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Empirical Validation of an Executive Function Battery for use in Childhood and Adolescence

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Abstract

This research explores the reliability and efficacy of a child and adolescent adaptation of an adult battery of executive functioning, measuring the constructs of reasoning, short-term memory and verbal processing. The intent of the research is twofold as it intends to support an age appropriate adjustment of a battery of tasks presented by Hampshire, Highfield, Parkin and Owen (2012), and secondly to display the necessity of looking at executive functions as multifaceted and therefore requiring multiple tasks to encompass their complexities. The adjusted battery in analysis is composed of nine tasks that have been amended to be age appropriate for a sample of children aged 8, and adolescents (15-17). These tasks were administered to a group of 8- year- olds recruited through the London Child Development Pool with task completion facilitated online, as well as to a large group of adolescents participating in a study on healthy relationships conducted by the Center of Addiction and Mental Health in London, Ontario. A descriptive comparison of means was conducted to establish that an accurate developmental trajectory of the constructs of reasoning, short-term memory and verbal processing exists with the use of the age adjusted battery. A correlational analysis was completed with the Multidimensional Aptitude Battery- II in the adolescent cohort, which supported the reliable transition of the constructs of reasoning and short-term memory but raised concerns with the accuracy of the verbal processing component. Limitations of the study were discussed as well as future directions for this research.

Empirical Validation of Executive Function Battery used in Childhood and Adolescents

Investigations into the developmental trajectories of executive functions have resulted in the revelations that the individual processes that compose executive functions present with distinct developmental progressions, however no current battery of tasks measures these constructs from childhood to adulthood (Brocki &Bohlin, 2004). Therefore the conclusions made about how these underlying constructs of executive function develop are not uniform in nature. Current research lacks a cohesive set of tasks used to reliably measure the constructs of reasoning, short- time memory and verbal processing as they evolve through childhood, adolescence and finally into adulthood. Present measures of these constructs differ within the literature, and fail to provide a concrete platform from which to derive theory about the development of these constructs. The formation of accurate developmental trajectories of executive functions requires the establishment of unified measurements in order to reliably investigate how these constructs improve over time. The establishment of a battery of tasks that measures these constructs at an early age, and continues to measure their growth is crucial in this pursuit. The current study investigates the reliability of an age-adjusted battery of tasks established by Hampshire, Highfield, Parkin and Owen (2012), in the pursuits of a dependable battery for long-range measurement of executive function.

The adult battery composed by Hampshire et al., (2012) has been shown as an accurate measure of the constructs of reasoning, short-term memory and verbal processing, and the current study aims to investigate if this efficacy is present in the child and adolescent versions of this battery (Hampshire et al., 2012). This original battery is composed of 12 tasks, which were subsequently adjusted for the age cohorts of 8- year-

olds and adolescents. It is the intent of this research to establish that the complex processes involved in executive functions continue to be reliably measured by the adjusted battery originally constructed by Hampshire et al., (2012). The transition from the adult battery composed by Hampshire et al., (2012) to the adolescent and child batteries was facilitated through alterations in many of the visual representations of these adult tasks. These adjustments altered the themes of many games, with the goal of maintaining children's attention and increasing motivation to complete the battery.

Along with the establishment of a reliable child and adolescent battery, this research intends on supporting the notion that a battery of tasks, over individual tasks, more accurately quantifies abilities within individual executive function constructs. The literature has found measures of executive functioning that use individual tasks to quantify these complex neurological processes (Best, Miller & Naglieri, 2011), however these smaller tasks may present research with an inadequate depth of understanding. The current study intends to support the notion that numerous tasks within a battery are necessary to accurately quantify the complexities of these processes, and thus provide a more reliable measurement of these constructs. With the large differentiation in tasks, and task requirements in the current literature, the establishment of a reliable battery from childhood to adulthood would improve the usefulness of the conclusions made. The use of a battery of tasks to quantify the processes of reasoning, short- term memory and verbal processing intends to suggest that complexities reside within each of these structures that are best measured through the combination of numerous tasks (Hampshire et al., 2012).

Through the establishment of a reliable battery of tasks, a more accurate trajectory of development can be investigated. The need for a concrete developmental trajectory is crucial in understanding the progress of children, and the validation of a battery of executive functioning from childhood to adulthood would allow for greater understanding of how these processes grow. Miyake, Friedman, Emerson, Witzki, Howerter and Wager (2000) stress the need for a coherent theory on the advancements of executive functioning, however this accurate developmental trajectory can only be achieved with reliable and consistent measurement of these complex processes. The current research therefore aims to fill the gap in current measurements of these constructs by providing a battery of tasks that measures reasoning, short-term memory and verbal processing from childhood into adolescence and during adulthood.

Constructs Present in the Battery

The discussion of the measurements currently used in executive function research must first begin with an understanding of the processes that comprise this term. Executive functioning has been defined as the mental processes that provide the mind with the capacity to plan, move between tasks, filter distractions and manipulate information (Brocki & Bohlin, 2004). It is therefore important to note that the three constructs of reasoning, short- term memory and verbal processing do not solely encompass executive function but comprise three subsections of interest.

The construct of short- term memory presented in the Hampshire et al., (2012) battery of tasks is also described within the literature as working memory. The function of working memory has been deemed an important aspect of executive function, and is defined as the “capacity of maintaining information and using that information to guide

immediate behaviour in the absence of informative external cues" (Brocki & Bohlin, 2004). The ability of reasoning can be understood as the skill that supports the brain's transition between differing tasks, and facilitation of efficient switches from one idea to another (Anderson, Anderson, Northam & Jacobs, 2001). The last construct of investigation, verbal processing, is a critical aspect of executive functioning as it describes the ability to retrieve information from memory during tasks related to semantic understanding (Dias, Menezes & Seabra, 2013).

Visu-petra, Benga and Miclea (2007) explain that research in the executive functioning domain is difficult as there is no universal consensus regarding research paradigms. Current research is being conducted with numerous models, and differential cognitive demands placed on each task have complicated the formation of a normative developmental trajectory. The need for task refinement suggests that a reliable measurement of executive function from childhood to adulthood is necessary to understand developmental progress.

An understanding of the developmental trajectories present within the current literature is necessary; to better understand how the adjusted battery should project the growth of reasoning, short- term memory and verbal processing. An important aspect of executive function research is the evidence that each cognitive construct included in the label of executive function develops at different developmental rates (Dias et al., 2013). This evidence supports the need for age appropriate methods of investigation, to ensure tasks are measurements of accurate growth for each construct.

The constructs in question within the current study possess three distinct developmental trajectories. The research on the development of reasoning indicates that

this growth ends at approximately fifteen years of age (Best et al., 2011). Best et al., (2011) asked participants (age 5-17) to complete a planned codes task, which resulted in an increase in accuracy up until the age of fifteen. This development in reasoning indicates that as the age of the participants increased, their ability to accurately complete the task improved. Dias et al. (2013), echoes this in their suggestion that reasoning and cognitive flexibility maximums have been reached by the age of fifteen. Their findings displayed a jump in improvement from the ages of five to seven, and a subsequent steady increase in cognitive flexibility abilities until adolescents are fifteen (Dias et al., 2013).

