Game-Based Selective Attention Intervention

Effect of Blink on Selective Attention for Street Youth in Zambia

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Abstract

The following study was conducted to evaluate the effect of a game-based intervention in the form of a card game, Blink, on selective attention for a sample of street youth in Zambia, Africa. Based on previous research suggesting that selective attention and executive functioning may be modified by game-based interventions in various populations and contexts, this study sought to employ a card game intervention for selective attention. The study was conducted with a repeated measures design, with a paired sample within-groups *t*-test adapted from the TEA-Ch Sky Search measure of selective attention, and the card game Blink as a selective attention intervention. The participants ($n = 8$) showed a significant increase in selective attention skills after playing Blink for a duration of roughly two weeks $t(7) = -3.135$, $p = 0.016$, $d = 1.11$, supporting the research hypothesis that a game-based intervention can be a useful tool for improving selective attention. The implication of the study was that it may be feasible to implement further educational and cognitive interventions for the target population through cost-effective game-based interventions.

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Game-Based Selective Attention Intervention: Effect of Blink on Selective Attention for Street Youth in Zambia

Although there has been a recent surge in the amount of psychological research being conducted in non-Western contexts, little research has been found on executive functioning in non-Western cultures, particularly in Africa (Nampijja, et al., 2010). The current study sought to fill that gap through an exploratory study on a specific cognitive construct for a target population of street youth in Zambia. As no previous research has been conducted with this population in an empirical study, the current research attempted to lay a foundation by implementing a selective attention intervention for the sample of street children. The focus was on improving selective attention through a game-based intervention in the form of the card game Blink. The study has implications for further research in the area of cognitive interventions for Zambian street youth.

Literature Review

There has been varied and extensive research in the field of selective attention, and the current review seeks to focus on typical and atypical development of selective attention. This evaluation will also explore the relationship between selective attention and academic achievement, as well as demographic factors that affect selective attention, such as cultural background and socioeconomic status. Specific cultural considerations of the Zambian street youth as they are relevant to selective attention are also addressed. The review of the literature concludes with a discussion on previous interventions for selective attention, as well as game-based interventions for other areas of executive functioning.

Selective Attention

Typical development of selective attention. The development of selective attention is a normative part of child development that has garnered considerable research over the past few decades, especially in the Western world. Selective attention is a theoretical construct of neurological functioning delineated as a part of overall attention, and a vast amount of research has been conducted to understand the developmental path of selective attention throughout the lifespan. Selective attention is a specific construct within executive functioning in the prefrontal cortex, which is essentially the ability of numerous processes in the brain to unite in order to accomplish purposeful, goal-directed behavior (Anderson, 2002; Anderson, et al., 2001). Researchers have come to an approximate understanding of four major domains within executive function: attentional control (including selective attention), cognitive flexibility, goal setting, and information processing (Anderson, 2002). Selective attention is defined as the "ability to focus on relevant information while ignoring distractors" (Stevens, et al., 2013, p. 74). The specific region where attention occurs in the brain is in the prefrontal cortex, which has been discovered to be responsible for goal-directed behavior in general (Anderson, et al., 2001; Akshoomoff, 2002; Farah, et al., 2006). An aspect of prefrontal functioning highly related to selective attention is working memory, the function that maintains information gained from selectively attending to relevant stimuli for a short time for subsequent use (Mishra, Bavalier, & Gazzaley, 2012).

The developmental track of selective attention follows the same basic pattern as executive functioning, although the most significant periods of growth occur at different times. In general, executive function appears in infancy and enjoys its most rapid

development through early and late childhood, while attentional control develops rapidly in early childhood and is fully developed by ages 7 to 9 (Anderson, 2002; Dye & Bavalier, 2009). The specific developmental trajectory of selective attention has also gathered considerable research attention. The definition mentioned above (Stevens, et al., 2013) presents the contemporary understanding of selective attention. The very idea of selective attention as a neurological function suggests that the brain carries a limited capacity for information processing, forcing the mind to flexibly allocate attention only towards important stimuli (Lane & Pearson, 1982; Plude, Enns, & Brodeur, 1994). The working theory is that children's brains are less flexible and that they have more trouble inhibiting their responses to irrelevant stimuli (Lane & Pearson, 1982). Supporting this theory, the study done by Lane and Pearson (1982) found that younger children were less able to ignore irrelevant stimuli based on dimensions, and they had a harder time classifying the stimuli by dimension than the adults in the study. Their research also established that children were more susceptible to incidental learning – remembering of irrelevant stimuli – than adolescents and adults, hypothetically due to their lower levels of selectivity (Lane & Pearson, 1982).

