion: The cognitively challenging motor task was a feasible way to interrupt children's sitting time and promote physical activity in mainstream schools, but required changes in special schools. Further research could investigate the effectiveness of these types of task interruptions on children's physical and cognitive health.

Keywords: Active breaks; Classroom; Cognition; Physical activity; Sedentary behavior

1. Introduction

Physically active children have a more favorable body composition, better musculoskeletal health, and improved cardiovascular fitness.[1,2] In the past 2 decades, research has also shown that physical activity (PA) enhances children's cognitive functioning and educational attainment.[3,4] In contrast, sedentary behavior in school-aged children is associated with negative health-related outcomes that seem to be independent from activity levels.[5] Negative outcomes include increased cardiometabolic risk factors and lower self-esteem,[6−8] as well as poorer cognitive development.[9]

The adoption of healthy, as well as unhealthy, behaviors starts very early in life and tracks into adolescence and then into adulthood.[10−12] Promoting an active lifestyle in childhood is a key preventive measure for lifelong health benefits. Given its relevance for population health, PA guidelines[13] recommend

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* Corresponding author:
E-mail address: emiliano.mazzoli@deakin.edu.au (E. Mazzoli).

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that children should engage in a minimum of 60 min of moderate-to-vigorous intensity PA every day.[2] More recently, some countries have introduced additional guidelines for sedentary behavior (e.g., *Australia's Physical Activity and Sedentary Behaviour Guidelines for Children (5–12 years)*), suggesting that in addition to being physically active, school-aged children should reduce and break up sitting time as often as possible and restrict recreational screen time to less than 2 h a day.[14,15]

Despite these guidelines, the prevalence of children meeting PA recommendations is low. For example, objective PA data collected from 10 countries show that less than 40% of children aged between 9 and 10 years meet the PA guidelines.[16] Furthermore, children with neurodevelopmental disorders are less active and have lower physical fitness and poorer motor skills compared with their typically developing peers.[17,18] Schools are considered a key setting in which promote PA, because children spend most of their weekday waking hours in this environment.[19,20] There are also considerable opportunities within schools to decrease and break up children's sitting and increase their PA, given that on average primary school children spend more than 70% of their school time sitting.[21]

The use of classroom-based PA can help to decrease sitting time,[22] improve PA,[23,24] and enhance attention,[25,26] on-task behavior,[27,28] and academic achievement.[29] School-based strategies to break up classroom sitting and promote PA include active breaks (i.e., short bouts of PA unrelated to the school curriculum and implemented in the classroom), active lessons (i.e., integration of PA into curricular lessons, e.g., active math), and modifications to the classroom environment (e.g., the use of standing desks).[30] However, to date, the majority of studies exploring the effects of classroom-based active breaks have used noncognitively challenging aerobic activities (e.g., jumping jacks).[29]

There is increasing evidence of the positive relationship between cardiovascular fitness and improved cognitive functions in children.[31,32] More recent research proposes that cognitively challenging motor tasks (i.e., motor tasks that involve physical exertion and mental engagement), compared with less cognitively demanding motor tasks such as aerobic exercise, may be more likely to benefit cognitive[33–35] and metacognitive functions,[4,36] which may also lead to improved academic performance.[37] It is hypothesized that this improvement might be because a cognitively challenging stimulation, combined with PA, facilitates neuroplasticity[38] by creating new connections within the brain network.[39,40] As a result of decades of research on PA and cognition, Tomporowski et al.[41] suggests that it is possible to manipulate the level of cognitive engagement of a motor task by applying at least 1 of the following 3 principles: contextual interference (i.e., the introduction of random changes in the context and conditions of the task, which forces the performer to adapt her actions in response to those unpredictable changes), mental control (i.e., the introduction of rules that challenge specific core executive functions (working memory, inhibition and/or cognitive flexibility)), and discovery (i.e., the use of open-ended tasks, clear goals, and not completely defined rules, allowing the participants to find creative solutions to the different situations that may arise during the task execution). Despite this finding, the feasibility of cognitively challenging active breaks (or motor tasks) in the classroom has rarely been investigated. To our knowledge, no previous studies have explored school-based active breaks with children with neurodevelopmental disorders, even though this might be a scalable way of encouraging PA and helping to improve physical and cognitive health-related outcomes in this population.[42,43] In typically developing children, research on classroom-based active breaks has typically focused on intervention effectiveness. Factors affecting implementation (e.g., perceived barriers and facilitators) are often evaluated at a later stage,[44] and the feasibility of introducing PA in the school curriculum before implementation is not always considered or reported.[45] This is important in terms of understanding the success or lack of success of a program.

The aim of this study was to assess the feasibility of implementing a cognitively challenging motor task (or active break) to interrupt classroom sitting time and improve PA in mainstream and special (i.e., including children with mild intellectual disability and autistic spectrum disorder) Australian primary schools.

2. Methods

2.1. Participant recruitment

The study was approved by the Deakin University Human Research Ethics Committee (2016-382) and the Department of Education and Training of Victoria (2016_003257). Overall, 2 mainstream primary schools and 1 special school were recruited in 2017 via convenience sampling. A total of 12 teachers (5 mainstream and 7 special teachers), representing school Grades 1–6, consented to participate. Teachers were recruited across a range of year levels to capture differences in the feasibility of implementing cognitively challenging active breaks among children of different ages. Parents or guardians of children were invited to complete a demographic survey and provide consent for their child to participate in an audio recorded focus group interview regarding their perceptions about the cognitively challenging motor task. Overall, 47 children (36 from the mainstream primary schools and 11 from the special school) consented to take part. A total of 2 children from the mainstream schools and all children from the special school could not be interviewed owing to the neurodevelopmental disorder severity ($n = 1$), or because they were absent on the assessment day ($n = 4$), or owing to late consent ($n = 8$).