Brocki and Bohlin (2004) investigated working memory, to which they concluded that this function also adjusts with time and maturation. They propose this maturation as a progression through three stages, occurring in early childhood (ages 6-8), middle childhood (ages 9-12), and the last stage occurring in adolescence. In their investigation of working memory, Best et al., (2011) asked participants (age 5-17) to complete a matching numbers task, from which they discovered that older ages displayed higher accuracy and a decreased completion time. This suggests an increase in ability to manipulate information within short- term memory up until age 17 (Best et al., 2011). The contrast in developmental end points from Brocki and Bohlin (2004) and Best et al., (2011) display the lack on consensus on tasks and consequently the accuracy of current trajectories.

When investigating verbal processing Dias et al., (2013) discussed conflicting trajectories of this construct's development. Their investigation suggested significant growth in function between the ages of 11 and 17, as well as literature, which supported a

blunting of progress at age 12. This finding suggests that more clarity needs to be established within this construct, and the current study aims to aid in this ambiguity.

As well as creating a more detailed developmental trajectory of the constructs of reasoning, short- term memory and verbal processing, the revision of the tasks in the current battery provides clarity to the current definitions of these concepts. Current research lacks a consensus on the individual processes that comprise executive function. This lack of clarity is displayed by Anderson et al., (2001), as their construct of cognitive flexibility contains working memory where the separation of these two larger processes is most often divided (Dias et al., 2013; Hampshire et al., 2012). This confusion on the components comprising executive function is replicated with the numerous tasks and paradigms currently attempting to quantify these constructs. While previous tasks may provide groundwork on the understanding of these constructs, they fail to provide cohesion among the research.

The current literature lacks a consensus of the measures used to quantify executive function, and the debate continues over what best measures these specific constructs. Miyake et al., (2000) quantify working memory with a *Keep Track task, Letter Memory task* and *Tone monitoring*. While the current battery uses a *Paired Associates task, Spatial Span Blocks* and a *Visio spatial* task to quantify this construct (Hampshire et al., 2012), and as previously mentioned Best et al., (2001) use one task of *Matching Numbers* to define this construct. These differing methods of measurement illustrate the lack of consensus in the understanding of this construct. This lack of cohesion in measurement tasks is echoed in research on reasoning as Miyake et al., (2000) measure their reasoning construct of shifting with a *Plus-Minus task, Number Letter Associations* and a *Local-*

Global task, while the current battery uses tasks of *Rotations, Feature Matching* and *Polygons.* Best at al., (2001) use a singular *Planned Codes task* for their construct of cognitive flexibility, which may be an under investigation of the complexities of this construct. The lack of consensus on these constructs continues in research conducted by Anderson, Anderson, Northam, and Jacobs (2011), as they measure cognitive flexibility with a *Contingency Naming Task* and a *Verbal Fluency test*. This measurement also overlaps with verbal processing, and therefore contributes to the confusion in concept differentiation. Reasoning has been measured by Dias et al., (2013) with the use of one *Trail-making task*, displaying the numerous measures of these cognitive constructs. The research displays that the distinct constructs of reasoning, short- term memory and verbal processing require more cohesive measurements in order to consolidate research paradigms and provide aid in the understanding of the complexities of development.

The use of a battery of tasks is not a novel idea, as Miyake et al., (2000) measure the constructs of shifting, updating and inhibition with the use of nine tasks. However while Miyake at al., (2000) also provide a battery of tasks, their behavioral analysis fails to provide neurological reinforcement of their specific battery. Hampshire et al., (2012) have created a battery of tasks that maps onto separate demand regions of the brain, supporting the distinction of these constructs and increasing the validity of their measures. The confusion over the differentiation of constructs previously discussed is removed with the use of the current battery, as the functional analysis supports the concrete separation of these two constructs. Their factor analysis resulted in the division of two major sets of multiple demand regions, providing evidence that these separate neurological regions are used for specific cognitive demands (Hampshire et al., 2012).

Factor solutions were generated using both behavioral and neuroimaging data, providing two significant principal components. These two components of short-term memory and reasoning mapped onto two distinctive neurological networks, providing support for the behavioral distinction of these two concepts (Hampshire et al., 2012). The reinforcement of brain imaging data provides support for the utilization of this battery as the most accurate measure of these constructs from childhood to adolescence. Amalgamations of behavioral data and fMRI analysis create a coherent understanding of the differentiation of reasoning and short-term memory in terms of task completion and neural activation. This functional difference in demand regions of the brain was not found by Miyake et al., (2000), and provides support for the adjustment of the battery of tasks formed by Hampshire et al., (2012).

The battery of tasks created by Hampshire et al., (2012) has provided a concrete starting point, but the importance of an age appropriate version of this battery of tasks should not be overlooked. Brocki and Bohlin (2004) state that a vast amount of literature stems from current understandings of adult neuropsychological processes and raises the importance of evaluations being age appropriate. The use of adult performance as a guideline of performance in executive function tasks neglects to acknowledge the complexities of growth throughout childhood and adolescence. Brocki and Bohlin (2004) indicated that the use of adult constructs of executive function might leave a gap in the understanding of how these processes develop. By limiting the search in childhood to only the constructs of executive function present in the adult literature, the research inadequately explores the possibilities associated with development. It is therefore

imperative that these constructs be examined by measures that respect the cognitive capacities of age.

Each of the individual constructs of reasoning, short- term memory, and verbal processing are integral components of human intelligence, and play a large role in an individual's competency (Hampshire et al., 2012). The utilization of the same tasks presented by Hampshire et al., (2012) with appropriate adjustments for age will allow for a more reliable production of a developmental trajectory for these components. Through the utilization of the battery created by Hampshire et al., (2012), the constructs of short-term memory, reasoning and verbal processing will be better understood at age 8 and in adolescence. This structure of three tasks per construct allows for a greater understanding of the progression in these domains, and will aid in the understanding of their development.

The investigation into whether these processes are arranged similarly in childhood and adolescence is important for a greater understanding of how executive functions develops. The growth of individual executive functions that work in cohesion to assist the brain in completing tasks are crucial in the understanding of neurotypical brain development. A comprehensive understanding of the arrangement of processes in childhood and adolescence is necessary for the advancement of programs to facilitate growth of these constructs. The younger interventions are made available to aid children with deficits in each of these functions, the greater possibility for impact (Qian, Shuai, Chan, Qian & Wang, 2013). Dias et al., (2013), propose that this understanding of neurotypical development is crucial in the understanding of those who do not follow this trajectory. Through further investigation into the processes that occur in neurotypical

development, investigators will be able to better understand the mechanisms behind atypical development. With the establishment of a reliable battery of short- term memory, reasoning and verbal processing from 8 years to adulthood, a precedent would be set indicating that a battery of tasks may also be useful in the investigation of other executive function components such as inhibitory control.

The current study utilizes a group of 8- year- olds, and adolescents (15-17) to assess the efficacy of the adjusted Hampshire et al., (2012) battery of tasks. Based on the research presented it is hypothesized that the completion scores of the eight- year old group will display lower than the adult cohort due to their reduced cognitive capacity. Due to the current literature understanding of these processes, it is expected that the adolescents will display highly similar scores to that of the adults in all three of the cognitive domains. This hypothesis is rooted in literature that explains short- term memory, reasoning and verbal processing development plateauing during or before this time period (Brocki & Bohlin, 2004, Anderson et al., 2011, Dias et al., 2013)

To further support the efficacy of the adjustment to the Hampshire et al., (2012) battery of tasks, correlations will be conducted between scores of short-term memory, reasoning, verbal processing and scores on the spatial and verbal components of the Multidimensional Aptitude Battery – II. It is hypothesized that all three factors of executive functioning will correlate highly with the spatial measure in this battery, while only the verbal processing factor is expected to correlate highly with the verbal measure in the Multidimensional Aptitude Battery- II.