Atypical development of selective attention. Extensive research on selective attention has been conducted over the past few decades, but few causal relationships have been delineated for typical and atypical development. However, correlational links between selective attention skills and developmental problems and academic achievement have been recognized. For children and adolescents aged 7 to 15, Anderson (2002) found a relationship between selective attention deficits and other developmental problems, such as impulsivity, lack of self-control, failure to complete tasks, and

committing procedural mistakes. Deficiencies in selective attention are rarely isolated from other developmental problems, and common comorbid developmental disabilities include autism spectrum disorder (ASD), attention-deficit hyperactivity disorder (ADHD), and learning disabilities (Keehn, Muller, & Townsend, 2012; Stevens, et al., 2013; Tamm, 2012). Considerable attention is given to selective attention deficiencies in the realm of ADHD, as children with ADHD have a tendency for difficulties in alternating attention, selective attention, sustained attention, and divided attention (Tamm, 2012). Much research regarding attention interventions is associated with studies on ADHD, due to the belief that improving attention abilities through cognitive training interventions may improve ADHD symptoms (Heaton, et al., 2001; Klinberg, et al., 2005; Pagenstecher, 2010; Tamm, 2012). Another common comorbid problem often linked with deficits in selective attention is reading disability. Keehn, Muller, and Townsend (2012) and Stevens, et al. (2013) both discovered a link between deficiency in selective attention, impairment in language development, and reading disabilities. Evidence exists that deficits in selective attention can lead to further problems in school-related settings, including difficulties in responding to instructions and reading capability (Stevens, et al., 2013).

Selective attention and academic achievement. Accordingly, many studies have linked early selective attention skills with subsequent academic achievement. A meta-analysis of six longitudinal studies conducted by Duncan, et al. (2007) revealed that the strongest predictors of later academic achievement were school-entry math, literacy, and attention skills, while internalizing and externalizing problems and social skills were not significant predictors of academic achievement. Another study reported that higher

attention skills in kindergarten were significantly correlated with higher engagement trajectories in the classroom in a longitudinal study from first through sixth grade (Pagani, Fitzpatrick, & Parent, 2012). Overall executive functioning has also been shown to impact academic achievement. A cross-cultural research study discovered that various executive functioning skills were predictive of future academic achievement in samples of both Chinese and American preschoolers (Lan, Legare, Ponitz, Li, & Morrison, 2011). While working memory was the strongest predictor of academic achievement, selective attention was the most significant predictor for literacy skills in both China and the United States, and attentional control was important in all aspects of achievement (Lan, et al., 2011). In another study, Kishiyama, Boyce, Jimenez, Perry, and Knight (2008) reported that 28 children with low prefrontal functioning in selective attention scored lower on academic achievement and intelligence tests.

Finally, in an attempt to ascertain the particular relevance of selective attention allocation in academic performance, Willner, Gatzke-Kopp, Bierman, Greenberg, and Segalowitz (2015) employed a neurophysiological measure of selective attention in a sample of low socioeconomic status (SES) kindergartners. The researchers discovered that higher selective attention scores were a strong predictor of adaptive learning-related behaviors and later academic achievement, especially in the areas of math and literacy (Willner, et al., 2015). Lower attention skills were a marker for learning disabilities, and were more strongly related to future achievement than externalizing behavior problems and social skills, just as Duncan, et al., (2007) indicated.

Demographic considerations in selective attention. Varied demographic contexts may afford differences in selective attention skills as well, and this discussion

will focus on the potential mediating factors of cultural background and socioeconomic status. According to the literature, cultural background does not appear to have a major impact on the developmental track of selective attention without the presence of additional mediating variables. A study conducted by Diaz, et al., (2013) tested almost 600 Brazilian children aged 6 through 14 in order to ascertain whether any significant differences were present between Brazilians and other nationalities in executive functioning. Similar to other findings previously mentioned, there was a trend toward better performance as age increased in every single test, including selective attention, and performance became more stable at ages 11 to 12 (Diaz, et al., 2013). These findings are similar to results in Finland, Sweden, the Netherlands, Mexico, and the United States (Diaz, et al., 2013). Studies on selective attention have also been conducted across continents in Australia, China, the United States, Uganda, and Indonesia that yielded only small differences in selective attention scores amongst the various countries (Heaton, et al., 2001; Manly, et al., 2001; Nampijja, et al., 2010; Nokes, 1999; Pagenstecher, 2010; Sakti, et al., 1999). Each study used the Test of Everday Attention for Children (TEA-Ch) measure of selective attention originally piloted by Manly, et al., (2001) and made minor modifications based on cultural variables. The TEA-Ch test requires participants to locate target images amongst distractor images, with scores based on how many of the target images they were able to locate correctly (Manly, et al., 2001).

However, while the developmental trajectory of selective attention is similar across cultures, the way in which cognitive ability is displayed in school-related tasks (e.g., categorical structure of recall) may differ based on language, socioeconomic status, ethnicity, local literacy skills, education, and access to technology (Nampijja, et al.,

2010). Specifically, a study done by Diaz, et al. (2013), showed that the variable of SES may mediate the relationship between cultural context and selective attention test scores – in other words, when there is a lower SES, selective attention scores tend to be lower. Mezzacappa (2004) researched the specific correlation of SES to alerting, orienting, and executive attention in a large sample of urban children in Chicago ranging from 4 to 7 years old, and found that children of a lower SES displayed slower reaction times and significant differences in each attention test as compared to children of a higher SES. A research effort conducted by Lipina, et al. (2013) investigated the effect of poverty on executive functioning for children 4 to 6 years old of different levels of socioeconomic status in Argentina. It was shown that children of a lower SES displayed lower efficacy in the specific realms of selective attention and working memory as a part of their prefrontal executive functioning (Lipina, et al., 2013). In the research by Duncan, et al. (2007), low SES predicted lower attention skills, which in turn predicted lower achievement. The findings allowed the researchers to conclude that there is justification for targeting interventions at children's attention skills in order to promote academic achievement for populations with traditionally low socioeconomic status. This implication gives credence to the current study in implementing a selective attention intervention for a sample of Zambian street youth in poverty.

