The association between sedentary behavior and cognitive ability in older adults

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Building executive function in pre-school children through play: a curriculum

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ABSTRACT

Executive function (EF) is a term that defines a group of cognitive abilities fundamental to goal-directed behaviour. EF is a strong predictor of both academic and life success. Therefore, it is important to develop EFs in the early years of life. We created a curriculum of games (BBF) for preschool children that focused on improving EFs. The purpose of the study was to assess the curriculum's impact. We asked the parents of 86 children to respond to three surveys. The majority (72) of these children participated in the BBF curriculum, while 14 were in a control group. These surveys were given twice; pre- and post-curriculum implementation. We found significant improvements in various behaviours measured by the three questionnaires in the BBF group that did not occur in the control group. This suggests that the BBF curriculum can be implemented as a programme to improve cognitive abilities in children.

KEYWORDS

Executive function; preschool; play; curriculum

Introduction

Executive functions (EFs) are a group of mental processes supported by the prefrontal cortex. These mental processes include: self-regulation, task switching, working memory, and socio-emotional control (Diamond & Ling, 2016; Miyake et al., 2000; Zelazo, Carlson, & Kesek, 2008). EF skillsets play an important role in our daily lives throughout our lifespan. For example, we use behavioural inhibition to carefully make a decision, rather than reacting to our initial impulse (Diamond & Ling, 2016). Because these skills play such a large role in our daily activities, it is important to find ways to hone them.

EF skill level has been found to predict school success (Willoughby, Magnus, Vernon-Feagans, Blair, & Investigators, 2017), and improve academic capabilities for years to come (Alloway & Alloway, 2010). Alloway and Alloway tested children on a variety of memory and IQ tests both before and after a six-year period. At the second test, children were also assessed on academic attainment by two standardized measures. The results showed that working memory was an independent predictor (from IQ) of such academic success. Furthermore, previous research has shown that behavioural inhibition is crucial for

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developing theory-of-mind (the understanding of other's thought processes), thus impacting school readiness (Carlson & Moses, 2001).

In addition to academic success, strengthening of EF has been found to benefit behavioural control, overall health, and enable individuals to make greater contributions to the work force (Center on the Developing Child, 2012). The long-term outcomes of low EF ability include increased antisocial behaviours, physical aggression, and emotional instability (McQuade, Breaux, Miller, & Mathias, 2017). for example, one study (McQuade et al., 2017) examined children (aged 8–12), both with and without ADHD diagnosis, on a variety of EF tasks. Their results demonstrated that those with poor EF skills engaged in more physical aggression and more ADHD type behaviours (e.g. hyperactivity, attention problems, and impulsivity). Because poorly developed EF can be detrimental for life in general (McQuade et al., 2017; Qian et al., 2017) it is important to strengthen these abilities in the early years.

While we know EF abilities are critical to childhood development, the question then is how do we appropriately build these skills? It has been suggested that three major factors are involved with a child's early development: relationships, activities, and their environment (Child, 2012). While there are many environments in which children spend their time that could influence early development (home, sports etc.), school settings allow for a certain level of methodological control because all students in the same class experience the same curriculum. Indeed, school settings influences all three of the major factors involved in early development, through relationships (with teacher/care-givers/classmates), activities (curriculum) as well as the physical environment. Teachers and caregivers play a vital role in creating an environment conducive to early learning. Thus, having a teacher /caregiver implement a curriculum designed to enhance EF ability, is a way to improve a child's development. One such curriculum focused on literacy, language, and mathematics (Weiland & Yoshikawa, 2013). Even though, they did not directly target EF abilities, they still found improvements in the children's EF skills. This demonstrates that a change in curriculum can, in fact, improve EF in young children.

In 2014, the province of Alberta (Canada) assessed the competencies of kindergarten-aged children (Early Child Development Mapping Project, 2014). Social skills, physical health, emotional maturity, language abilities, and communication were tested using the Early Development Instrument. The results showed that in comparison to the rest of Canada, a greater percentage of Alberta's children were not meeting the criteria for kindergarten readiness. Furthermore, a higher percentage of children living in the city of Lethbridge were disadvantaged compared to the Alberta average. While there are many possibilities as to why the children in Lethbridge performed poorly on this assessment, we wanted to investigate (regardless of the reason why this disadvantage exists) whether an EF intervention could improve their school-readiness in this population.