Method

Participants

This study was comprised of 235 participants from two age cohorts, with 20 eight-year-old participants and 215 grade nine and ten students (*M*= 15.9). The eight year- old participants were collected using the London Child Development Pool, and each participant completed a battery of 11 tasks individually at home (Hampshire et al., 2012). Parents provided consent to have their children participate in research that would help better understand the intricacies of intelligence in children. This cohort of children agreed to participate in this study on a long-term basis, with the understanding that this set of tasks will be completed three times over the course of the next three years. These participants were compensated with the chance to win an IPod shuffle. The inclusionary criterion for this study was fluency in English and access to a computer, while the study excluded children who suffer from significant visual and developmental delay.

The adolescent participants (15-17) were collected from an evaluation of the Healthy Relationships Plus Program conducted by the Center of Addiction and Mental Health in London, Ontario. These students completed a reduced battery of nine executive functioning tasks on the first day of this 8-day program in a high school classroom setting, on a computer (Hampshire et al., 2012). Participants were awarded gift cards totaling 225 dollars for their participation in the study as well as in 4 month, 8 month and 12 month follow ups.

Materials

The investigation into executive function processes was conducted using a modified battery of executive functioning tasks used by Hampshire et al. (2012).

Hampshire et al (2012) provided a battery of tasks containing 12 games; one task was removed from the original battery for eight-year-old use due to complexity, and four removed for the use in the adolescent sample. These tasks were removed by the Center of Addiction and Mental Health London to produce a battery in which each factor of reasoning, short- term memory and verbal processing had three supporting tasks. The result of these adjustments was a battery of nine tasks used in the current analysis. These tasks were measured on the basis of timed trials, or number of correct responses. For the purpose of analysis each trial was given an overall score of successfulness, which allowed for comparison between the two measures.

Constructs in Battery. Each executive function was measured with the use of three tasks (See appendix A). The measure of reasoning is composed of three games whose successfulness is measured through timed trials, entitled Adam's Pizza, X ray machine and Charlie's Chocolates. The spatial rotation task entitled Adam's Pizza aims to measure the ability to manipulate objects in mind. This task presents the participant with two pizzas placed next to each other on screen. Each trial the pizzas are rotated by multiples of 90 degrees and the participant must then indicate whether the pizza's toppings are identical. The participant's correct answers prompt the addition of another topping on the pizza, and incorrect trials result in the removal of a topping. Participants can solve as many problems as possible within 90 seconds. The spatial matching task with polygons entitled X ray Machine begins with a display of a pair of overlapping polygons on the left of the screen. Participants must identify if one of the polygons present on the right of the screen is also present on the left. The difference between the polygons becomes increasingly subtle as the responses continue correctly, while incorrect

answers prompt a more pronounced difference in polygons. Charlie's Chocolate's is the feature-matching task in this battery, in which two boxes of chocolates are displayed on the screen, each containing a set of chocolates. Half the trials are characterized by one differing chocolate in one of the boxes. The participant must then indicate whether the two chocolate boxes are identical. Correct trials prompt the addition of another chocolate, with incorrect trials decreasing the number of chocolates.

Short- term memory is measured with games entitled Farmer Fred, Ancient tomb and Harry's Haunted Hotel. These are tasks of spatial working memory, spatial span, and paired associates respectively (See appendix A). Farmer Fred is a task in which sets of numbered apples are displayed at the same time. Subsequently the numbers are removed and the participant is instructed to pick the apples in numerical order. Each successful trial is followed by an increase in one apple and unsuccessful trials result in the removal of an apple. The test finishes after three errors. Ancient tomb is a spatial span task based on the Corsi Block Tapping Task. A 5 by 5 grid is displayed on the screen, followed by a random sequence of flashing squares. The participant is prompted by a tone and mouse curser to repeat the sequence by replicating the pattern previously presented. The first trial presents four lights in sequence, with a correct answer increasing the number of lights in sequence and incorrect answers followed by a reduction of lights. The highest achievement on this task is sixteen lights, with the minimum being two. The conclusion of this game occurs when the participant commits three errors. The paired associates task named Harry's Haunted Hotel presents the participants with a hotel background, containing 14 boxes at random locations. Participant's view objects displayed in the boxes, and are subsequently asked to recall in a random order which boxes contained

each individual object. If the participant answers correctly the object amount increases by one, and if incorrectly this amount decreases by 1. The conclusion of this game occurs when the participant commits three errors.

The last construct of verbal processing was composed of Code Breaker, Willy the Wizard and Tricky Toms Word Machine. Code breaker is a measure of digit span founded in the Weschler intelligence test. The participants in this task view a sequence of digits and are subsequently instructed to repeat the sequence of numbers using their keyboard. Correct trials increase the quantity of numbers in the sequence, with incorrect answers prompting the removal of a number from the sequence. Willy the Wizard is a measure of grammatical reasoning. This task asks the participant questions such as "square is not bigger than circle" and the participant then indicates if the statement is an accurate representation of the picture on screen. The participant is scored on number of correct responses within 90 seconds. Tricky Tom's Word machine is designed as a more challenging and complex version of the Stroop task. The participants are presented with a colored word at the top of their screen, and must indicate which of the two colored words at the bottom of the screen depict the color that the top word is drawn in. The color word pairing may be doubly incongruent, incongruent or congruent depending on the scenario. The participant may answer as many scenarios as possible in 90 seconds.

Multidimensional Aptitude Battery – II. This battery was used to quantify intelligence in the adolescent sample. This battery consists of two constructs labeled verbal and performance. The verbal measure consists of tasks on information, comprehension, arithmetic, similarities, and vocabulary (Carless, 2000). The performance measure consists of tasks of digit symbols, picture completion, spatial tasks, picture

arrangement and object assembly. This battery has been found a reliable measure of these two distinct constructs with its intended use for adolescents sixteen and over (Carless, 2000).

These tasks were completed with the use of a computer for both age cohorts.

Procedure

Participants in the eight year- old cohort completed the battery of executive functioning tasks online in their homes. Participant's parents were called and asked if they would be interested in having their child participate in a study on executive function (See Appendix B). Upon agreeing to participate in the study, the parents received an initial email indicating how the study would proceed (See appendix C). This email provided instruction on the database in which they were entered, and provided parents with a username and password. Participants were then provided with the letter of information (See appendix D), and gave informed consent to participating in the study. The children then received a general introduction to the games and were instructed to begin. Next the children completed one full round of the eleven games, and subsequently completed the same tasks at any point within the next week. The data in question was obtained from the second session of play, as the initial session was intended to familiarize the participants with the games. The set of tasks was set to take participants under 45 minutes to complete.