Disparities in socioeconomic conditions have also been shown to impact prefrontal functioning in a study conducted with children aged 7 to 12 in San Francisco (Kishiyama, et al., 2008). Using electrophysiological evidence, the researchers discovered that lower SES children were impaired in executive attention skills, working memory, and cognitive flexibility compared to higher SES children at a level comparable

to patients with lateral prefrontal cortex damage. The researchers concluded that it may be helpful to target specific prefrontal processes, such as attention, for interventions with children of low SES (Kishiyama, et al., 2008), comparable to conclusions mentioned previously from Willner, et al. (2015).

Another study focused on the larger construct of neurocognitive development, and attempted to understand its relationship to childhood poverty. It was found that growing up in poverty was associated with reduced cognitive achievement (Farah, et al., 2006). The researchers conducted a battery of tests among 60 kindergarten students of both middle and low SES, and located significant differences in neurocognitive systems associated with the prefrontal cortex and executive functioning, which go through extensive post-natal development and are subject to environmental impact (Farah, et al., 2006). The study showed significant disparities among low SES children in the executive functioning domains of working memory, cognitive control, language, and memory. Working memory and cognitive control are closely linked to selective attention in executive functioning (Kishiyama, et al., 2008; Klingberg, et al., 2005; Lipina, et al., 2013; Mishra, Bavelier, & Gazzaley, 2012).

It was previously contended that attention and language deficiencies are linked (Farah, et al., 2006; Keehn, Muller, & Townsend, 2012; Stevens, et al., 2013). The study done by Stevens, et al. (2013) found that children at risk for reading disabilities who had selective attention deficiencies were commonly from low SES contexts. The literature reviewed shows that selective attention ability does not significantly differ in various cultures in regards to typical development or cultural background, but the factors of socioeconomic status and poverty are strong mediating factors most closely associated

with deficiencies in selective attention. Selective attention is an aspect of executive functioning that is susceptible to environmental stressors, and this is why it was a relevant target construct for the sample of Zambian street youth of this study, who were suffering widespread poverty.

Cultural Considerations of Zambian Street Children

The population in consideration for this study – youth living primarily on the streets of a large city in Zambia, Africa – raises many specific concerns that may not apply to other populations of school-age children. While most children in developed countries are assumed to have regular access to food, shelter, and support of a guardian who will ensure school attendance, these basic needs are not met for the population of street children in this study. Therefore, it is necessary to explore the specific cultural and demographic considerations of Zambian youth in order to understand how a Western measure and intervention may be adapted to appropriately meet their particular needs in street life and education. Common difficulties faced by the children relevant to this study include deep poverty, orphanhood, and lack of access to schooling. The target population of this study consisted of Zambian street children who were mostly orphans in poverty who were not attending school.

Zambia's economy has been focused almost entirely on copper mining, but it endured a major decline in copper prices in the mid-1970s, and the economy has continued on a downward trajectory since this time (Mwansa, Mufune, & Osei-Hwedie, 1994). As of 2008, the unemployment rate was 68.6 percent, yet only 11 percent of those considered employed were formally employed (Labour Force Survey Report, 2008). The Zambian population is extremely young, with approximately 66 percent of its population

under the age of 25 years old (Mwansa, et al., 1994). As with many other African countries, Zambia suffers from the HIV/AIDS epidemic, and it is estimated that 1 in 5 Zambian adults is affected with HIV/AIDS (Robson & Sylvester, 2007). HIV is the main culprit for the high number of orphans in Zambia, with the current number of orphans estimated at 1.4 million, 10 percent of its population of 14 million citizens (UNICEF, 2013). These societal issues of unemployment and the HIV/AIDS epidemic indirectly but drastically affect the number of children living on the streets.

It is estimated that over 75,000 children currently live on the streets in Zambia, a statistic mostly comprised of male orphans and children from poor communites who never completed primary school and who typically practice extensive drug use and participate in frequent sexual activity (Kelly, 2000; Robson & Sylvester, 2007). An assessment of street children in the city where the current study was completed was conducted by Project Concern International Zambia in collaboration with a collection of nongovernmental organizations (NGOs) working with street children in order to understand their living conditions and greatest needs (Lemba, 2002). One thousand, two hundred and thirty-two children between the ages of 4-18 were interviewed, although 60 percent of them were between the ages of 12 to 16 years old. Over half of them were either single or double orphans. The majority of the children originally lived in the low-income compounds before moving to the streets, and over 90 percent had caregivers who were unemployed. The top listed reasons for living on the streets included poverty, financial needs, family problems, and mistreatment by caregivers (Lemba, 2002). Almost 50 percent of the children said that making money was their main reason for remaining on the streets.