EF interventions have been suggested as a method to support children who are lagging behind developmentally (Willoughby et al., 2017). In the Willoughby longitudinal study children participated regularly in EF activities beginning at age two months through to the age of 3–5 years old. They were assessed on both their pre-kindergarten level of EF and on their academic achievement at the end of their kindergarten year. The results showed that children with low EF levels did not experience age-graded improvements by the age of 3–5. The authors argue that incorporating direct EF interventions into early childhood education is a viable strategy for improving school success in kindergarten. Moreover, disadvantaged children are those who will benefit the most from an intervention in the long-term.

The Building Brains and Futures (BBF) project was created to address the developmental delays in children within the city of Lethbridge (as measured by the ECMap 2014). While there are many factors as to why the children were lagging developmentally, we explored the possibility that the early education sites within the city needed to put emphasis on strengthening EF. This might be a result of the lack of adult awareness on the topic, or because EF building activities are not an integral part of the current programme. Therefore, we implemented a curriculum with a focus on EF (Gibb, Piquette, Harker, Raza, & Rathwell, 2015). This curriculum was based on games and play. The importance of play should not be overlooked as there is evidence that play can be used as a therapy for children with ADHD (who notoriously struggle with EF) (Panksepp, 2007; Panksepp, Burgdorf, Turner, & Gordon, 2003), and play can help with behavioural inhibition (Panksepp, 2008). Panksepp (2008) has argued that creating play sanctuaries for preschool children could facilitate the maturation of the frontal lobes that supports EF. Our 'playful' curriculum is affordable, portable, and easy to integrate into early childhood classrooms. To assess the effectiveness of our programme we conducted a baseline evaluation of the children's EF, then instituted the curriculum, and finally completed post-test analysis (after a minimum of six weeks exposure to the programme). Prior to the start of the programme, we had parents fill out both Ages and Stages Questionnaires (the ASQ and the ASQ:SE) to assess child development. Parents also completed the Behavioural Rating Inventory of Executive Function for Preschool children (BRIEF-P) to assess the child's EF abilities. At the end of the programme, the parents filled out the three questionnaires again. Importantly, all questionnaires are standardized for age, so changes in performance due to maturation are accounted for. To further ensure that any improvement was not due to age or demand characteristics, we analyzed data from one of our sites that did not institute the curriculum (control group). We hypothesized that after the integration of our curriculum into the existing pre-school programme, children would show increased EF abilities and would therefore have better reported outcomes as measured by the ASQ, ASQ:SE, and BRIEF-P questionnaires, and that these improvements would not be present in our control group.

Materials and methods

Participants

The new learning curriculum was implemented in four early education sites, all located in the Lethbridge area. The average SES for the four sites was either low or medium-low. We recruited 74 participants across four sites (38 males, 48 females) for data analyses purposes (Site A ($n = 27$, average minutes exposed to the curriculum = 5736), Site B ($n = 11$, average minutes exposed to the curriculum = 2478.5), Site C ($n = 18$, average minutes exposed to the curriculum = 469.75) and Site D ($n = 16$, average minutes exposed to the curriculum = 2305.5)). In our preliminary data collection, one of the sites (Site D) did not implement the curriculum, therefore, for the purpose of the data analyses they are used as the control group (Site E ($n = 14$, average minutes exposed to the curriculum = 0)). It should be noted that the parents of the control group children were unaware that their children did not receive the curriculum. All children were right handed, as confirmed by a modified version of the Edinburgh (Oldfield, 1971) and Waterloo (Brown, Roy, Rohr, & Bryden, 2006) handedness questionnaires. All participants included in the analyses were between the ages of 3 and 6 years old and consent to include them was obtained from their parents/guardians. In agreement with the declaration of Helsinki informed consent was obtained prior to the start of the study.

BBF curriculum

The goal of our BBF learning curriculum was to increase EF ability in children. In order to achieve this goal, our main focus was to improve teacher/caregiver knowledge of these skills. They were trained in the curriculum before implementing it in their classroom. The curriculum includes 10 different five-minute skill-building games. Each of these activities focuses on strengthening EF. The ten games include: red light green light, Simon says, Stroop (opposites), musical freeze, pretend play, circle time with lips and ears, shared project, wait for it, dimensional change card sort, and right is right. A brief description of each activity follows this, but more information on each of the games can be found elsewhere (Gibb et al., 2015).