Participants in the adolescent group completed the battery of executive functioning tasks as a component to a larger program evaluation of the Healthy Relationships Plus Program for Youth, conducted by the Center of Addiction and Mental Health in London, Ontario. The parents of these students were provided with a letter of

information (See Appendix E), and informed consent was obtained (See Appendix F) for the participation in this larger program, with the understanding that their children would participate in numerous measures for later analysis. The adolescent participants were given a letter of information (Appendix G) and also provided informed consent (Appendix H) to participate in the Healthy Relationships Plus Program. These students completed nine of the 11 tasks existent in the 8 year-old conditions, which are the grounds for the removal of these two tasks for the purpose of equitable analysis (Hampshire et al., 2012). These games took approximately 45 minutes for the participants to complete on the first day of the eight- day program, and were completed in a classroom setting with the use of computers.

Results

Correlations were conducted between the three factors of short-term memory, reasoning, verbal processing in the current battery, and the spatial and verbal components of the Multidimensional Aptitude Battery – II. The results indicated significant positive correlations between the spatial component of the Multidimensional Aptitude Battery II (MAB-II) and short term memory $r(209)= .450$, $p <.01$, reasoning $r(209)= .450$, $p <.01$ as well as verbal processing $r(209)= .440$, $p <.01$.

Correlations conducted with the verbal component of the Multidimensional Aptitude Battery- II revealed significant correlations with short term memory $r(209)=.237$ $p <.05$, reasoning $r(209)= .237$, $p <.01$ and verbal processing $r(209)= .196$ $p <.01$.

Further investigation of the verbal processing construct in the Hampshire et al., (2012) battery and the verbal component of the Multidimensional Aptitude Battery- II

resulted in only one significant correlation found between the grammatical reasoning task and the verbal component of the Multidimensional Aptitude Battery – II ($r(209)= .410$ $p < .01$). The correlations conducted between this verbal component and the stroop task, $r(209)= .133$, *ns* and the digit span task $r(209)= -.083$, *ns* were found to be not significant.

Correlations between specific verbal processing tasks in the Hampshire et al., (2012) battery and the spatial component of the MAB- II concluded significant relationships with the grammatical reasoning task $r(209)= .392$ $p < .01$, and stroop task $r(209)= .291$ $p < .01$. However the digit span task, Code Breaker revealed a lack of connection to this construct $r(209)= .410$, *ns*.

A descriptive comparison of means was conducted displaying the developmental trajectories of these constructs. The first construct analyzed was that of verbal processing, with means and standard deviations of child, adolescents and adults displayed a developmentally appropriate trajectory for each task (Dias et al., 2013). This was found as each task had the lowest means in childhood, followed by adolescence then adulthood (See Table 1).

Table 1

Means and Standard deviations of tasks of Verbal Processing

	Child Mean	Child Standard Deviation	Adolescent Mean	Adolescent Standard Deviation	Adult Mean	Adult Standard Deviation
Grammatical reasoning	6.4	3.89	9.76	5.77	17.38	5.01
Digit span	4.9	1.12	6.34	2.1	7.22	1.52
Stroop	21.6	9.89	29.8	7.12	30.92	13.01

The second comparison of means and standard deviations displayed that each task presented within the construct of short- term memory displayed a steady increase in scores (See Table 2). This finding was reflective of the current research on developmental trajectories previously mentioned (Brocki & Bohlin, 2004).

Table 2

Means and Standard deviations of tasks of Short Term Memory

	Child Mean	Child Standard Deviation	Adolescent Mean	Adolescent Standard Deviation	Adult Mean	Adult Standard Deviation
Paired associates	3.9	1.26	4.42	1.04	5.28	1.13
Monkey ladder	6.3	0.79	7.28	1.06	7.85	1.15
Spatial Span Blocks	4.28	1.94	4.96	0.74	6.15	1.07

Analysis of the reasoning measure displayed more complex results. The first task of rotations displayed a large increase from childhood to adolescence, but this large jump was not reflected between adolescence and adulthood (See Table 3). Both the feature matching and polygon task displayed higher scores in adolescence than in adulthood.

Table 3
Means and Standard deviations of tasks of Reasoning

	Child	Child	Adolescent	Adolescent	Adult	Adult
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Rotations	57	57	87.37	57.9	88.72	36.32
Feature match	94.3	43	149.1	47.5	131.35	32.79
Polygons	40.6	29.8	61.2	40.37	51.41	24.86

Discussion

After conducting a correlational analysis, the factors of short- term memory and reasoning were found to be accurate measures of their constructs due to their significant correlations with the spatial component of the Multidimensional Aptitude Battery-II. The tasks that quantify the spatial element of the Multidimensional Aptitude Battery- II are similar in nature to those present within the measurements of reasoning and short- term memory, as well as the established reliability of this battery has led to the conclusion that short- term memory and reasoning are constructs strongly present in adolescence, and accurately measured by the current battery.

The correlational analysis conducted between the verbal processing component of the current battery and the verbal factor in the Multidimensional Aptitude Battery-II produced a significant correlation however, minimal in strength. This brings to question

the accuracy of the measurements within the verbal processing measure. As the Multidimensional Aptitude Battery-II contains a high validity rating, its lack of correlation with the verbal processing component of the Hampshire et al., (2012) battery is something of note. When further correlations were conducted with the individual tasks in the verbal processing construct it was found that the grammatical reasoning task of Willy the Wizard was the best correlate with verbal strength in the Multidimensional Aptitude Battery-II. With only one of the three tasks correlating highly with the verbal component of the Multidimensional Aptitude Battery – II, the efficacy of this construct in the current battery is brought into question. Further analysis of verbal processing displayed that the tasks of grammatical reasoning and stroop both correlated significantly with the spatial factor in the Multidimensional Aptitude Battery-II (MAB-II). The higher correlation with the spatial component of the MAB-II indicated that these tasks may be measuring executive function, but this function may not be verbal processing. The analysis also displayed that the digit span task did not correlate significantly with either the spatial or the verbal component of the MAB- II. This leads to hesitancy in the further inclusion of this task, as it did not indicate as a reliable measure of any of the discussed executive functions. The ability for a battery to be parsed apart into stronger tasks, and those that do not add novel information speaks to the ability a battery of tasks has to encompass more complex cognitive processes. The use of a battery allows for the removal and addition of further tasks and provides a larger picture from which to draw conclusions.

The lack of verbal processing accuracy is contrary to what was hypothesized, and brings into question what executive function the factor labeled is measuring. Brocki and

Bohlin (2004) discussed the limitations in looking at adolescent executive function through the eyes of adult data, and this perspective may suggest that although this construct is strong within the adult data, it may not be a construct of interest prior to that stage of maturation. The correlations between these three tasks of grammatical reasoning, digit span and stroop task may form a reliable factor in adulthood, but this cohesion might not be present in adolescence. In the behavioral and fMRI analysis conducted by Hampshire et al., (2012), it was found that 90% of the variance within the battery was accounted for by the factors of short- term memory and reasoning. This is ground for the suggestion of the removal of the verbal processing factor as a valid measure of this construct until further investigation is conducted on what the construct it is truly measuring.

The descriptive comparison of means displayed that the hypothesized trajectories beginning with low scores in childhood, higher scores in adolescence and highest scores in adults was found in short- term memory and verbal processing. These findings indicate that there is substantial cognitive development between the ages of 8 and 15, as predicted (Brocki & Bohlin, 2004, Anderson et al., 2011, Dias et al., 2013). The construct of reasoning displayed higher scores in adolescence than in adulthood, which was contrary to the hypothesized trajectory (Dias et al., 2013). This finding indicates that adjustment to the battery may have decreased the complexity of the tasks to a lower than necessary level for the adolescents. The tasks used in the reasoning construct are visual in nature, and an increase of the presence of visual stimuli in the world of an adolescent may have increased their capacity in this domain (Spence & Feng, 2013). Spence and Feng (2013)

suggest that videogames increase spatial rotation ability, which may provide an explanation for the increase in capability in this field.