In regard to education, over three-quarters of the children were no longer attending school, and the majority of those who were attended community schools, which are schools run by volunteer community members rather than the government (Lemba, 2002; Mumba, 2002). The average grade reached by the children before dropping out was grade 4. Thirty-six percent of the participants had never attended school at all, and 9 out of 10 children said school fees were the main reason they were not going to school. When the children were asked what they wanted the most help with, over 70 percent asked for education (Lemba, 2002). It was reported in another study on Zambian education that primary reasons for not attending school were poverty, long distances, a low parental and societal value placed on education, and the unaffordable school fees (Mumba, 2002). While these findings are important for Zambian children in general, the situation is worse for street children, who have even less access to school than populations of higher SES in Zambia (Lemba, 2002). This is the situation faced by the street children of Zambia, and the country is in a state of economic ruin to the point that few resources are available for helping these street children, aside from the private non-profit centers located around the country (Lemba, 2002; Mwansa, et al., 1994).

As the earlier discussion on the relationship between poverty, selective attention, and academic achievement made clear, poverty is a significant mediating factor between selective attention deficits and academic achievement, and early selective attention skills are highly predictive of future academic achievement. With this in mind, it is necessary to understand how the orphan status of Zambian street youth may affect both selective attention skills and academic achievement. Children without parents are less likely to attend school, with only 65 percent attending in 2000, compared to 78 percent of children

with parents (Kelly, 2000). Orphans who do enroll in school are characterized by low attendance and an increase in discrimination and stigmatization, increasing their school-related anxiety. Orphans are also likely to need to financially provide for themselves and take care of their families, giving them a reason for dropping out of school to make money on the streets (Kelly, 2000). Overall, orphans in poverty in Zambia are more likely to live on the streets, which impacts their school attendance and achievement. However, no previous studies have directly examined selective attention deficits of Zambian street youth, so the current study is presupposing generalization of the significant links between poverty and selective attention deficits as a basis for implementing a selective attention intervention for this sample population.

Selective Attention Interventions

The present study sought to employ a game-based intervention for selective attention with the sample of Zambian street youth, although the literature is sparse and inconclusive in this domain. However, this review will highlight interventions on selective attention, as well as game-based interventions for executive functioning in the constructs of working memory and selective attention. Many attempts have been made at improving selective attention capability for children through interventions. Discussed here are interventions that focused on improving selective attention for children at risk for reading disabilities and children with ADHD (Klingberg, et al., 2005; Stevens, et al., 2013; Tamm, Epstein, Peugh, Nakonezny, & Hughes, 2013). The study conducted by Tamm, et al. (2013) sought to understand whether practice and training for attention would improve attention efficiency for a sample of 132 children with ADHD ages 7 to 15. They used the “Pay Attention!” curriculum and saw improvements in divided,

sustained, alternating, and selective attention, including improvements in speed and efficiency when compared to the control group. Researchers also saw improvements in ADHD symptoms generally (Tamm, et al., 2013). The research conducted by Klingberg, et al. (2005) saw that a working memory training for 53 children aged 7 to 12 years old with ADHD experienced favorable results, with a significant treatment effect compared to the control group in verbal working memory, response inhibition, and complex reasoning, and parental reports of reductions in inattention symptoms.

Due to the comorbid prevalence of deficiencies in selective attention and reading ability, another study was conducted by Stevens et al. (2013), who administered a reading intervention focusing on early reading skills for kindergartners at risk for reading disabilities in order to determine if the intervention could also improve selective attention. Researchers administered pre and posttests for both selective attention and reading skills, and the results showed that the at-risk group caught up to the on-target group in both selective attention and reading after only one semester of the reading intervention. These children were mostly from a lower socioeconomic status, and the study provided evidence for the practicality of an early intervention in elasticity and improvement in selective attention for children of low socioeconomic status (Stevens, et al., 2013).

Impact of video games on executive functioning. While little research exists that investigates the impact of non-digital games such as card and board games on executive function and selective attention, the literature reveals a plethora of information regarding the impact of playing action video games on attention. A review of literature on game-based trainings completed by Mishra, Bavalier, and Gazzaley (2012) revealed that

habitual action videogame participation improved performance in spatial, temporal, object-based, and sustained attention skills, notably in the spatial selection of targets among distractors in adolescents and young adults. Their research also showed that videogame players had higher working memory scores than non-videogame players, and game-based visual perception training improved working memory as well (Mishra, et al., 2012).

Another study conducted by Dye and Bavalier (2009) found that from ages 7-22, participants who played videogames had higher scores on all attention tests, and they also had higher functioning in the spatial attention skill of allocationg attention across a field to search for a target. There was no significant difference due to age, but videogame playing had a substantial main effect on improving selective visual attention (Dye & Bavalier, 2009). Research conducted in 2003 by Green and Bavalier (2003) strengthens these findings with more evidence that visual spatial attention improved with habitual video game playing, and a controlled videogame training also showed improvement on the part of 16 non-gamers aged 18 to 23 from pre-training to post-training abilities. These findings at the least provide evidence that visual selective attention skills and ability to search for relevant targets may be improved through playing active games that challenge the visual field of attention, providing justification for employing a game-based intervention for selective attention.

Game-based interventions. Most game-based interventions in the literature focus on computer-based trainings in classrooms or computer games to improve overall cognition. A few studies that used videogame training interventions to improve executive functioning have already been mentioned (Dye & Bavalier, 2003; Green & Bavalier,

2009; Mishra, et al., 2012). One study that focused on the use of game-based interventions to improve academic achievement was conducted by Freitas (2006), which centered on the benefits of computer games and simulations in supporting learning initiatives as observed by adult professionals in education fields. An observation from the study was that game-based learning is grounded on the assumption that learning can be generalized to other real-life contexts, making skills learned in games adaptable and useful (Freitas, 2006). Games give access to learners with low literacy levels or other low skill levels, and they are potentially useful in improving specific target skills such as literacy, numerical skills, and executive functioning (Freitas, 2006).