The EF's that we focus on include: Inhibition, shifting, working memory, planning, and emotional control. Inhibition refers to the child's ability to refrain from responding, while shifting refers to their ability to shift between tasks/rules. Working memory has been defined as the process by which information is stored and can be manipulated for complex cognitive tasks (for example: language comprehension; (Baddeley, 1992)).

Red light, green light. This game involves the teacher/caregiver providing the children verbal or visual cues as to when they should move (green light) and when they should stop (red light). The children can also take turns being the ones to give the instructions. If the child fails to follow the cues, the child will be called out. This game develops inhibition, shifting, working memory, monitoring, and emotional control skills (Table 1).

Simon says. In this game, the adult stands in front of the children and instructs them to follow all actions that start with the words 'Simon says.' For example, 'Simon says put your hands on your head.' The child should then place their hands on their head. However, if the adult gives an action without saying 'Simon says' the children must not complete that action. If the child does, then the child is out. This game develops inhibition, shifting, working memory, monitoring, and emotional control.

Opposites (Stroop). The children are shown a picture from a deck that can have 'opposite' depictions. For example, if the child is shown a picture of 'the sun' the child is expected to say 'night' and when shown 'the moon' the child should respond 'day' (see Figure 1). They should respond as quickly as possible. This is an adapted version of Gerstadt and colleagues Stroop task (1994). This game focuses on inhibition, shifting, working memory, monitoring, and emotional control.

Musical freeze. For this game the instructor choses a pose from a variety of poses depicted by stickmen (for example, see Figure 2). With music playing, the child is instructed to assume the pose that is revealed as soon as the music stops. A new pose is then chosen

Table 1. Each of the EFs developed in the BBF programme. We provide the games that build each of these EFs and an example of how the EFs are built.

EF	Games	Example
Inhibition	Red light, green light; Simon says; Opposites; Musical freeze; Pretend play; Circle time with lips and ears; Shared project; Wait for it … ; Dimensional card sort; Model building	Simon says develops inhibition skills by challenging children to only move when the correct verbal instruction is given, and thus inhibit their response if 'Simon says' is not included in the instruction.
Shifting	Red light, green light; Simon says; Opposites; Pretend play; Shared project; Dimensional card sort	For the dimensional card sort, the children must shift between changing rules during the game in order to have success.
Working memory	Red light, green light; Simon says; Opposites; Musical freeze; Pretend play; Circle time with lips and ears; Shared project; Wait for it … ; Dimensional card sort; Model building	Working memory is developed in red light, green light by having the children be aware of how to execute the rules (move only on green light, stop on red light).
Planning	Pretend play; Shared project; Dimensional card sort; Model building	Model building helps to build planning skills as the children must plan what they are building before (or during) the completion of the model.
Emotional control	Red light, green light; Simon says; Opposites; Musical freeze; Pretend play; Circle time with lips and ears; Shared project; Wait for it … ; Dimensional card sort	Emotional control skills are built in the opposites task after the child makes a mistake. Specifically, having them understand how to react after making an error.
Monitoring	Red light, green light; Simon says; Opposites; Musical freeze; Pretend play; Circle time with lips and ears; Shared project; Wait for it … ; Dimensional card sort; Model building	Musical freeze requires monitoring as the children must watch what pose the instructor makes in order to correctly match it.
Organizing of materials	Shared project; Model building	Shared project requires the children to organize the materials that they need to accomplish their goal.
Initiation	Musical Freeze; Pretend play; Shared project	Initiation is developed in pretend play because the children must decide who is taking what role, and what they are accomplishing.

for the next musical interlude. For older children they must perform the pose correctly or else they will get counted out. The last person to perform the pose is also counted as out. The game can continue until there is a clear winner. This game works on a number of EF abilities including: inhibition, working memory, monitoring, emotional control, and initiation.