2.2. Procedure

Teachers attended a 20-min training session on the proposed motor task, consisting of an imitation game including motor components, such as jumping and hopping, combined with a mentally engaging component. With a time delay between the teachers' and children's execution of each part of the sequence, similar to a singing round but as a PA, the task (i.e., My Clock Is Late)[41] applies the aforementioned principle of mental control. This delayed imitation task is assumed to involve both the ability to inhibit habitual responses (simple response inhibition task)[46] and the ability to update and manipulate information being held in mind (complex working memory task).[46] Indeed, children must inhibit the habitual tendency to immediately imitate the teacher's movements. In addition, they must hold the observed movement pattern in working memory until they can execute it. While executing, they must update the working memory by substituting the movement pattern in execution with the one just observed.

An oral presentation, physical demonstrations, and written instructions on how to introduce this motor task into the classroom were provided. Teachers were also presented with scenarios and suggestions on possible teaching progressions and simplifications to make the task more suitable for children of different ages and skills. Although the activity was originally designed for typically developing children,[41] the suggested teaching progression allowed teachers to modify the activity to match children's skills (e.g., breaking the task down into a smaller number of movement types, simplifying the type of motor tasks performed—i.e., jumping instead of hopping—or increasing the number of repetitions of each movement to allow children to have more time to synchronize with the whole group). In sum, the teaching strategies used to match the optimal challenge point for children with different developmental trajectories and skill levels included segmentation,[47] modulation of interlimb coordination demand, and adjustments in the ratio between repetition and change. After the training, teachers completed a 15-min one-on-one semistructured interview to capture their initial impressions, concerns, expectations, and ideas regarding the perceived appropriateness and usefulness of the task, as well as their perceptions of its fit within the school organization.

Teachers were asked to implement the 4-min cognitively challenging motor task twice a day for 1 week and were encouraged to adapt the activity to suit their classroom and students. After the 1-week implementation period, teachers participated in a follow-up one-on-one interview lasting approximately 10 min. Consenting children participated in focus group interviews lasting up to 15 min to explore their opinions and experiences of the cognitively challenging motor task. Interviews were conducted by the same researcher within the school premises during school hours and were audio recorded for later transcription and analysis. To capture emerging themes from the interviews, the researcher kept a flexible approach, allowing some additional questions.

Furthermore, the implementation was directly observed in the classroom 1 day during the week for each teacher in the trial. The observing researcher took notes on the teachers' and children's behavior during the implementation, as well as the success or failure of execution and other aspects related to practicality (e.g., time necessary for implementation, clarity of instructions, and enjoyment).

2.3. *Framework for feasibility study*

The feasibility of implementing the cognitively challenging motor task as an active break was investigated using a previously developed framework for feasibility studies.[48] The framework contains 8 dimensions of feasibility: (1) acceptability (e.g., satisfaction), (2) demand (e.g., intention to use), (3) implementation (e.g., success or failure of execution), (4) practicality (e.g., ability of participants to carry out the activity), (5) integration (e.g., fit with infrastructure), (6) adaptation (e.g., degree to which similar outcomes are obtained with a modified format), (7) expansion (e.g., potential success of a previously tested activity in a new context), and (8) limited efficacy testing (e.g., preliminary effects of the program tested with a small sample). To meet the aim of this study, 5 dimensions (acceptability, demand, implementation, practicality, and integration) were assessed. A more detailed explanation of the 5 selected feasibility dimensions is provided in Table 1.

2.4. *Measures*

2.4.1. *Interview questions*

A set of 17 pretrial and 23 post-trial interview questions for teachers and a set of 9 focus group questions for children were developed based on the 5 selected feasibility dimensions.[48] The face validity of the interview questions was established with 3 teachers, known to the researchers and not involved in the trial, before the commencement of the study. Of these 3 teachers, 2 completed a validation survey, which asked them to record the perceived question intent, the clarity, and the fit within each feasibility focus area. One teacher participated in a simulated interview session and provided feedback on the comprehension and potential repetitiveness of the interview questions, as well as on the duration of the interview overall. Outcomes of the validation testing led to the refinement of the original questions down to 48 questions (i.e., 15 pretrial and 21 post-trial questions for teachers and 12 focus group questions for children) to simplify wording and remove redundant or overlapping questions. The final interview schedule is presented in Supplementary Table 1.

2.4.2. *Demographics*

The teachers' age group and years of teaching experience were collected via a survey. Children's demographic characteristics (i.e., date of birth, language spoken at home, parents' country of origin, education, occupation, and income) were collected via a parent survey.

2.5. *Data analysis and management*

All the interviews were transcribed verbatim by 1 researcher. Transcriptions were saved as digital documents (i.e., Microsoft Word 2018, Version 1806, Microsoft, Redmond, WA, USA) and subsequently imported in NVivo 11 software (Version 11.3.1.777; QSR International Pty Ltd., Melbourne, VIC, Australia) for data analysis.[49] Teachers' and children's perspectives on the cognitively challenging active breaks were analyzed using a framework approach.[50] This approach involves applying conceptual labels (i.e., codes) to the transcribed data to group similar codes into more general and conceptual categories, and finally to enter the summarized data into the adopted analytical framework (i.e., charting the

Table 1
Feasibility areas of focus, definition, research goals, and outcomes of interest.