Another computer-based game intervention focused on math achievement for a sample of 437 middle schoolers and tested a mathematical instructional game (Bai, Pan, Hirumi, & Kebritchi, 2012). Researchers employed a pre and posttest in order to test for improvement in math skills as a result of the game, and found that the math game improved knowledge acquisition and maintained students' motivation to learn compared to the control group. The conclusion of the study was that the game was a more effective teaching tool because games pique interest of students and give a clear purpose and goals to meet, using the constructs of arousal, direction, and persistence to increase motivation (Bai, et al., 2012). A study by Scott (2013) indicated that using games in conjunction with normal teaching may help achieve learning goals because such games give the ability to cater to individual needs of students when one-on-one instruction is not feasible.

Another study examined how games may be used to improve educational outcomes of children in low-income rural communities in India. The researchers provided

210 children aged 6 to 14 with mobile learning technology games, and found that even without previous technology exposure, the children quickly learned how to play the games and excelled at the increasingly difficult tasks in the mobile learning games (Kim, et al., 2012). It was postulated that the presence of play created opportunities for learning without the requirement of adults to teach the children, encouraging active problem solving and facilitating rapid learning (Kim, et al., 2012). These findings suggest that games may be used to teach low-income children with little access to schooling or technology with great hopes for success.

Finally, two studies employed non-computer based interventions, using both board games and card games for their learning interventions. Whyte and Bull (2008) examined the effects of three different number board games on number skills of a sample of 45 preschoolers. They gave a pretest, conducted four intervention sessions with the games, then gave a posttest which displayed that the linear number board game significantly improved performance in each of the posttest dimensions, including counting ability, number comprehension, and numerical estimation (Whyte & Bull, 2008).

Likewise, Bendixen-Noe (2010) conducted a study which examined elementary school teachers and students' perceptions of board and card games relevant to learning outcomes after they were implemented into the classroom over a school year. It was shown that students were more enthusiastic about learning, and they were able to delve deeper into the reading and mathematics material through use of the games (Bendixen-Noe, 2010). Card games had benefits of not only improving academic achievement, but also in challenging critical thinking and problem solving, encouraging social interaction

and collaboration, and developing strategy. It was concluded that games are an effective method for fostering motivation and helping students learn in a more dynamic manner (Bendixen-Noe, 2010).

Overall, games have had a positive impact on learning and achievement, whether in the form of computer-based or card games, and in both structured and unstructured classroom settings. They are a cost-effective and engaging method that does not require intensive teacher training or resources. This overview displayed the current literature on common selective attention interventions and non-computerized game-based interventions. However, no literature was discovered that directly evaluated the benefits of using a non-computerized game-based intervention on selective attention.

Current Study

The current study sought to be an exploratory study into the arena of selective attention game-based interventions for street youth in Zambia, Africa. To the best knowledge of the researcher, no current research has been conducted in this specific area, and interventions for Zambian street youth are greatly needed. As the literature review displayed, there is currently a high rate of poverty and lack of access to schooling for street children in Zambia, problematic because low socioeconomic status is related to deficiencies in selective attention. Early levels of selective attention are predictive of future academic achievement, so the prevalence of poverty and subsequent issues in the attentional control domain of executive functioning are increasingly problematic for academic outcomes in this population. Essentially, it is determined that there are significant relationships between poverty, selective attention, and academic achievement.

The literature also shows that selective attention is a dynamic construct that may improve upon varying types of interventions without age as a significant factor. However, it is not known whether selective attention may be improved for a population of Zambian street children with similar success as in other interventions in more developed contexts. Exploring the feasibility of a selective attention intervention for street children may give credence to the implementation of further cognitive interventions with similar populations. Willner, et al. (2015) and Kishiyama, et al. (2008) established that because higher selective attention predicted academic achievement, it is justified in implementing attention interventions for low SES populations for the sake of improving academic outcomes. The current study sought to fulfill that request by implementing this selective attention intervention with the population of Zambian street youth who have grown up in poverty.

There is also a considerable lack of research on non-computerized game-based interventions, as most studies have the resources to employ more efficient and adaptable computer simulations. Therefore, little attention is given to board and card games as interventions in any context, much less in a developing nation. While it is known that videogame-based interventions are effective in improving selective attention, and non-computerized games are useful for academic instruction, there is a gap in the research in how card games may be used specifically for selective attention. As a result of preexisting research and the gaps in literature presented, the present study will implement a game-based intervention in the form of the card game Blink, in order to ascertain its effect on selective attention for Zambian street youth. This study seeks to answer the research question: Will selective attention scores improve after an intervention in the

form of the card game Blink for a sample of Zambian street youth? It is hypothesized that the selective attention scores of the sample will significantly improve from the pretest to the posttest.