Pretend play. This game involves two children taking on a 'role' (e.g. doctor and patient). They should be encouraged to play in an unstructured manner, but some guidance may be

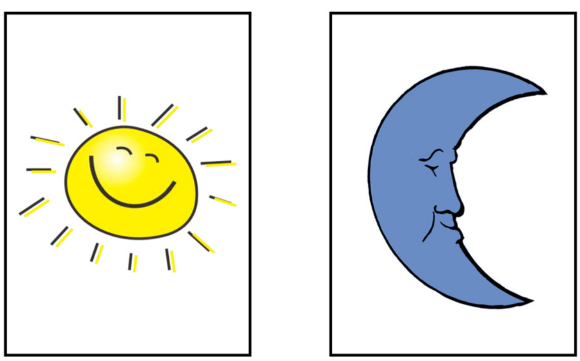

Figure 1. An example of the pictures the children would see in the Stroop game. If they were presented with the moon they should respond 'day.' If shown a sun they should respond 'night.'

needed at the start. The children should be encouraged to switch roles periodically. Pretend play encourages initiation, planning, inhibition, working memory, shifting, monitoring, emotional control and the organization of materials.

Circle time with lips and ears. Children receive either a picture of a pair of lips (indicates they are the speaker) or a picture of an ear (indicates they are the listeners). Only children with the lips are allowed to speak. Children then exchange the lips and ear. This game builds inhibition, working memory, monitoring, and emotional control skills. Emotional control is built in this activity, as the children cannot speak unless they have the lips, therefore they must control their emotions during the period when they have the ears.

Shared project. Children work in pairs to create either a picture or another form of constructive creation from assorted household materials (e.g. paper, boxes, tape). They are encouraged to decide what is to be created and how it will be done. They are encouraged to build their project together in an unstructured manner. This game builds inhibition, planning, initiation, organization of materials, working memory, shifting, monitoring, and emotional control skills.

Wait for it … . The instructor dispenses a tasty treat to all the children. The children are instructed to refrain from eating it until the instructor says they are allowed to do so. If they wait until the instruction is given to eat the treat, they receive a second treat. If they cannot wait for the instruction, they do not receive the second treat. This game builds inhibition, working memory, monitoring, and emotional control. Inhibition and emotional control are developed in this activity as they try to stop the urge to eat the treat until they are instructed to do so. This was adapted from Walter Mischel's famous marshmallow test (Mischel, Shoda, & Rodriguez, 1989).

Dimensional change card sort. The instructor shows the child a deck of cards that contain two dimensions: colour and shape. The instructor informs the child that the deck can be

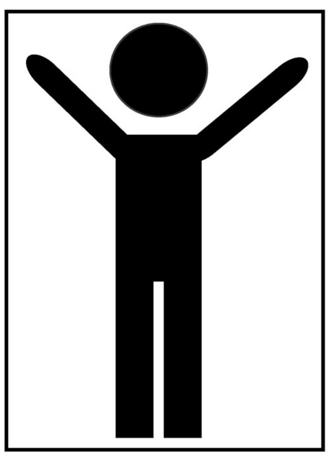

Figure 2. An example of one of the poses. If the instructor chose this pose, then when the music stops all the children must perform this pose as quickly as possible.

sorted according to either. They then work with the child to sort the cards into both possible dimensions (colour and shape), and eventually how to switch from one dimension to another. This activity builds shifting, inhibition, working memory, monitoring, plan/organize, and emotional control skills.

Model Building. The instructor places Lego® or Duplo® blocks on a table surface in front of the child. Also in front there is a pre-built model. The child is asked to recreate a model from the pieces that are evenly distributed on the left and right sides of the table. The instructor should encourage the child to use their preferred hand to reach out for the desired blocks to build the model regardless of where the blocks are on the table. The game will help build inhibition, planning, organization of materials, working memory, and monitoring skills.

Some of these activities (lips and ears, shared project) have been adapted from the tools of the mind programme (Bodrova & Leong, 2006), and the dimensional change card sort was adapted from Philip Zelazo's original protocol (Zelazo, 2006). In order to examine how effective the BBF curriculum was, children involved in the data analyses were tested twice in a pre- and post-programme design.

Pre- and post-testing. The parent/guardian of the children involved in the study completed the following three questionnaires both before and after the implementation of the curriculum (BBF group), or before and after a minimum of 6 weeks (no exposure to the curriculum; control group). Importantly, as these questionnaires are all standardized for age, any improvement in score is not as a result of the child being older at the time of the post-test.

ASQ. The Ages and Stages Questionnaire (ASQ) is a standardized tool of measuring development. It is comprised of five separate subscales (communication, gross motor skills, fine motor skills, adaptive problem solving, and personal-social skills). For every subscale, there are 6 questions (30 questions total). The questions are comprised of statements, for example: 'Does your child wash her hands using soap and water and dry off with a towel without help' and the parent must respond either yes, sometimes, or not yet.