Focus area	Definition	Research goals for interviews	Outcomes of interest for this study
Acceptability	How the intended individual recipients—both targeted individuals and those involved in implementing programs—react to the intervention.	To what extent is the cognitively challenging motor task judged as suitable, satisfying, or attractive to teachers and children?	Satisfaction Intent to continue use Perceived appropriateness Fit within the school culture Link with education Comparison with current practice
Demand	Estimated use or actually documented use of selected intervention activities in a defined intervention population or setting.	To what extent is the cognitively challenging motor task likely to be used?	Current use of active breaks or similar activities Expressed interest or intention to use Perceived demand
Implementation	Extent, likelihood, and manner in which an intervention can be fully implemented as planned and proposed, often in an uncontrolled design.	To what extent can the cognitively challenging motor task be successfully delivered (i.e., teacher led) to intended participants (i.e., children) in some defined, but not fully controlled, contexts (i.e., classrooms)?	Degree of execution Success or failure of execution Amount and type of resources needed to implement Factors affecting implementation ease or difficulty (barriers/facilitators) Fidelity to the program Strategies put in place to deliver the task Efficiency, speed, or quality of implementation
Practicality	Extent to which an intervention can be delivered when resources, time, commitment, or some combination thereof are constrained in some way.	To what extent can the cognitively challenging motor task be carried out with intended participants using existing means, resources, and circumstances and without outside intervention?	Positive or negative effects on target participants Ability of participants to carry out the task
Integration	Level of system change needed to integrate a new program or process into an existing infrastructure or program. Documentation of change that occurs within the organizational setting or the social/physical environment as a direct result of integrating the new program.	To what extent can the cognitively challenging motor task be integrated within the existing school system?	Perceived fit with infrastructure (timetable, curriculum, space, and school policies)

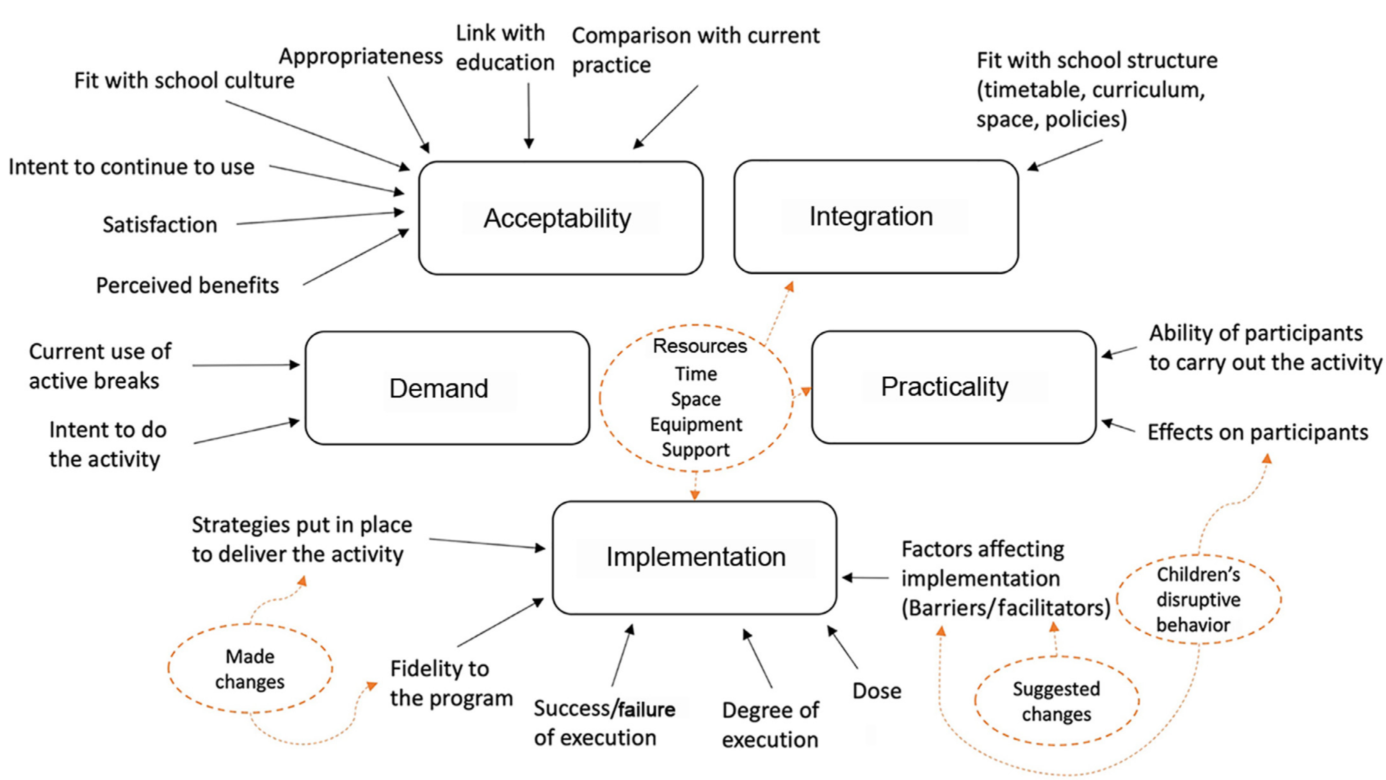

Fig. 1. Assignment of coded data to areas of feasibility.

data). Data analysis was conducted by 3 authors, who completed a coding reliability testing of 5 interviews (i.e., 10% of the data). The interview transcripts were read, coded, and collated into categories relevant to the 5 feasibility dimensions. Successively, a comparison between the reviewers' coding was conducted and divergent choices were discussed until agreement was found. The remaining data analysis was conducted by 1 researcher, and the accuracy of the data analysis was later verified by the other 2 reviewers. Fig. 1 shows the way in which the coded data were charted into each of the 5 feasibility dimensions.