Method

Design

The current study sought to assess the improvement of selective attention skills through a game-based intervention called Blink and tested selective attention with a repeated measures design. Selective attention was operationalized as the participants' ability to selectively locate and circle the target fruits amidst distractor fruits on the testing measure. Although the hope was to have both an experimental and control group, the small sample of children who continued attending the center for the duration of the study and took both the pre and posttests necessitated a within-subjects design instead. A game-based intervention was selected because it required few resources and fit well with the flexible and fluid schedule of the drop-in center that served the target population.

Participants

The target population for this study was children between the ages of 10 to 18 who were currently living on the streets of a large city in Zambia. The sample population was selected as a convenience sample, with participants being those who regularly attended a drop-in center for street youth where the study took place. While 25 of the youth took the pretest and began playing the game, only 8 participants remained at the center long enough to take the posttest at the end of the two-week intervention period. Of those who took both tests, there were 7 males and 1 female, due to the lack of females who attended the center during the study. The age range was 10 through 16, with a mean

age of 13.5 years old (*SD* = 1.77). The majority of the children were illiterate, although a few had attended school earlier in their lives. None of the participants were attending school at the time of the study.

Procedure

After receiving approval for the study from the IRB, the group of 25 original participants were recruited by volunteers at the center and began attending the center. Each participant spent roughly seven hours at the center each day, coming off the street for the daytime hours then going out again at night. During their time at the center, the street children were given the opportunity to bathe, wash their clothes, play games during free time and receive two hot meals. They were also required to do chores around the center, follow a set of center rules, and attend counseling, teaching, and dramatic arts groups, depending on which volunteers were available to provide the activities at the center each day.

The Picture Search pretest was administered to each participant on their first day at the center. The researcher explained the instructions through a translator present at the center while materials were handed out to the children by volunteers. The participants were instructed not to flip over their paper to view the fruit until the researcher instructed them. They all began at the same time, and at the end of fifteen seconds were instructed to put their writing implements down. Volunteers assisted in collecting the tests and ensuring that the children did not circle any more fruit after the time limit was up. Scoring was determined by creating a percentage of the number of fruits correctly circled as compared to the total number of target fruits amongst the distractors on the measure. The high scores could range from 18 to 23 target fruits, with a proportion from a low of 0

correct to a high score of 18 to 23 correct. The proportions were then converted into percentages, with percentages as the dependent variable, for the sake of easily displaying and interpreting the data.

Blink was then introduced to the participants, with the researcher teaching them the game in small groups of two or three during their free time each day. The game was played at their leisure throughout the following two weeks of the intervention period during free times at the center, although the researcher and volunteers encouraged game play as much as possible. Due to the nature of available resources and the difference in children's willingness to play the game frequently, a few participants may have played the game more than others. However, the approximate amount of time played each day was about 15 to 30 minutes during the children's free time. At the end of the intervention period, roughly two weeks, a posttest was administered to the willing participants who had remained at the center since the beginning of the study. Posttests with different target fruits than each individual's pretest were administered with the goal of preventing possible practice effects. A proportion and percentage was again calculated for the correct number of fruits selected in the posttest.

Materials

Materials needed for the study involved the card game Blink, sheets of paper with the pre and posttests on them, and writing implements in order to take the tests. A game-based intervention was sought that would stretch the cognitive flexibility of the sample in the specific realm of selective attention, while being both culturally relevant and literacy-free. Blink was chosen for multiple reasons, but especially for its culturally-adaptable interface – the cards employ different colors and shapes in various quantities, with no

words and no culturally-specific images. Blink is a speed-based game with either 2 or 3 players at a time, with the goal of being the first player to run out of all his/her cards. Once the game begins, a player may flip over three cards in his/her hand at a time in order to match his/her cards with the discard pile, with the cards needing to match in either number, color, or type of shape (e.g., one could match a card with three green stars with a card with 2 brown stars, matched by its star shape). Whoever is able to run out of all the cards in his/her hand first will win Blink. Blink was recommended by the Harvard University Center on the Developing Child (2013) as a useful tool for children in improving executive functioning, which gave the researcher reason to believe it was a viable option targeting selective attention for the current study.

Measure

The measure used to test selective attention was adapted from a well-validated measure of selective attention in the Test of Everyday Attention for Children (TEA-Ch) called Sky Search (Manly, et al., 2001). The original study, conducted in Australia, gave children a sheet of paper with pairs of spacecraft and asked them to find the 20 paired spacecraft among over a hundred distractors. The participants' speed and accuracy were assessed. The convergent validity of the test was determined by the finding that Sky Search was significantly correlated with other selective attention tests, and the measure was not linked to IQ scores, showing that it did not measure general cognitive ability (Manly, et al., 2001). The measure was used in other replications of a selective attention study in many different contexts, including in China (Nokes, 1999), Indonesia (Sakti, et al., 1999), the United States (Heaton, et al., 2001), and Uganda (Nampijja, et al., 2010).