The responses from each six questions are summed to calculate a score for each subscale. An answer of yes is worth 10 points, sometimes is worth 5, and not yet is scored as a 0. Higher scores indicate that the child is developing well.

ASQ:SE. This questionnaire is a specialized version of the ASQ, designed to specifically measure the social emotional (SE) development of the children (Squires, Bricker, & Twombly, 2002). It is comprised of 36 questions. For example: 'Can your child name a friend', or 'Does your child seem more active than other children his age.' Again, the parent has to mark if this is true most of the time, sometimes, or rarely/never. Each answer is accompanied by a letter Z, V, or X. Depending on the question a Z could correspond to never, or to true most of the time. A Z is worth 0 points, V is worth 5, and X is worth 10. In addition, the parent is required to mark if each question is an area of concern. If they do, an additional five points is added to the score. Here, a lower score indicates better development

BRIEF-P. The Behavioural Rating Inventory of Executive Function (BRIEF-P) was used as a way to measure EF abilities in the children. This questionnaire is comprised of 63 questions. Each question required the parent/guardian of the child to rate a behaviour on a scale of 1–3. A 1 would indicate that the behaviour had not been a problem, a 2 indicated that this was sometimes a problem, and a 3 indicated that this was often a problem in the last month. For a complete explanation of the BRIEF-P test see (Roth, Isquith, & Gioia, 2005). Each behaviour belonged to one of three subscales: Inhibitory Self-Control (ISCI), Flexibility (FI), and Emergent Metacognition (EMI). Inhibition and emotional control comprised the ISCI, shift and emotional control are part of FI, and working memory, plan/organize comprised the EMI. Summed together, the ISCI, FI, and EMI comprise the Global Executive Composite (GEC). Because these scores are highly intercorrelated (r values of our data range from .49-.96, all p values <.001), we decided to only use the GEC for analyses purposes. We chose the GEC as it is considered to measure the child's overall EF ability. Each GEC raw score collected were standardized for age using the BRIEF-P handbook (Roth et al., 2005).

Analyses

As our data were not normally distributed, we performed Wilcoxon tests to examine whether the scores on the ASQ, ASQ:SE and BRIEF-P were significantly different before (pre-test) and following the implementation of our curriculum (post-test). In order to investigate if any significant effect was a result of aging and not due to the BBF programme, we conducted separate analyses for the BBF group (received the programme) and the control group (did not receive the programme). We used each subscale of the ASQ (4), and the ASQ:SE (1), as dependent variables. For the BRIEF-P we analyzed the GEC standardized scores (1). The independent variable was programme exposure (pre and post). Alpha was set to $p < .05$.

Results

We conducted a preliminary 2(session (pre/post))×5 (site) mixed-design repeated-measures ANOVA in order to assess if there were differences in all variables measured across the sites. We found no difference between sites p's >.2.

ASQ

Control group: The children in the control group's scores on the communication portion of the ASQ significantly improved [N = 14, Z = 2.8, $p < .01$] from 48.2 ± 3.5 at the pre-test compared to 55.7 ± 1.7 at the post-test. There were no other significant effects.

BBF group: The children in the BBF group's scores on the communication portion of the ASQ significantly improved [N = 59, Z = 4.1, $p < .01$] from 47.1 ± 1.7 at the pre-test compared to 51.8 ± 1.4 at the pre-test. They also scored significantly higher on the problem solving measure of the ASQ [N = 60, Z = 2.6, $p = .05$], with their score improving from 48.9 ± 1.6 at the pre-test to 51.8 ± 1.4 at the post-test. Lastly, they scored significantly higher on the personal social ASQ measure [N = 59, Z = 3.5, $p < .01$] at the post-test (54.1 ± 1.3) compared to the pre-test (49.3 ± 1.6). See Figure 3.

ASQ: SE

For the following section, a lower score indicates superior performance.

Control group: There was no change in score between pre and post-test ($p = .42$).

BBF group: The children in the BBF group significantly improved on the ASQ: SE [N = 60, Z=−2.82, $p = .03$] from 52.1 ± 5.3 at the pre-test to 42.9 ± 5 at the post-test. See Figure 3.

BRIEF-P

For the following section, a lower score indicates that the children had better EF abilities.