3. Results

3.1. Demographic characteristics of participants

A total of 12 teachers (92% females) and 34 children (47% girls) provided interview data. The age of children who were interviewed was 9.3 ± 1.7 years, and teachers (the majority aged between 20 and 34 years old) had, on average, 8.1 ± 9.2 years of teaching experience. Table 2 describes the demographic characteristics of participants in the study and Table 3 presents the demographic information of parents of children who were interviewed.

3.2. Acceptability

3.2.1. Teachers' perspectives before the trial

Before the trial, all teachers perceived that the motor task was appropriate for the children's needs and skills and was in line with the school culture (Supplementary Table 2). For example, 1 teacher reported that "all children need this and it's just an expectation that we have across the board that we stop and we have active breaks." (Teacher 5, mainstream school, Grade 5/6.) Nonetheless, a number of teachers in special schools expressed concerns regarding the appropriateness of the physical and mental demand of the cognitively challenging motor task for children with neurodevelopmental disorders: "I've got a pretty high (ability) group in some ways, but still have very big troubles with executive functioning and self-regulation skills, you know, and impulse control and stuff like that." (Teacher 10, special school, junior section.)

Mainstream school teachers agreed that the activity seemed to be more suitable for children in the first stage of school (6- to 8-year-old children), while special school teachers reported that the motor task would have been better suited in the upper levels (i.e., 8- to 12-year-old children): "We tend to find that in the junior school it's more accepted to be a bit sillier and to have a break." (Teacher 1, mainstream school, Grade 2.) Also: "My kids are 5 to 7. Some of them are first year. So, some of them ... there's a couple that probably only have an intellectual age of about 3. I think that they'll certainly be able to copy, but not the delayed part of it. But you know, we'll see how we go." (Teacher 9, special school, junior section.)

All teachers identified the activity as potentially engaging and enjoyable for children. For example, one said: "I think they'll love it!" (Teacher 6, special school, junior section.) They all expressed satisfaction in relation to its mentally

Table 2
Demographic information of participants as frequencies n (%).

Characteristic	Teachers (n = 12)	Children	
		Consenting (n = 47)	Interviewed (n = 34)
Sex			
Female	11 (91.7)	20 (42.6)	16 (47.1)
Male	1 (8.3)	27 (57.4)	18 (52.9)
School type and grades			
Mainstream	5 (41.6)	36 (76.6)	34 (100.0)
Grades 1–2	3 (25.0)	21 (44.7)	20 (58.8)
Grades 3–4	1 (8.3)	5 (10.6)	5 (14.7)
Grades 5–6	1 (8.3)	10 (21.3)	9 (26.5)
Special	7 (58.4)	11 (23.4)	
Junior	5 (41.7)	6 (12.8)	
Primary	2 (16.7)	5 (10.6)	
Development			
Typical development		35 (74.5)	33 (97.1)
Neurodevelopmental disorder		12 (25.5)	1 (2.9)
Language spoken at home			
English		38 (80.9)	30 (88.2)
Other language		9 (19.1)	4 (11.8)

Table 3
Demographic information of parents of interviewed children as frequencies n (%).

Characteristic	Mother/guardian (n = 33)	Father/guardian, (n = 33)
Country of origin		
Australia	19 (57.6)	16 (48.5)
Asia	12 (36.4)	12 (36.4)
UK/Ireland	–	1 (3.0)
New Zealand	–	2 (6.1)
Other[a]	2 (6.1)	2 (6.1)
Education		
Some high school	2 (6.1)	1 (3.0)
Completed high school	6 (18.2)	4 (12.1)
Technical/trade certificate/ apprenticeship	3 (9.1)	7 (21.2)
University or tertiary qualification	21 (63.6)	20 (60.6)
Not applicable	1 (3.0)	1 (3.0)
Employment status[b]		
Employed full time in paid employment	8 (24.2)	29 (87.9)
Employed part time in paid employment	14 (42.4)	1 (3.0)
Employed part time in unpaid employment	1 (3.0)	–
Student	–	2 (6.1)
Unemployed	2 (6.1)	
Home duties full time	9 (27.3)	2 (6.1)
Other[c]	1 (3.0)	
Combined income		
AUD30,000–AUD59,000	6 (19.4)	
AUD60,000–AUD119,000	13 (41.9)	
AUD120,000–AUD180,000	10 (32.3)	
>AUD180,000	2 (6.5)	

Note: Total percentage values may not add to 100 owing to rounding.
[a] Bosnia and Herzegovina and Sudan.
[b] Multiple responses.
[c] Self-employed, deceased.

challenging component and for the possibility to tailor it to the specific skills of the class. Also, some were interested in the idea of using this classroom-based activity as a tool for education.

A large proportion of teachers identified potential benefits of the cognitively challenging motor task for children's physical and cognitive health: "They might gain the skill of hopping . . . which is always going to help them with brain development anyway, or any cognitive skills." (Teacher 10, special school, junior section.) However, some teachers also expressed concerns regarding the possibility for the task to be disruptive: "I do also have some kids who are very active and lively . . ., there would be a tendency in my class to then make everyone go 'woooooo' type of thing." (Teacher 2, mainstream school, Grade 2.)

3.2.2. Teachers' perspectives after the trial

Overall, the teachers' perceptions of the motor task remained positive after the trial, confirming many of the opinions reported before implementation (Supplementary Table 2). Most of the teachers expressed satisfaction and the intent to continue to use the activity beyond the duration of the trial, reporting that children mostly enjoyed taking part: "The enjoyment that you could see on the kids' faces. I thought other than (after) a week they would become 'oh not this again!', but they were happy to get up and give it a go." (Teacher 3, mainstream school, Grade 1/2.)