To conclude the factors of short term memory and verbal processing were found to increase over developmental maturation as predicted, which indicated that the tasks captured the cognitive capacities at these stages of development. The factor of reasoning provided unexpected results, which suggests that further research should be conducted to discover if the tasks were too simplified, or if adolescents have an increase in this executive function due to generational differences in environment.

Limitations

This research is however limited in its depth due to a limited sample size in the youngest cohort of eight- year- olds. While the results display an initial understanding of these constructs in childhood the limited sample size prevents the generalization of the data in question.

A second limitation of the current study is the location in which the eight-year-old cohort completed their data collection. While the collection of adolescent data was administered through representatives from the Center of Addiction and Mental Health, the home environment of the 8- year- olds brings with it an err of caution. This is due to the fact that child attention on the tasks at hand cannot be confirmed.

Implications and Future Directions

The conclusions drawn from this analysis suggest that further work on the verbal processing measure of this age- adjusted battery is required. The further investigation of this construct is warranted due to the lack of current literature explaining this construct. The strong correlation between the grammatical reasoning task and the verbal component

of the MAB-II provides a strong start in the future task formation of an adolescent measurement of verbal processing. However, the minimal correlation of the digit span task with both the spatial and verbal components of the MAB-II brings into question what additional information this task provides, and its use in future alterations of this battery should be cautioned.

This analysis suggests that the reasoning and short- term memory constructs present in the current battery, continue to be accurately measured in adolescence. This assumption was made on the basis of significant positive correlations with the spatial component of the Multidimensional Aptitude Battery –II. Future research should look at replicating Hampshire et al., (2012), by conducting the completion of the adjusted battery within a MRI. This research would aid in the reinforcement of this specific battery as well as provide information in when the differentiation of demand regions occurs. This research would provide both a behavioral and neurological trajectory of development, allowing for a greater understanding of how these constructs develop in terms of task completion and neural activation. Future studies should look at childhood aptitude tests, and replicate the correlational analysis the conducted in the current study with adolescents. This would provide reinforcement for the childhood battery, as their developmental trajectories follow past research. A correlational analysis would provide a higher reliability of the constructs in this youngest age cohort.

Conclusion

The purpose of this study was to investigate the efficacy of an age adjusted battery of tasks originally constructed for adult use by Hampshire et al., (2012). It was found that the developmental trajectories of the constructs of reasoning, short-term

memory and verbal processing reflected what is understood in the current literature (Dias et al., 2013, Best et al., 2001, Brocki and Bohlin, 2004). Within the adolescent cohort it was found that the adjusted battery continued to reliably measure the constructs of reasoning and short- term memory, however the validity of the construct of verbal processing was brought into question. A minimal correlation was found between this construct and that of the verbal component of the Multidimensional Aptitude Battery, which resulted in a concern of the necessity and efficiency of this construct in the battery. This fact combined with the low correlations has led to concern over what the three tasks of verbal processing bring to the existing battery.

Through the descriptive comparison of means, as well as correlational analysis it was concluded that the measure of short-term memory was accurately measured from childhood to adulthood. The construct of reasoning was reliably measured from childhood to adulthood, with the understanding that further investigation is required on the adolescent battery tasks. Verbal processing was found to be an unreliable addition to the present battery, through a lack of significant correlations between this construct and the verbal and spatial components of the MAB-II. These findings suggest that executive functions may display differently in adolescence than in adulthood, specifically for verbal processing, but does support that the constructs of reasoning and short- term memory strongly exist in both developmental stages. The ability for individual constructs within the battery of tasks to be investigated as singular components allows for numerous platforms of analysis and provides increased support for the final individual constructs. The multiple dimensions explored within the individual battery support the use of the Hampshire et al., (2012) adjusted battery when accurately quantifying larger cognitive

processes. This analysis suggests that the adjusted Hampshire et al., (2012) battery is a step in the right direction for research on these constructs at younger ages, and the accuracy with which the reasoning and short- term memory constructs were measured is extremely promising.

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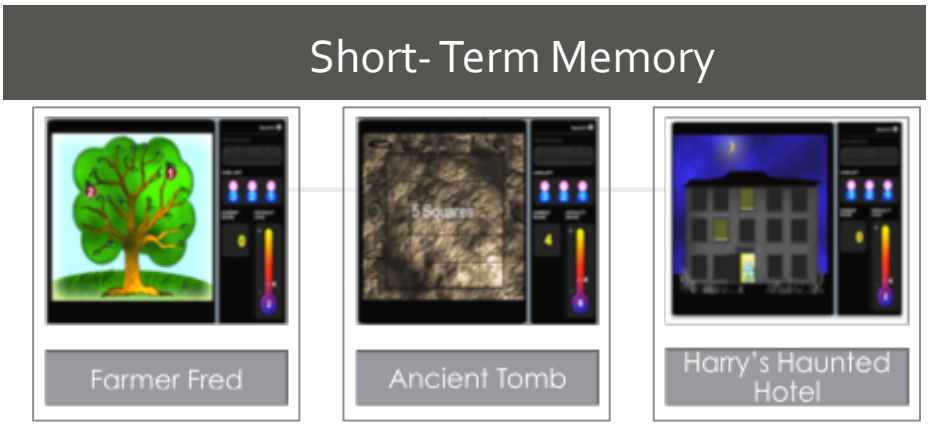
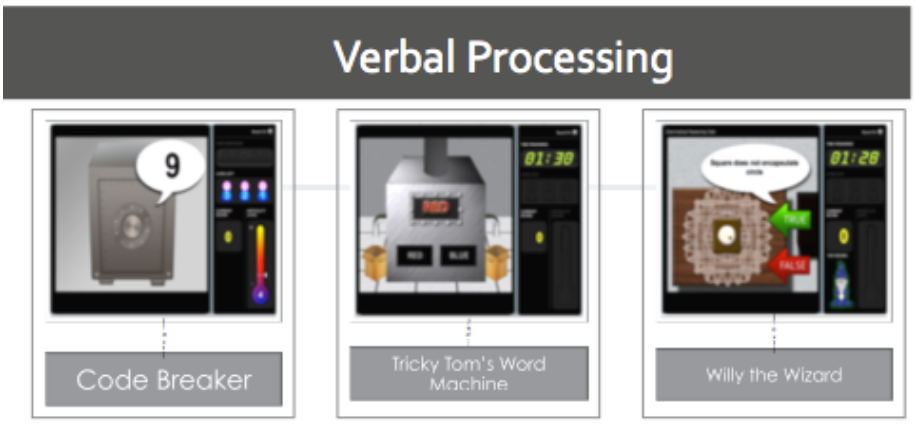
Appendix A

Initial Screen of Games


Short- Term Memory
Farmer Fred
Ancient Tomb
Harry's Haunted Hotel


Verbal Processing
Code Breaker
Tricky Tom's Word Machine
Willy the Wizard

Appendix B

Telephone Script

Hello, may I please speak with (insert the name of the parent of the child participant here).