Control group: There was no change in scores from pre-to post-test.

BBF group: There was a significant improvement [N = 35, Z=−2.3, $p = .02$] on the GEC scale of the BRIEF from 57.9 ± 1.8 at the pre-test to 55.3 ± 1.8 at the post-test. See Figure 4.

Discussion

The objective of this study was to evaluate the effectiveness of the BBF curriculum for improving EF in preschool-aged children. These executive functions consist of the mental processes that regulate behaviour which include: inhibition, shifting, cognitive flexibility, and working memory. The curriculum we implemented placed a heavy emphasis on these four behaviours. To test if this curriculum improved development and EF abilities, we asked the parents/guardians of the 72 children in our programme to complete three surveys (ASQ and ASQ:SE (development) and BRIEF-P (EF)) once before the implementation of the programme (pre-test), and again after a minimum six weeks of exposure to the curriculum (post-test; BBF group). We also had the parents of 14 children

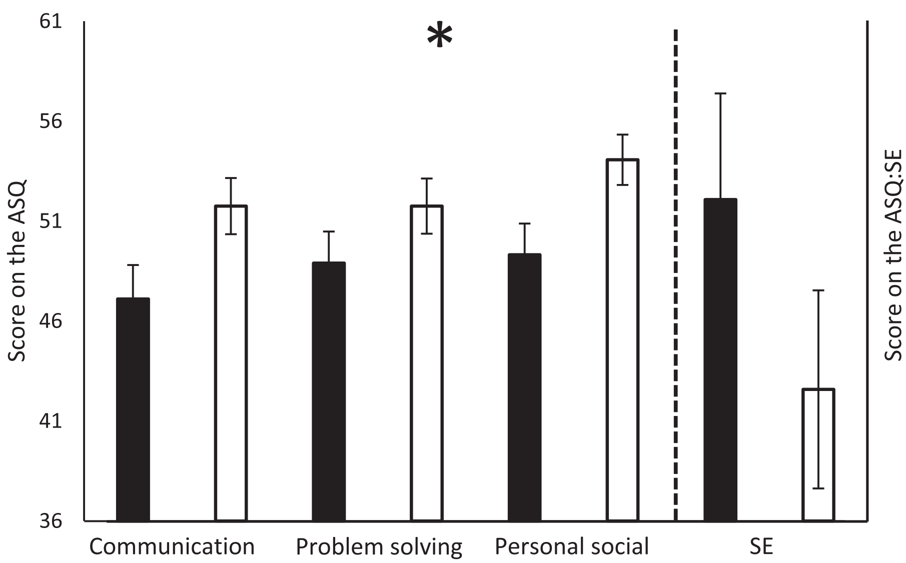

Figure 3. The significant changes on the ASQ. The pre-test is in black and the post-test is in white. Please note for the social emotional measure (ASQ:SE) a smaller score indicates better social emotional skills.

complete the questionnaires twice, with no exposure to the curriculum (control group). The parent's of the children in the control group were unaware that their children did not receive the BBF curriculum. We found significant improvements in various measures of all three questionnaires in the BBF group only. This suggests that the BBF curriculum can be implemented as a way to improve preschooler's development and EF.

As all these tests (ASQ, ASQ:SE, BRIEF-P) are standardized for the participant's age, the results cannot be attributed to the child being older at the post-test. In addition, the fact that the control group did not improve on the majority of measures, reinforces that the improvements in the BBF group are not due to age. Therefore, we propose that these improvements on the questionnaires are likely to be the result of engagement with the BBF curriculum itself. This is in line with previous studies that have shown that school-based programmes can improve child outcomes (Diamond, Barnett, Thomas, & Munro, 2007; Weiland & Yoshikawa, 2013). For example, one study evaluated an EF enhancing curriculum designed for preschool-aged children (Diamond et al., 2007). The authors found that compared to an alternative programme, that included the same academic content (but little emphasis on EF) the children in the EF programme outperformed their peers on measures of inhibitory control. This suggests that the nature and intent of an EF curriculum positively influences child development. Results from the current study show that the BBF curriculum increases EF abilities in pre-school children.