Some teachers were surprised by the positive response received from children, particularly from those with neurodevelopmental disorders:

> "I didn't have any defiance, which is good. I usually will always have 1 or 2 kids that refuse to do any form of active break and sit in the corner. Every single child wanted to be a part of it and the child that I thought would have struggled . . . with her fine motor skills, didn't struggle any more than anyone else, with that little bit of a wobble every now and then with a hop. But that was fine, they knew they just had to keep going." (Teacher 1, mainstream school, Grade 2.)

In contrast, various teachers expressed concerns regarding the appropriateness of the task for children with neurodevelopmental disorders, particularly the younger children:

> "I don't think the physical aspect is a huge problem. Maybe for some kids because they don't get the concept of the physical. It's more just to do with how they can engage independently, so if they can understand that they're meant to be focusing and listening in a group, the task is doable. But the issue really is that they don't know how to focus very well." (Teacher 10, special school, junior section.)

In addition to the perceived health benefits, more than one-half of the teachers perceived the cognitively challenging motor task as potentially beneficial for children's focus. More than one third of the teachers also mentioned that performing the task together promoted teamwork and a sense of belonging to the class. Some teachers identified that it could have potential benefits for themselves: "I found it was nice to actually be an active participant, you know, with the kids. . . . I felt more connected while doing it." (Teacher 3, mainstream school, Grade 2.)

3.2.3. Children's perspectives

Children's perceptions in relation to the acceptability of the cognitively challenging motor task appeared to be mostly positive (Supplementary Table 3). A large proportion of children found it enjoyable and fun. Children generally said that they enjoyed the challenging component, which was seen by many as the part that made the activity fun: "Some people were laughing during the actions." (child, Grade 2); and "It's kind of fun because instead of everybody doing the same thing at once you've got to focus on what your group is doing." (child, Grade 3/4.) Many children expressed the intent to continue to use the task and enunciated a series of perceived benefits: "We should keep doing it, because it takes some drowsy energy, so when we sit back down we might not wriggle as much." (child, Grade 2.)

One child referred to the alignment of the cognitively challenging motor task with the school culture: "And, thinking of what we do, is still a part of our education and growing our mind. So, the active brain breaks are better than just stretching our legs." (child, Grade 3/4.)

Although most of the children reported having enjoyed the task and the challenges posed, some individual differences emerged. A few children reported that they did not particularly enjoy being physically active or that they would have preferred a less challenging task. For example, one child said: "I think I didn't really like when we had to move and move and move. I think it'd be easier if we actually copied it. It would be easier if we copied it." (child, Grade 2.) Some children reported that a few classmates became restless after the motor task, and they would have preferred to keep playing rather than going back to work: "Because they want to play. And sometimes when Mr. H. is in our classroom they think they can just play." (child, Grade 2.)

3.3. Demand

3.3.1. Teachers' perspectives before the trial

In terms of demand, all teachers recognized the children's need for breaks throughout the school day, and many reported that they already do or are trying to implement some forms of active breaks in their classrooms (Supplementary Table 2). For example, a teacher said:

> "Yeah, I think it's really necessary. I think my kids need it a lot in my classroom day. They're going to be wiggly and a bit antsy, so every now and then we'll stand up and you know: 'Shake your hands. Shake your feet. Do a wiggle. Okay, sit back down let's do some more work now.' So, yeah they really benefit from that kind of refocus." (Teacher 8, special school, junior section.)

Various teachers reported that the current use of activity break strategies was not always based on evidence or specific aims, and that their regular implementation may lack consistency. Teachers mostly expressed that children would have been very keen to engage in any form of movement-based tasks. However, a few teachers identified a potential lack of interest: "Oh, like I said, I have my couple kids that may decide that it's not for them. That's ok. It's not a forced thing so... I can't force anyone to do anything." (Teacher 3, mainstream school, Grade 2.)

3.3.2. Teachers' perspectives after the trial

After the trial, teachers' perceptions of the cognitively challenging motor task in relation to whether children wanted it remained positive (Supplementary Table 2): "They ask for it. You know, they tell you we need to." (Teacher 4, mainstream school, Grade 3/4.) In contrast, 3 specialist teachers from the junior section reported that some children did not want to participate: "Some of them didn't, like 2 of them. J. wasn't bothered, he couldn't care less, you know, the spinning and stuff didn't bother him. M. didn't enjoy it, he didn't want to do it (the motor task)." (Teacher 10, special school, junior section.) Despite these contrasting comments, all teachers reported that using active breaks in general was a good idea, and that it should be done more regularly throughout the school day, provided that these tasks should be tailored to the children's specific needs and skills.

3.3.3. Children's perspectives

Children's responses in relation to the breaks were mostly positive (Supplementary Table 3). A large proportion of children identified the need for breaking up sitting time throughout the day and reported their intent to participate in the motor task:

> "Because when you are sitting down a lot, you get sometimes a bit tired from sitting down a lot. And you are not really active, and you only have one and half hours because of recess and lunch, in school times. Because you are mostly active at those times. But you like, need to be more active at times to make sure that your brain gets breaks when they need it." (child, Grade 2.)

Most of the children said they should do more active breaks during the day: "Actually, I feel we should do it 4 times a day. To get our brain breaks 4 times a day, about that." (child, Grade 2.) In a more neutral comment on this aspect, only 1 child said that he thought that doing the motor task 1 or 2 times a day was enough.