I am calling from the Cognitive Development and Neuroimaging Lab at the University of Western Ontario on behalf of Dr. Bruce Morton. I am calling to ask if you and your child might be interested in participating in a research study. We are conducting a study on the development of intelligence in children. Would you be interested in hearing more about this study?

If no, thank them for their time and say good-bye.If yes, continue to explain the study details to them based on the letter of information.

We will be asking your child to play 12 computer games once to familiarize themselves then a second time within one week of the first. The premise of each game is different and is designed to be entertaining. Each session will take approximately 45 minutes. This will be done over the course of 3 years.

Would you be interested in participating in this study? *(If yes, continue. If no, thank them*

for their time and say good-bye.)

If yes... May you please provide me with your email address so that we can send you the link that will **PROVIDE YOU WITH ACCESS TO THE STUDY CONSENT DOCUMENTS AND WILL** allow your child to play the computer games?

We will learn a great deal about the development of children's intelligence in the present study. It will be extremely valuable to engage some of the children in the present study in future studies. For this, we need to know if we can contact you again over the next five years. **ANSWERING YES SIMPLY TELLS US YOU MAY BE INTERESTED IN FUTURE STUDIES. YOU ARE UNDER NO OBLIGATION TO PARTICIPATE IN ANY FUTURE STUDIES BY INDICATING YOUR WILLINGNESS TO BE CONTACTED. YOUR CONTACT INFORMATION WILL NOT BE USED FOR ANY OTHER PURPOSE AND WILL BE KEPT STRICTLY CONFIDENTIAL.**

Appendix C

Initial Email

Hello <insert parent name here>,

Thank you for taking time to speak with me today about Dr. Bruce Morton's study on the development of intelligence in children.

Your son/daughter <insert child name here> has been signed up for CBS Trials. His login information is:

Email: <insert parent email here> Password: <insert CBS trial pswrd here>

You should begin receiving emails from info@cbstrials.com this evening. The email will indicate your child has a trial waiting to be completed and will contain a link to your account on the server. If you do not receive the email, check your email trash - it is probably getting treated as spam. Alternatively, you can login directly to your account by going to: www2.cbstrials.com

The sessions include 13 computer games that will take approximately 45 minutes. Your child will have 7 days to complete the first session. This is important to complete as this contains the Letter of Information. The second session for the first year will be a week later and your child will have 10 days to complete it.

Approximately one year from now, you will be sent a reminder email from the secure server 24 hours in advance of the next session with a link to the same computer games. Your child will be asked to log on to the site and play the games two times again. You will be invited to participate for a third time one year after the second time. As it is an important component to our study, we would like to encourage you to participate at all three time points.

If you have questions about this research please feel free to contact Dr. Bruce Morton (519-661-2111, x84795; bmorton3@uwo.ca), our lab coordinator, Bea Goffin (519-661-2111, x81442; bgoffin@uwo.ca), or myself (519-661-2111, x81116; crelke@uwo.ca).

Best of luck with it! Sincerely,

Appendix D

Letter of information

An on-line study of the growth of fluid intelligence Principal Investigator: Dr. J. Bruce Morton Letter of Information

As you read this letter, the pronouns “you” and “your” should be read as referring to the participant rather than to the parent/guardian/next-of-kin who is signing the consent form for the participant.

You are invited to participate in a study entitled “The growth of intelligence in children”. This study will investigate how children’s capacities for reasoning and solving novel problems change over the course of time. We are currently looking for 100 children in each of 3 age groups: 6, 9 and 12 years.

Experimental procedure

This study is voluntary. If you agree to participate, you will be involved in 3 sessions spaced one year apart.

At each time-point, you will be asked to play 11 computer games to their completion. This will take approximately 45 minutes. You will also be asked to play all of the computer games a second time within one week of the first. The games involve such activities as identifying patterns, memorizing sequences and ordering items. The premise of each game is different and is designed to be entertaining.

You will be assigned a unique participant number and login name. To complete a session, you will log in to a secure server maintained by the experimenters. At the end of the session, you simply need to logout.

Approximately one year from now, you will be sent a reminder email from the secure server 24 hours in advance of the next session with a link to the same computer games. You will be asked to log on to the site and play the games two times again. You will be invited to participate for a third time one year after the second time. In other words, you will be asked to play the 11 computer games six times over the course of three years. As it is an important component to our study, we would like to encourage you to participate at all three time points.

Inclusion Criteria

Typically developing children aged 6, 9, or 12 years are eligible to participate in the current study. Children must be fluent in English and have access to a computer.

Exclusion Criteria

Children with visual and/or significant developmental delays are not eligible to participate in this study.

Possible Risks and Harms

There are no known or anticipated risks or discomforts associated with participating in this study.

Possible Benefits

There will be no direct benefit to you by participating in this study. However, we hope that the results of this research will help us to better understand how children think and learn as they grow.

Compensation

You will not be compensated for your participation in this research, however, your child's name will be entered into a draw for one of 3 iPod shuffles each year that they participate in the study.

Voluntary Participation

Participation in this study is voluntary. You do not waive any legal rights by indicating your consent to participate. You may refuse to participate, refuse to answer any questions or withdraw from the study at any time with no consequences to you.

Confidentiality

All data collected will remain confidential and accessible only to the investigators of this study. If the results are published, your name will not be used. When we publish results of the study, your own name and your child's name will not be used. Representatives of the University of Western

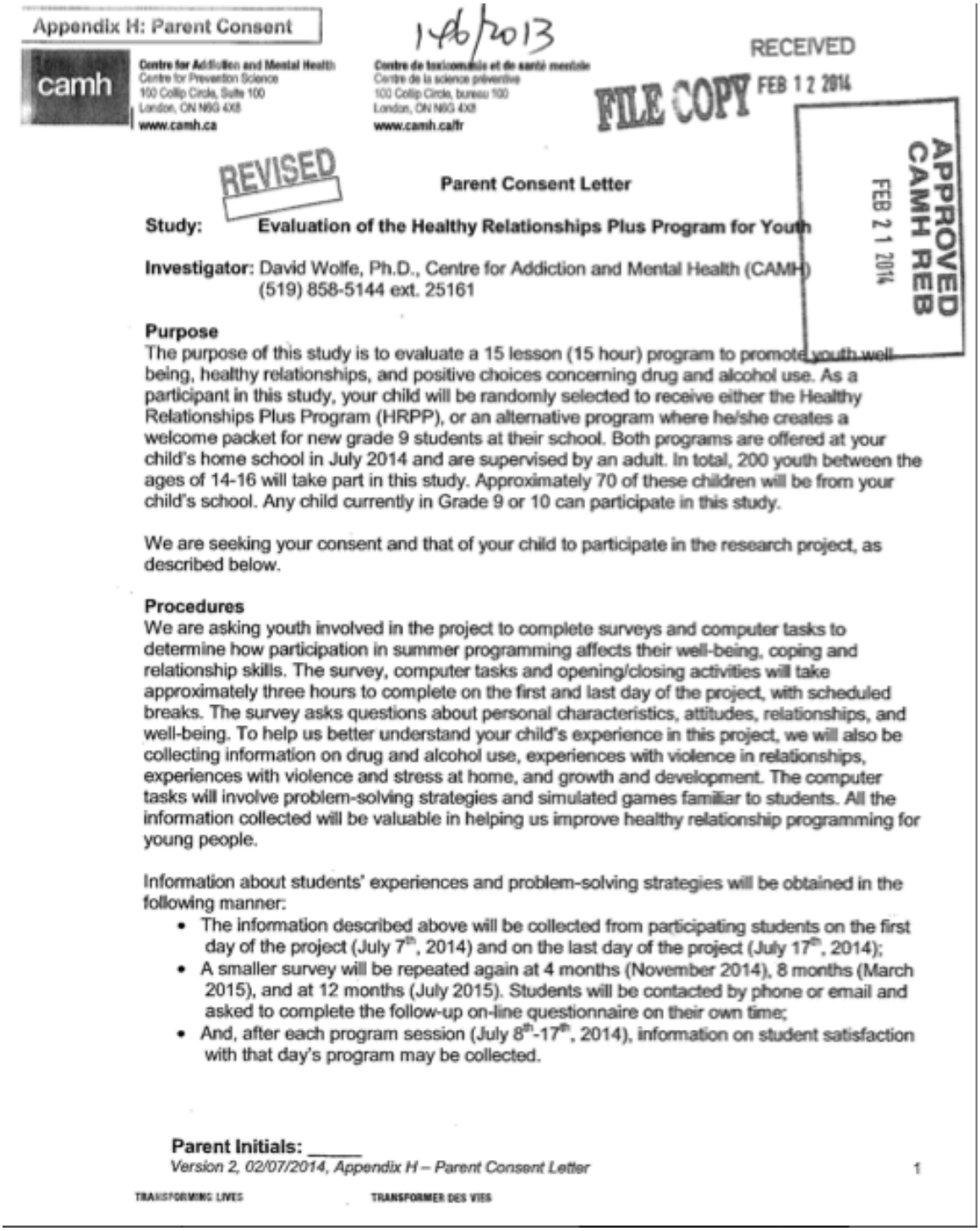
Ontario Non-Medical Research Ethics Board may contact you or require access to your study-related records to monitor the conduct of the research.