The adaptation of Sky Search conducted in Uganda was of particular interest to this study, as it was the most culturally-relevant study to the target population in Zambia. Similar to Zambia, Ugandan school enrollment is less regulated than in Western contexts, and many children do not attend school, so the study done by Nampijja, et al. (2010) adapted the TEA-Ch measures to be culturally-relevant cognitive tests. They adapted Sky Search based on differences from participants of the original test in language, testing experience, widespread poverty, and the lack of access to modern technology. The new version was called Picture Search, and the participants were given 10 seconds to locate as many target pictures as possible which matched the image in the top left-hand corner (Nampijja, et al., 2010). The results of the study suggested that it was a suitable adapted measure of selective attention for similar populations, signifying that it should be generalizable to the street youth in Zambia. The Picture Search measures selective attention effectively because it causes participants to focus on relevant stimuli while inhibiting attention to irrelevant stimuli (Nampijja, et al., 2010; Lane & Pearson, 1982). Picture Search was also deemed appropriate for the scope of this study due to its game-like nature, which links it well with the game-based intervention.

The current measure was designed with nine different types of fruit randomly arranged in rows on a page, with one target fruit in the top left corner. Nine templates of the measure were created, each with a different target fruit in the corner. This was done so that the posttest would have a different fruit from the pretest for each participant, in order to control for practice effect. A total of 180 fruit were placed on the page, and possible scores depended on how many target and distractor fruits were among the 180

fruits on the page. The range of possible scores was from 18 to 23 target fruit among 157 – 162 distractors. A sample measure is included in the appendix.

Results

Although 25 participants were originally included in the study, only 9 participants completed both the pre and posttest after playing Blink for a period of two weeks. Due to the accidental distribution of a pre and posttest with the same target fruit, one participant was removed from the data to correct for practice effect. The scores on the pre and posttests were calculated by dividing the number of correctly identified target fruit by the total number of target fruit on the testing measure, creating a standard proportion of correct answers, from which percentages were gathered. Because each target fruit had a different number of possible correct selections of target fruits amongst distractors with a range of 18-23, the percentage of correctly selected fruits provided the ability to compare the data from each participant. A paired-sample *t*-test was employed in order to evaluate the data and determine any difference between the pre and posttest.

The mean percent correctly identified on the pretest was 54.5 (SD = 0.20). The mean percent identified for the posttest was 81 (SD = 0.18). These means represent the average percentage of target fruit correctly identified in each test, and the standard deviations represent how far the distribution was spread. There was a statistically significant positive difference in the posttest results, with a mean difference in scores of 27 percent, $t(7) = -3.135$, $p = 0.016$, $d = 1.11$. According to Cohen's standards (1988), the results showed a large effect size of 1.11, signaling that the means of the pre and posttests were 1.11 standard deviations apart. The research hypothesis that the selective attention

scores of the sample would significantly improve after intervention of the card game Blink was supported.

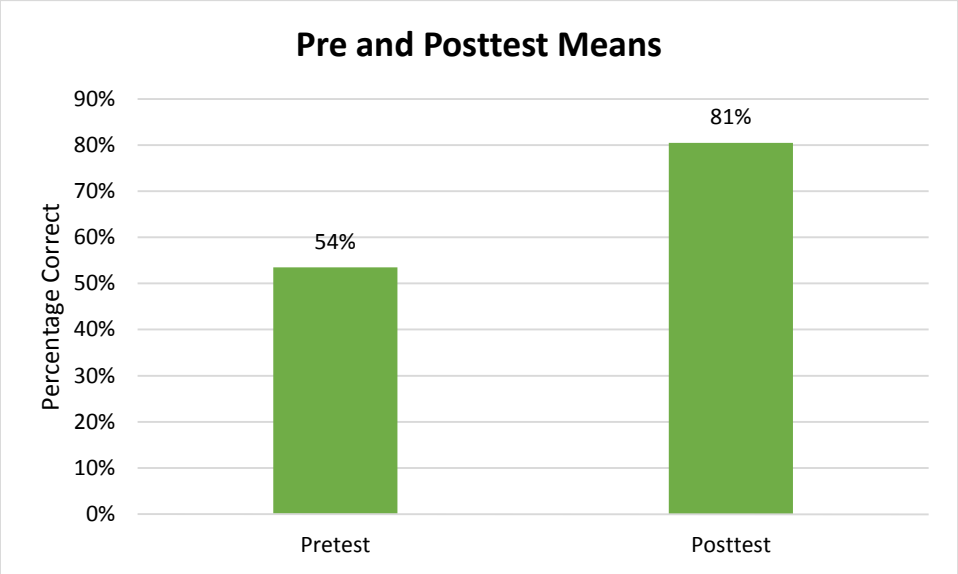

Figure 1. Bar graph of pretest and posttest means on a selective attention measure for a sample of street youth living in a large city in Zambia, Africa.

Discussion

The current study sought to determine whether a game-based intervention in the form of the game Blink would significantly improve selective attention scores for a sample of Zambian street youth. The results showed a statistically significant positive difference between the pre and posttest measures, supporting the research hypothesis that selective attention ability improved after the intervention of playing Blink. This study sought to be an exploratory intervention in one area of the cognitive development of street children, with the hope that it might open the door for more comprehensive and varied research interventions in the future. It explored the viability of using a cost-

effective game-based intervention for a sample of street youth who do not have access to any education beyond attending drop-in centers.

Essentially, this finding shows that after only two weeks of playing Blink, the children improved significantly in their ability to selectively locate target fruit amongst distractor fruits. A significant difference was especially notable due to the small sample size of eight viable participants from which to draw data, as significant results are more likely whenever the sample size increases. Due to the high test-retest reliability of previous Picture Search measures conducted (Pagenstecher, 2010; Heaton, et al., 2001; Manly, et al., 2001; Nampijja, et al., 2010; Sakti, et al., 1999; Nokes, 1999), it may be assumed that a significant difference in these scores could be attributed to the Blink game-based intervention rather than a lack of reliability in the test.