3.4. Implementation

3.4.1. Teachers' perspectives before and after the trial

Perceived barriers and facilitators, as well as adopted strategies and reported fidelity to the instruction, were the main aspects that emerged in relation to the implementation of the cognitively challenging motor task (Supplementary Table 3). Before the trial, the most relevant barriers to implementation appeared to be the time necessary to conduct the task and the children's responses/behaviors during implementation, which were prevalent reasons for concern for special school teachers: "Sometimes if there are certain kids it may take them a while to settle to begin with. So, by implementing a movement break for everyone, it may not always work, I guess because it may have taken a certain child an extra 10 minutes to settle to begin with." (Teacher 9, special school, junior section.) Accordingly, after the trial, and again mostly in special schools, these 2 factors seemed to be the most relevant. The time required to implement the motor task seemed influenced by factors other than the task itself: "The last activity took so long, because a big focus in our class is teaching them how to appropriately engage in activity, so while they can do the activity 4 or 5 minutes what could happen is that they go crazy, and then the activity is done, but they haven't learned how to appropriately act in a classroom." (Teacher 10, special school, junior section.)

Some teachers in mainstream schools reported that children in the higher grades might find it harder to fit regular active breaks into their schedules owing to the greater number of other curricular activities they were involved in, compared with the earlier stages. Moreover, considering that the proposed trial consisted of 1 motor task only, another barrier identified by teachers in the mainstream schools was the possible boredom associated with performing the same task over an extended period of time: "Maybe if, you know, if we do it twice a day for a week, they may get a little bit over it by a certain stage. So, it might be something that I put in that repertoire that I pull out every now and then." (Teacher 3, mainstream school, Grade 2.)

Most teachers suggested a number of possible facilitators to the implementation, for example, keeping the activity simple, providing a range of adaptable challenges for children with neurodevelopmental disorders, and embedding it as part of routine school practices: "For me the transition is already hard enough with getting books away and getting the next one out. Don't have to add any more one tools, just me and the kids, which is good." (Teacher 1, mainstream school, Grade 2.) Specifically regarding children with neurodevelopmental disorders, after the trial most teachers found the cognitive motor task too challenging and unanimously reported that a simpler form of the task (i.e., simple imitation) was already quite stimulating for them: "I think they were more focused with the simple imitation, because they just had to copy exactly what I was doing." (Teacher 11, special school, primary section.) Additionally, some teachers identified a series of other factors that could positively affect the implementation, such as teacher practice and training, the use of music, videos, and visual cards, as well as the involvement of support staff to assist children in need of help during the implementation: "When you do something with them, I can tell when I've lost them because I am not confident in selling it. So, I think the time I spend thinking about it and sharing it with the kids is really beneficial. Because it needs to be right or else they won't follow." (Teacher 10, special school, junior section.)

In terms of fidelity, one-half of the teachers pre-trial reported that they would follow the instructions. Although most of them followed the general structure they were given, many teachers post-trial reported some types of adjustments. Teachers in the mainstream schools who worked with older children (Grades 3–6) said they needed to develop the cognitive motor task to make it more challenging:

> "Today we did one that was a counting one, where you go you're sort of counting ... you're counting up to a point and then you go backwards. So, there's a counting pattern. And that was really quite difficult, but they wanted to introduce the clapping in the middle of the counting to make it harder. So, they're creating. You know they're coming up with ideas to make it more challenging." (Teacher 4, mainstream school, Grade 3/4.)

In contrast, most of the teachers in special schools reported they could not deliver the task as requested because its complexity was beyond children's abilities: "I didn't really follow it the way it was written. I was just trying to get the skill down, which was just knowing they need to copy me, because you know if I do four or five they wouldn't even copy me. . . . It is just horrendous! It's overload for them." (Teacher 10, special school, junior section.) Although the cognitively challenging active breaks were intended to take approximately 4 min to implement, teachers' experiences varied broadly in terms of implementation time, ranging from 2 to 20 min. In addition, teachers were asked to implement the motor task twice a day for 1 week. The largest proportion of teachers reported that they could run 1–2 sessions a day. Fewer teachers, who seemed to be more familiar with active breaks and movement in general, stated they could do it 3 times or more a day.

Various teachers reported that the execution of the cognitively challenging motor task was easy and did not require changes to the classroom setting: "It was very easy, very easy. It was just get up and find a spot not near anybody else. Simple." (Teacher 12, special school, primary section.)

The strategies adopted by most of the teachers mainly involved small changes to the sequence of movements (i.e., the type and number of skills included in the sequence), with a few teachers exploring some more structural changes: "We did the routine altogether. And then we did it as a round, so that there were 4 groups: group 1 started, then 2, 3, and 4. And once we did that, then we went around twice." (Teacher 4, mainstream school, Grade 3/4.)

3.4.2. Children's perspectives

The most relevant barrier reported by children was the potential boredom of repeating the same task over an extended period of time (Supplementary Table 3). A few children recognized that the activity could be challenging also for the teachers. On one hand, this could be a source of fun; on the other hand, this factor could hinder the proper implementation of the activity. Practice and the simplification of the sequence were identified by children as the most relevant facilitators for implementation. Another interesting aspect that was perceived as a possible facilitator was children's participation in the design of the activities: "At recess, some of us might think of some more active brain breaks to share with us so we can do that." (child, Grade 3/4.)

Some children perceived the cognitively challenging motor task as easy to learn and execute. In contrast, some said that the task was quite challenging for them but clarified that after a few tries it became easier. For example, 1 child said: "Well, it was quite hard if you ask me, but it got easier." (child, Grade 3/4.) Most children reported that they did the motor task once or twice a day, mostly in the morning. Their description of what was done mostly matched the instructions the teachers were given, thus confirming the successful execution. A few children reported that their teachers forgot to run the task sometimes: "Sometimes Mr. W. forgets, but we have done it once today." (child, Grade 2.)