The ASQ is a questionnaire specifically designed to examine a child's development (Squires et al., 2002). Given that we found significant improvement in the BBF group on most domain of this questionnaire (communication, personal social, problem solving, and social emotional), it appears that our curriculum helps improve child

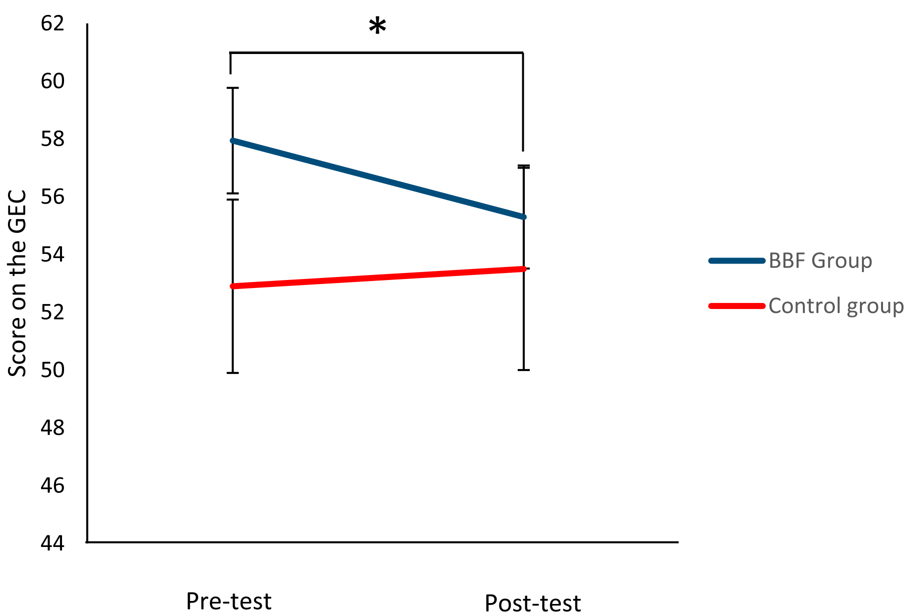

Figure 4. The change in scores for the BBF group (blue) and the control group (red) for the GEC measure of the BRIEF-P. While the BBF group significantly improved their scores at the post-test (lower score indicates superior performance), the control group's scores did not change.

development on the cognitive measures. The BBF curriculum places emphasis on activities that increase listening comprehension (wait for it), rapid naming of objects (e.g. opposites), narrative skills (e.g. circle time with lips and ears), and receptive vocabulary (e.g. dimensional change card sort). These are all skills that factor into communication. The increased emphasis on these skills may have led to better development in the communication subscale of the ASQ at the post-test. The children in the BBF group also showed improvement on the personal social subscale. These skills can be thought of as abilities that help the child tend to their personal needs (washing hands) as well as how to interact with others (play with friends). The BBF curriculum focuses on these skills by enhancing emotional control, listening, and monitoring. Some of the games that focus on increasing these skills include 'wait for it', and 'circle time with lips and ears.' The BBF curriculum also improved the children's problem solving skills at the post-test. Questions on the problem-solving subscale of the ASQ included: 'Does your child pretend play?' 'Does your child follow three different directions using the words 'Under' 'Between' and 'Middle'? These skills are fostered in the BBF programme through games such as: pretend play, musical freeze, and dimensional card sort. Lastly, the ASQ:SE is aimed at addressing social or emotional issues. Again, a lower score on this subscale indicates better SE ability. Of our ten games in the BBF curriculum, nine of them focused on improving emotional control. Previous research, has identified that social emotional curriculums can improve children's emotional knowledge in less than one year of preschool (Domitrovich, Cortes, & Greenberg, 2007). Domitrovich and colleagues (2007) evaluated a curriculum that focused on social emotional skills. Importantly, at the end of this study the parents rated their children as being more socially competent compared to their peers who were not involved in the programme. We found similar results in our study, even though we did not explicitly target social emotional skills in our programme, rather we incorporated these skills into the EF games. Overall, we believe that by emphasizing skills on which each of these subscales are built and by repeatedly practicing them, we significantly improved the children's developmental rating in the subscales.

It is important to note that the control group also improved on the communication subscale of the ASQ. Thus, the improvements on this subscale are not solely due to the BBF curriculum, but could also be a result of attending an early education centre (Huang, Invernizzi, & Drake, 2012). One might predict that attending these types of settings will improve communication skills. We recognize that the size of the control group is quite small ($n = 14$), and thus further research is needed to substantiate the contribution of the BBF programme for the developmental gains seen in the BBF group.