If you have questions about this research, and/or if you want to obtain copies of the results of this research upon its completion, please contact Dr. J. Bruce Morton (519-661-2111, x84795; bmorton3@uwo.ca) or our lab coordinator, Bea Goffin (519-661-2111, x81442; bgoffin@uwo.ca).

If you have any questions about the conduct of this study or your rights as a research participant you may contact the Director, Office of Research Ethics, The University of Western Ontario, 519-661-3036 or email at: ethics@uwo.ca

Appendix E

Parental Letter of information



Appendix H: Parent Consent

1/6/2013

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Parent Consent Letter

Study: **Evaluation of the Healthy Relationships Plus Program for Youth**

Investigator: David Wolfe, Ph.D., Centre for Addiction and Mental Health (CAMH)
(519) 858-5144 ext. 25161

Purpose

The purpose of this study is to evaluate a 15 lesson (15 hour) program to promote youth well being, healthy relationships, and positive choices concerning drug and alcohol use. As a participant in this study, your child will be randomly selected to receive either the Healthy Relationships Plus Program (HRPP), or an alternative program where he/she creates a welcome packet for new grade 9 students at their school. Both programs are offered at your child's home school in July 2014 and are supervised by an adult. In total, 200 youth between the ages of 14-16 will take part in this study. Approximately 70 of these children will be from your child's school. Any child currently in Grade 9 or 10 can participate in this study.

We are seeking your consent and that of your child to participate in the research project, as described below.

Procedures

We are asking youth involved in the project to complete surveys and computer tasks to determine how participation in summer programming affects their well-being, coping and relationship skills. The survey, computer tasks and opening/closing activities will take approximately three hours to complete on the first and last day of the project, with scheduled breaks. The survey asks questions about personal characteristics, attitudes, relationships, and well-being. To help us better understand your child's experience in this project, we will also be collecting information on drug and alcohol use, experiences with violence in relationships, experiences with violence and stress at home, and growth and development. The computer tasks will involve problem-solving strategies and simulated games familiar to students. All the information collected will be valuable in helping us improve healthy relationship programming for young people.

Information about students' experiences and problem-solving strategies will be obtained in the following manner:

- The information described above will be collected from participating students on the first day of the project (July 7th, 2014) and on the last day of the project (July 17th, 2014);
- A smaller survey will be repeated again at 4 months (November 2014), 8 months (March 2015), and at 12 months (July 2015). Students will be contacted by phone or email and asked to complete the follow-up on-line questionnaire on their own time;
- And, after each program session (July 8th-17th, 2014), information on student satisfaction with that day's program may be collected.

Parent Initials: _____

Version 2, 02/07/2014, Appendix H – Parent Consent Letter 1

TRANSFORMING LIVES TRANSFORMER DES VIES

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We are also asking participating parents to provide brief information on their contact information, their education, their child's ethnic identity, and their child's behavioural characteristics. The behavioural characteristics of your child will help us get an idea of group composition for the program prior to the start date, and help us meet specific needs your child might have during summer programming. These characteristics are not used for selecting participants.

Follow-Up
It is important that we follow-up with students to assess the long-term outcomes of the project. This is why we will ask students to complete a short survey at four month intervals throughout the year. If your, or your child's, contact information should change over the course of the study, please contact us at the number on the last page of this information form. The contact information you and your child provide will only be used to contact you about the study, and not for any other purposes.

Eligibility
All youth are eligible to participate if they are currently in Grade 9 or 10 and are available for the 9 days of the program in July.

Confidentiality
The information you and your child give us is confidential. Only the researchers responsible for the project will be able to look at records containing your or your child's name, and to review the surveys or other materials containing your or your child's comments. There is one important exception. If the researchers or project staff feels that your child is in danger of harming him/herself or others, or that his/her health or life is in immediate danger, they are required by law to inform the appropriate authorities.

All questionnaires will be coded with a random number and kept in a locked room. Your child's name and all other information necessary to track his/her participation will be kept separate from the other information he or she provides. Only the investigator and his research staff will have access to this information. At the end of the study we will shred all papers with your or your child's name on them.

The information collected during this research may be used for educational purposes or become part of a published scientific report. This information, however, will **only** be reported in terms of group findings. **No** information will be reported that would allow anyone to be identified individually.

As part of continuing review of the research, your child's study records may be assessed on behalf of the Research Ethics Board. A person from the research ethics team may contact you (if your contact information is available) to ask your child questions about the research study and their consent to participate. The person assessing your file or contacting you and your child must maintain your confidentiality as well as that of your child's to the extent permitted by law.

As part of the Research Services Quality Assurance Program, this study may be monitored and/or audited by a member of the Quality Assurance Team. Your child's research records and

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CAMH records may be reviewed during which confidentiality will be maintained as per CAMH policies and extent permitted by law.

Risks
There are no known risks to participating in this study. It is possible that your child might be uncomfortable answering some questions on the surveys. However, participation in the study is voluntary. He or she will not be required to answer any question or participate in any activity that makes him or her uncomfortable.

Benefits
Developing healthy relationships is of interest to many teens. We think that your child will enjoy completing the surveys as they ask questions about topics that are important to teens. In addition, this research will provide significant social and scientific benefit through the knowledge that will be gained about healthy teen relationships.