The children reported that the main strategies were adaptations to the types of motor skills included as part of the sequence. Some suggested mimics of various sports moves, sounds and body percussions, as well as integrating curricular activities into the cognitively challenging motor task. About the latter concept, 1 child said: "Wouldn't mind to change, kind of like, different topics about it so instead of like maybe the maths. I'd like to change it like we do different topics at schools, so the active brain break will be like one day we do maths, one day we do English, one day do science, one day we do history." (child, Grade 3/4.)

3.5. Practicality

3.5.1. Teachers' perspectives before the trial

The most relevant aspect that emerged in relation to practicality was the children's ability to participate in the cognitively challenging motor task. Before the trial, mainstream school teachers were mostly confident that their children would have been able to carry out the task, whereas specialist teachers were either tentative or believed that their children could not perform the motor task as prescribed (Supplementary Table 2). For example, 1 teacher reported: "Some won't be able to do it, I don't think. And what I'm more concerned about is the kids that might have a meltdown." (Teacher 12, special school, primary section.)

3.5.2. Teachers' perspectives after the trial

After the trial, a greater proportion of teachers, compared with before the trial, reported that children were able to carry out the motor task appropriately, and many said they were surprised by the children's response (Supplementary Table 2). In contrast to what was reported before the trial, the same teacher said: "I was impressed by ... I didn't think that they would do as well as they did. So, I was you know I'd like to make it hard for them and to see how they go and yeah. They could do it." (Teacher 12, special school, primary section.) After the trial, a few teachers reported that the lack of space in their classroom might have compromised the children's ability to perform the motor task. A small minority of teachers provided contrasting comments on the perceived effectiveness the cognitively challenging motor task. Some believed that the children were more confident and focused after the task, whereas others reported that they either were not sure about the effectiveness or that the task might have overexcited some children rather than calmed them down. The following 2 examples reflect these conflicting views: "I think it would switch their brains on, so I think that worked pretty well." (Teacher 10, special school, junior section); and "I wouldn't use it necessarily as a brain break. I'd use it as like a fun little teamwork game that we could play as a class." (Teacher 11, special school, junior section.)

3.5.3. Children's perspectives

A large proportion of children reported that the cognitively challenging motor task made them feel good and energetic (Supplementary Table 3). Some others stated that after the task, they felt more relaxed and able to concentrate than before starting it. As an example, 1 child said: "The way I put it is it's basically like what you feel after you were hungry and you had a full dinner. So, you couldn't do this and then you had the brain break and you could do all of it." (child, Grade 3/4.) In contrast, a few children reported that they felt tired after the cognitively challenging motor task or they got a bit confused during its execution. For example, 1 child said: "Sometimes I get confused. Because we only have to copy what she says, not what she does. She does something else and she says something that we need to do." (child, Grade 2.)

3.6. Integration

3.6.1. Teachers' perspectives before the trial

Before the trial, less than one-half of the teachers who reported that regular active breaks were part of the school aims said that the motor task seemed to be a good fit with the infrastructure: "We have got a big push for common language at the moment, so I think a certain group of brain breaks, you know the active stuff, would be good, because we are trying to encourage a school-wide approach to things. And that includes just the way we communicate." (Teacher 1, mainstream school, Grade 2.) However, sometimes the lack of common language may obstruct the real application of school policies. For example, a teacher referred to the difficulties that might arise from conducting activities that have no formal allocation in the curricular schedule: "So there's sometimes a little bit of disparity, you know, maybe it's something that we all need to agree on is when they come back to your room is when you do it, you don't do it at the end of your session, something like that." (Teacher 3, mainstream school, Grade 2.)

3.6.2. Teachers' perspectives after the trial

After the trial, many teachers reported that the cognitively challenging motor task showed good fit with the infrastructure, especially with the timetable: "That was so fine for us in our timetable laid work. So, we did in the morning block and the middle block. I mean obviously like sometimes, yesterday for example we didn't do it yesterday because we had an excursion that was during the middle block. We were out of the school the whole time." (Teacher 2, mainstream school, Grade 2.) In contrast, in other cases the activity seemed to fit poorly with the school schedule and the available physical space. For example, 1 teacher reported: "It just depends on what we have on, because I have a lot of specialist stuff as well. So, some of the longer sessions it will definitely work." (Teacher 9, special school, junior section.)

3.6.3. Children's perspectives

Children only made 2 comments in relation to this area. One child noted how the current school schedule negatively influenced the opportunities for children to be physically active. Another child commented on how the availability of sufficient space in the classroom could reflect a better opportunity to conduct more active tasks: "Because we have some space around and we could just make it more active." (child, Grade 2.)

3.7. Direct observations

The results from the direct observations conducted in the classroom during the implementation of the motor task seemed to reflect what was reported by teachers and children. Noticeable differences were observed in the success of implementation. In both school types, some teachers—4 mainstream and 2 specialist teachers—seemed to be more familiar with the use of movement-based strategies and could implement the cognitively challenging motor task as suggested and within the forecasted duration (i.e., 4 min). These teachers could deliver the activity with engagement, and the children seemed to enjoy it. In contrast, some teachers—1 mainstream and 5 specialist teachers—seemed to be less familiar with movement and were less comfortable and less able to deliver the motor task or a simplified version of it. In this case, the children seemed to enjoy the break less and seemed to be more distracted, disengaged, or overexcited.