For the BRIEF-P questionnaire, we found that the GEC was significantly improved in the BBF group. The GEC takes into account scores on inhibition, emotional control, shifting, working memory and planning/organizing. Therefore, it is considered to be the measure of the child's overall EF ability. The finding that the GEC was improved following the BBF curriculum is in line with previous studies that have shown that in-school curriculums improve EF (Diamond et al., 2007; Raver et al., 2011). For example, Raver et al. (2011), demonstrated that 3–4 year old children (same age range as in our study) had better inhibitory control at the end of their programme. The Raver curriculum was focused on coaching the teacher on ways to manage children's behaviour and change the emotional climate of their classrooms. The authors found that the classrooms involved in the intervention showed enhancements in emotional climate. They argue that the improvements in inhibitory control observed in their study, were a result of the training the teachers received over the course of their programme and the teacher's effort to implement the programme daily (Chicago School Readiness Project). We attribute our results to the fact that repeatedly practicing EFs in the BBF curriculum, significantly improved these skills. Superior EFs (such as inhibition and working memory) result in academic and life success (Alloway & Alloway, 2010; Espy et al., 2004; Moffitt et al., 2011; Swanson & Sachse-Lee, 2001). Thus, by increasing EF ability in young children we could be setting up children for better academic performance and capability. An important factor for the BBF curriculum is that in contrast to other programmes,there is no cost associated with it and easy to implement in early childhood education facilities. Most of the research on working memory, for example, has used computerized training models (e.g. CogMed computerized working memory training (Klingberg et al., 2005; Thorell, Lindqvist, Bergman Nutley, Bohlin, & Klingberg, 2009)). As we found improvements in the GEC perhaps our curriculum is a more easily accessible, cheaper, and portable method to improve these skills.

We did not see improvements in all areas of the ASQ. Notably, we did not see increases in gross or fine motor ability. This could be because our programme targeted EF and not motor skills. In fact, the ASQ subscales we saw improvements in (communication, personal social, problem solving, and social emotional) are all targeted in the umbrella of EF. Therefore, we likely only saw improvements in the EFs that we emphasized in the curriculum. Other studies have found similar results (Domitrovich et al., 2007; Thorell et al., 2009). For example, Domitrovich and colleagues (2007) used a modified Stroop (opposites) task and found no improvement in inhibition after they implemented their extended curriculum. They attributed this finding to their curriculum not placing enough emphasis on building inhibitory control. Thus, in future modifications of the BBF curriculum should consider adding games that place a heavier emphasis on motor abilities, which did not significantly improve.

Lastly, it should be noted that while the BBF group improved on various measures of the questionnaires (ASQ, ASQ:SE, BRIEF-P) on which the control group did not; we did not find differences in EF ability between the sites in our repeated-measures analysis. This implies that even though some sites used the curriculum more than others, there were no differences in the amount of improvement. Notably, Site C joined the programme late, and therefore the children in this site were only exposed to the programme for 6-weeks. As we saw the same improvement in this site like all the rest, it indicates that 6-weeks in the BBF curriculum is enough time to induce changes in the children's abilities. We argue that this is due to the nature of the relationship between teacher and student during the implementation of the BBF programme. Perhaps, the quality of teaching results in improvement regardless of the amount of time spent in the programme. Future studies should investigate how much time spent on the curriculum is necessary to induce changes in the children's abilities. In addition, future research should investigate how much of a change in each of the questionnaires results in clinical changes in the children's behaviour. Regardless of these limitations, any improvement in this population should be regarded as positive.

To conclude, we implemented a BBF curriculum that emphasized the development of EF abilities in pre-school educational settings. The BBF curriculum was based on fun, fast, and easy to play games (for example 'Simon says' and 'red light green light'). The results from this preliminary study, support the use of the BBF curriculum as a way to enhance EF and development in preschool-aged children. This is important because improved EF in children could result in reduced need for special education, decreased antisocial behaviour, and EF disorder diagnoses (Diamond et al., 2007). It is therefore important for both teachers and parents/guardians to be trained in EF ability. In addition, research has shown that children with higher EF abilities in the early years are more successful in school, less likely to commit crime, and more likely to achieve career success (Moffitt et al., 2011). It is, therefore, vital that we find ways to improve EF skills in young children. We propose that the BBF curriculum is one of the avenues through which EFs can be fostered.

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