The findings of this study appear to fit the existing body of literature. The plasticity of cognitive skills such as selective attention has been documented (Tamm, et al., 2013; Stevens, et al., 2013), and subsequently supported in this study. The findings also fit the literature on game-based interventions, giving evidence that a game can be an effective tool for enhancing selective attention (Dye & Bavalier, 2009; Green & Bavalier, 2003; Mishra, Bavalier, & Gazzaley, 2012). Given that selective attention is an important aspect of executive function in predicting academic achievement (Duncan, et al., 2007; Lan, et al., 2011; Pagani, et al., 2012; Willner, et al., 2015), it could potentially have a positive impact on academic performance.

Due to the fluid atmosphere of the center where the study was conducted, the game was not played in structured times and settings. After the initial lesson from the researcher on how to play, the participants were given the option to play Blink at their

leisure during their free time each day. Each of the participants played on a regular basis, challenging each other and the volunteers at the center to play with them. Their enthusiasm toward the game was considerable, as it was a fun game to play rather than a lesson to learn. The game-like nature of the testing measure also facilitated motivation and competition amongst the participants as they sought to outperform their friends and excel at the task. The game-based intervention was useful for this population due to their love of card games and its low cost, as a result of a lack of resources to conduct a more comprehensive executive functioning intervention.

Limitations

Although the results of the study are statistically significant and do add substance to the body of literature, considerable limitations faced this study that should be noted. For one, the length of the intervention was not as long as preferred – although a significant difference did appear after only two weeks, a longer intervention period would have been desirable. The length of time was limited by the length of the researcher's time in Zambia, as well as the amount of time the participants remained at the center. Another limitation is the small sample size; the lack of accountability and consistency among the population of street children contributed to attrition of participants and the small number of youth that remained at the center long enough to complete both the pre and posttest. Due to the small sample size, the current study cannot determine whether these findings are generalizable to other street youth in Zambia and Africa. The small sample size also necessitated a within-subjects design, not allowing the presence of a control group. The lack of a control group became a limitation because it did not allow comparison of findings to a population that did not receive any intervention, and detracted from the

ability to substantiate a causal relationship. Practice effect of the testing measure was also a concern – however, this was minimized by ensuring that participants did not receive the same target fruit for the pre and posttests.

The researcher was also limited in her ability to communicate and translate instructions of both the testing measure and Blink. Although English is the national language of Zambia, most children who had not attended school spoke in their local tribal languages rather than English. Therefore, a translator was needed in order to explain directions, and the center where the study was conducted had a rather inconsistent rotation of volunteers who were able to translate. At times, older street children who knew English were the only ones available to translate, which may have caused issues in comprehension unknown to the researcher. This lack of structure in the center, a substantial cultural difference from the Western focus on organization, made it impossible to ensure that every child played Blink for roughly the same amount of time. Blink was played during the children's free time, and although the participants all appeared to play regularly, no method presented itself in order to ensure that they all played for the same durations. The lack of research directly focusing on the impact of a game-based intervention on selective attention for a sample of Zambian street youth does not allow comparison of results to previous findings. Further research will be necessary in order to generalize the findings beyond the current sample population.

It may also be considered a limitation that the lack of financial resources and available technology required a non-computer based card game. Most of the existing literature on game-based interventions focused on interactive computer games and simulations as teaching materials rather than card and board games. The sample may

have experienced more substantive growth if a computer-based intervention had been available for use. At present, the results simply give evidence that games in general may be a useful tool for cognitive interventions with this population. The limitations of the study are marked by the lack of resources available in the form of materials and Zambian volunteers to aid in conducting the research.

Recommendations for Future Research

With the statistically significant findings and limitations of this study in mind, many possible routes present themselves for future research. It is recommended that more research be done with the population of street youth in Zambia. It is a neglected population in the literature, so it is advised that further executive functioning interventions should be conducted for this population, for the sake of determining what types of interventions may be useful on a large scale over time. It is also recommended that future studies undertake a larger sample for longer periods of time, possibly conducting a longitudinal study delving into multiple interventions aimed at executive functioning. Finally, it would be preferable that future studies use a research design that includes a control group in addition to the experimental group which plays the card game, for the sake of gathering comparable data to be able to generalize the findings to larger populations.

Implications

While this study chose to focus on the plasticity and improvement of selective attention skills, it is possible that other executive functioning and cognitive deficiencies may also be remedied through similar replications of game-based interventions. It is likely that future studies may be able to generalize these findings not only to other

executive functioning skills but also to different target populations. As improvements in selective attention have been shown to impact academic outcomes, the results of this research provide impetus for education initiatives in Zambia and other developing countries in order to meet the needs of thousands of children who are not receiving an adequate education. It also provides evidence for games being recommended as a cost-effective intervention in developing countries such as Zambia who are faced with many environmental concerns, such as the HIV/AIDS epidemic and widespread poverty.

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Appendix

*Testing measure developed for pre and post-test has been removed for copyright purposes.