4. Discussion

The aim of this study was to investigate the feasibility of implementing a cognitively challenging motor task as an active break in mainstream and special primary schools. To our knowledge, this is the first study to assess the feasibility of a cognitively challenging active break in mainstream primary schools; it is also the first to explore any type of active breaks in special schools.

Our findings showed that it was feasible to implement this kind of cognitive motor task in the form of an active break in mainstream primary schools. Both teachers and children showed appreciation for the integrated nature of mentally and physically challenging components. Teachers and children from mainstream schools also seemed to agree on the need for a repertoire of varied and mentally engaging motor tasks, which may guarantee enjoyment and support regular implementation throughout the school year. This finding is in line with research suggesting that the enjoyable and motivating nature of exercise variety ensures the satisfaction of basic needs and that the maintenance of an optimal challenge point is important.[51,52]

Conversely, the use of the cognitively challenging motor task seemed to be less feasible in special schools, where teachers expressed concerns mainly regarding the excessive cognitive demands of the task. However, it may be feasible to conduct cognitively challenging motor tasks in special schools by tailoring the motor tasks to the specific needs of children with neurodevelopmental disorders. Feasibility concerns seem to be justified when considering that an excessive cognitive challenge may exceed an individual's capability and turn into costs rather than benefits.[53] This notion is especially true for children with developmental delays. This finding seems to confirm previous research highlighting that although typically developing children seem to reap cognitive benefits from cognitively challenging PA experiences, children with neurodevelopmental disorders may find the tasks too challenging.[54] To reach their cognitively optimal challenge point, children with neurodevelopmental disorders may need certain changes to the task, for example, including a series of support aides to facilitate inclusiveness and participation.[55] Other examples include the use of simple motor sequences (i.e., simple tasks based on 1 fundamental motor skill), decreasing the number of different motor components included in the task while increasing the number of repetitions of each motor component, the use of supporting material (e.g., visual cards), and avoiding concepts that the children perceive as complex and frustrating (e.g., the use of irregular rhythmic patterns).

In addition, the results of our study reinforced the idea that children who were 6–8 years of age seemed to be most appropriate for meeting the optimal balance between nominal, functional, and perceived difficulty (i.e., the fit between the complexity of the task to be learned, the ability to perform the task under given environmental conditions, and the perceived challenge). Although this finding emerged quite clearly in mainstream schools, it was also confirmed by the results obtained from special schools, where the activity seemed to be more appropriate for children who were at a later chronological age but at a similar developmental age of 6–8 years. Thus, it is important to acknowledge the practical difficulties associated with refining motor tasks to an optimal challenging point[53,54] to suit a group of individuals with different skills and needs.

As was found in other studies, the successful implementation of the cognitively challenging motor task in our study seemed to be influenced by a number of factors. Although teachers may acknowledge the potential benefit of implementing classroom-based PA programs,[56,57] several barriers, such as a lack of time, a lack of experience, and a perceived disruption of curricular activities, can hinder successful implementation.[58–61] In line with the findings of previous research exploring the feasibility of PA interventions in the school setting,[60,62] our findings also identified teachers' professional development and adoption of a school-wide approach as strategies that can potentially overcome barriers to implementation. A finding that emerged clearly in this study is that the implementation of active breaks in the classroom is almost entirely dependent on the teachers' initiative, values, and confidence. However, a school-wide approach might provide additional support to teachers by providing them with specific time, space, means, directions, and developmental opportunities to aid in the implementation of this form of active breaks.[63] Although their study was not specifically related to cognitively challenging motor tasks, Routen et al.[60] also found that promoting a school policy supporting PA was important to the perceived feasibility of classroom-based active breaks and the integration of physically active lessons in mainstream primary schools.

Overall, conducting active breaks in the classroom may contribute to children's health by improving PA as well as creating moments throughout the day that may decrease mental pressure on children and improve their predisposition to learning.[29] We believe that the use of appropriately tailored cognitively challenging motor tasks could potentially benefit children even more. However, the effectiveness of this form of active breaks requires further testing.

The study is not without limitations. First, we were unable to interview 11 children with neurodevelopmental disorders either owing to their limited ability to provide feedback or owing to their absence from school or their late consent. Teachers and children involved in the study also disproportionally represented the earlier primary school grades.

5. Conclusion

Cognitively challenging motor tasks seem to be feasible for use in mainstream schools to break up children's sitting time. In its current form, the motor task was less feasible for use in special schools, but it could become more feasible by tailoring the activity to the specific abilities and needs of the participants. Implementing cognitively challenging motor tasks may decrease the health risks associated with prolonged sitting time and low PA levels. It may also improve children's cognitive functions and on-task behavior, as well as academic outcomes. Future research is needed to clarify these aspects.

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Authors' contributions

EM carried out the study, prepared the information and training material, prepared and conducted the validity testing of the measures (i.e., interview questions), collected and analyzed the data, participated in the design of the study, and drafted the article; HK helped with the design of the study, assisted on the validation of the measures, participated in the data analysis, validated themes from the qualitative analysis, and commented on the article; JS and LMB helped with design of the study, advised on the measures, and commented on the article; CP participated in the conception of the study and in its design and helped draft the article; TM validated themes from the qualitative analysis and commented on the article; WPT helped with design of the study and commented on the article. All authors have read and approved the final version of the manuscript, and agree with the order of the presentation of the authors.

Competing interests

JS declares that she has a potential conflict of interest because her husband established a business to manufacture height-adjustable desks for schools in 2017. She had no involvement in the data analysis. The other authors declare that they have no competing interests.

Supplementary data

Supplementary data to this article can be found online at doi:10.1016/j.jshs.2019.01.002

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