Compensation
Your child will receive a total of $225 in gift cards to a local mall, movie theatre, or bookstore to compensate them for their time. Gift cards will be provided on Day 1 ($25), Day 5 ($50), Day 9 ($50) and at 4-month ($25), 8-month ($25) and 12-month follow-up ($50). On all 9 project days, snacks or lunch will be provided (depending on time of day). Transit tickets will be provided to get your child to and from their home school based on need.

Voluntary Participation
Your child's participation in this study is voluntary. He or she may choose to withdraw from the study at any time. In addition, the investigators or their staff responsible for this study may, at their discretion, end your child's participation at any time. Your choice to not have your child participate in this study will not affect his or her participation in any future program at school or in your community.

Additional Information
This letter is yours to keep. If you have any questions about this research that are not answered in these Information Sheets, please ask them. In addition, if you have any questions in the future, you may contact the study investigator at the telephone number on the first page. Dr. Padraig Darby, Chair, Research Ethics Board, Centre for Addiction and Mental Health, may be contacted by research subjects to discuss their rights. **Dr. Darby may be reached by telephone at (416) 535-8501 ext. 6876.**

Thank you for considering this project.

David Wolfe, PhD, ABPP
Role: Principle Investigator
Email: David.Wolfe@camh.ca
Telephone: (519) 858-5144 ext. 25161

Parent Initials: _____

Appendix F

Parental Consent Form

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PARENTAL CONSENT FORM

Please sign your name below if you agree to allow your child to participate in this research project. By signing this form, you are agreeing to:

1. Have your child complete a survey and computer task once at the beginning of the summer project and once again at the end;
2. Have your child attend 8 days of programming at their school in July 2014, and complete satisfaction forms at the end of each day;
3. Have your child complete follow-up questions every four months until July 2015.

I HAVE READ THE INFORMATION PROVIDED ABOUT THIS STUDY AND HAD MY QUESTIONS ANSWERED TO MY SATISFACTION. I VOLUNTARILY AGREE TO ALLOW MY CHILD TO PARTICIPATE IN THIS STUDY.

_____ _____

Name of parent or guardian (please print) Name of child (please print)

_____ _____

Signature of parent or guardian Date

Study Investigator:

David Wolfe, PhD, ABPP
Role: Principle Investigator
Email: David.Wolfe@camh.ca
Telephone: (519) 858-5144 ext. 25161

Appendix I: Youth Assent

146/2013

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FEB 2 1 2014

Youth Assent Letter

Study: **Evaluation of the Healthy Relationships Plus Program for Youth**

Investigator: David Wolfe, Ph.D., Centre for Addiction and Mental Health (CAMH)
(519) 858-5144 ext. 25161

Purpose
The purpose of this study is to evaluate a 15 lesson (15 hour) program to promote youth well-being, healthy relationships, and positive choices concerning drug and alcohol use. As a participant in this study, you will be randomly selected to receive either the Healthy Relationships Plus Program (HRPP), or an alternative program where you create a welcome packet for new grade 9 students at your school. Both programs are offered at your home school in July 2014 and are supervised by an adult. In total, 200 youth between the ages of ~~14-16 will~~ take part in this study. Approximately 70 of these youth will be from your school. Any student currently in Grade 9 or 10 can participate in this study.

We are seeking your assent to participate in the research project, as described below.

Procedures
As part of the research component, you will be asked to complete survey and computer tasks. The survey, computer tasks and opening/closing activities will take approximately three hours to complete on the first and last day of the project, with scheduled breaks. On the survey, there will be questions about personal characteristics, attitudes, relationships, and well-being. To help us better understand your experience in this project, we will also be collecting information on drug and alcohol use, experiences with violence in relationships, experiences with violence and stress at home, and your growth and development. The computer tasks will involve problem solving strategies and simulated games familiar to most students. All the information collected will be valuable in helping us improve healthy relationship programming for young people.

You will be asked information about your experiences and problem-solving strategies on the following schedule:

- The information described above will be collected from you on the first day of the project (July 7th, 2014) and on the last day of the project (July 17th, 2014);
- The survey will be repeated again at 4 months (November 2014), 8 months (March 2015), and at 12 months (July 2015). You will be contacted by phone or email and asked to complete the follow-up on-line questionnaire on your own time;
- And, after each program session (July 8th-17th, 2014), we may ask you questions about your satisfaction with that day's program.

Follow-Up
It is important that we follow-up with you to assess the long-term outcomes of the project. This is why we will ask you to complete a survey at four month intervals throughout the year.

Student Initials: _____

Appendix G

Youth Letter of Information

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The contact information you provide will only be used to contact you about the study, and not for any other purposes.

Eligibility
All youth are eligible to participate if they are currently in Grade 9 or 10 and are available for the 9 days of the program in July.

Confidentiality
Your survey responses are confidential. Only the researchers responsible for this project will be able to look at records containing your name, and to review the surveys or other materials containing your comments. There is one important exception. If you tell a researcher or program staff that you are in danger of harming yourself or others, or that you have experienced violence at home, we will have to tell someone.

Risks and Benefits
There are no known risks with participating in this study. You may feel uncomfortable answering some questions. The benefits of participating in this study include learning about community services for teens experiencing difficulties, and contributing to research about healthy teen relationships, which is important for developing programs in schools.

Compensation
Your will receive a total of $225 in gift cards to a local mall, movie theatre, or bookstore to compensate you for your time. Gift cards will be provided on Day 1 ($25), Day 5 ($50), Day 9 ($50) and at 4-month ($25), 8-month ($25) and 12-month follow-up ($50). On all 9 project days, snacks or lunch will be provided (depending on time of day). Transit tickets will be provided to get you to and from school based on need.

Voluntary Participation
Participation in this study is voluntary. You may choose to withdraw from the study at any time. You may choose not to participate in this study even if your parent/guardian has agreed to your participation. If you choose not to participate in the study, this will not affect your participation in any other school or community program in the future. Choosing not to participate in the study will not affect your grades.

Additional Information
This letter is yours to keep. If you have any questions about this research that are not answered in these Information Sheets, please ask them. In addition, if you have any questions in the future, you may contact the study investigator at the telephone number given on the first page. Dr. Padraig Darby, Chair, Research Ethics Board, Centre for Addiction and Mental Health, may be contacted by research subjects to discuss their rights. **Dr. Darby may be reached by telephone at (416) 535-8501 ext. 6876.**

Thank you for considering this project.
David Wolfe, PhD, ABPP
Role: Principle Investigator
Email: David.Wolfe@camh.ca / Telephone: (519) 858-5144 ext. 25161

Student Initials: _____

Appendix H

Youth Informed Consent

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YOUTH ASSENT FORM

Please sign your name below if you agree to participate in this research project. By signing this form, you are agreeing to:

1. Complete a survey and computer task once at the beginning of the summer project and once again at the end;
2. Attend 8 days of programming at your school in July 2014, and complete satisfaction forms at the end of each day;
3. Complete a survey every four months starting November 2014 until July 2015.

I HAVE READ THE INFORMATION PROVIDED ABOUT THIS STUDY AND HAD MY QUESTIONS ANSWERED TO MY SATISFACTION. I VOLUNTARILY AGREE TO PARTICIPATE IN THIS STUDY.

_____ _____
Name (please print) Signature

_____
Date

Study Investigator:

David Wolfe, PhD, ABPP
Role: Principle Investigator
Email: David.Wolfe@camh.ca
Telephone: (519) 858-5144 ext. 25161