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DEVELOPING AND FEASIBILITY TESTING OF COGNITIVE CONTROL AND FLEXIBILITY TRAINING FOR SYMPTOMATIC ATTENTION DEFICIT/HYPERACTIVE ADOLESCENTS

by

Abdul Hadi Tariq Raja
BSP191014

A Research Thesis submitted to the
DEPARTMENT OF PSYCHOLOGY
in partial fulfillment of the requirements for the degree
of BACHELOR OF SCIENCE IN PSYCHOLOGY

Faculty of Management and Social Sciences
Capital University of Science & Technology,
Islamabad

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CERTIFICATE OF APPROVAL

It is certified that the Research Thesis titled "Developing and Feasibility Testing of cognitive control and flexibility training for symptomatic attention deficit/hyperactive Adolescents" was carried out by Abdul Hadi Tariq Raja, Reg. No. BSP191014, under the supervision of Dr. Sabahat Haqqani, Capital University of Science & Technology, Islamabad, is fully adequate, in scope and in quality, as a Research Thesis for the degree of BS Psychology.

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Developing And Feasibility Testing Of Cognitive Control And Flexibility Training For Symptomatic Attention Deficit/Hyperactive Adolescents

By

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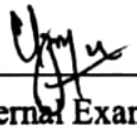

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DECLARATION

It is declared that this is an original piece of my own work, except where otherwise acknowledged in text and references. This work has not been submitted in any form for another degree or diploma at any university or other institution for tertiary education and shall not be submitted by me in the future for obtaining any degree from this or any other University or Institution.

Abdul Hadi Tariq Raja

BSP191014

January 2023

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ABSTRACT

Cognitive Control and Flexibility are among the areas of deficit in individuals with ADHD, specifically, response inhibition is an essential ability to control action and flexibility to shift and update cognitive sets selectively. Prior research studies had indicated that ADHD symptoms arise from deficits in higher-order cognitions, also called Executive Functions (EFs). While inhibitory control refers to the active and selective process of attending to task-related specific information while inhibiting irrelevant actions, Cognitive flexibility, on the other hand, requires constant updating of mental processes to adaptively meet situational demands. The present study aimed to develop and apply cognitive control and flexibility training using the Go-No-Go, Intra-Extra Dimensional set-shifting task. A total of (N = 142) participants were screened and among those, (n = 21) participants were positively screened for ADHD symptoms. participants were recruited using convince sampling. A quasi-experimental design was utilized where two groups of participants were formed, one with predominantly inattentive ADHD subtype and another with Combined ADHD symptoms. with no control group. The results indicate a statistically insignificant difference in attention and impulsivity following the intervention (p = .484 and .08). Such findings suggest that additional behavior-specific interventions might be more beneficial since general cognitive training yielded non-significant results.

Keywords: Cognitive Control, Cognitive Flexibility, ADHD, Executive Functions.

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List of Acronyms/Abbreviations

FAS	**Family Affluence Scale**
BIS	**Barratt Impulsiveness Scale**
ASRS	**Adult ADHD Self-Report Scale**
ACSC	**Attentional Control Scale for Children**
EFs	**Executive Functions**
ADHD	**Attention-Deficit Hyperactivity Disorder**
IDE	**Intra-Extra Dimensional Set-Shifting**
GNG	**Go-No-Go Task**

Chapter 1

Introduction

Inattention/elevated distractibility and impulsivity/hyperactivity constitute two core sets of symptoms delineating individuals with Attention-Deficit-Hyperactivity Disorder (ADHD). ADHD individuals endure a wide range of long-term poor outcomes, including academic, like failing/repeating grades, low scores on achievement tests, anti-social behaviors including delinquency, school expulsion, and in addition, negative outcomes within social relationships, such as peer nominations scores, and marital status are equally common (Shaw et al., 2012).

The DSM-5-based estimate suggests a 5% prevalence in children across cultures while 2.5% among adults, though Thomas and colleagues (2015) in their systematic review suggested a 7.2% pooled prevalence among children. Likewise, in the context of South Asia for example, prevalence studies in China, Taiwan, and India among children yielded 6.7%, 4.2%, and 7.1% respectively (Liu et al., 2018; Joseph & Devu, 2019). Yet, such estimates are generally lacking in Pakistan.

Individuals with ADHD exhibit deficits in higher-order processes needed for goal-directed, planned behavior, such as contemplating and maintaining future actions, sustaining attention, and successful inhibition of inappropriate actions. such processes are collectively known as Executive Functions “EF” and their dysfunction underlies ADHD symptom behaviors (Douglas, 1972; Pennington & Ozonoff, 1996; Sergeant et al., 1999). Research persistently suggests that deficits in 1) motor response inhibition, 2) cognitive flexibility, 3) working memory (WM), and 4) sustained attention are widely present among individuals with ADHD (Willcutt et al., 2005, 2008; Rubia, 2011, 2013; Pievsky & McGrath, 2019).

Response inhibition is a critical aspect of cognitive control and it refers to the cessation of action due to a change in goal, and several studies indicate a group-level impairment in cognitive control among individuals with ADHD (Zeeuw & Druston, 2017; Chiu, 2019). However, impulsivity is a multifaceted construct, and in the current study, response inhibition is related to the domain of impulsivity that refers to the inability to inhibit prepotent responses, that is responses that have been initiated and have a strong tendency to be maintained (Barkley, 1999). Such capacity is usually assessed via the Stop Signal Task and the Go-No-Go tasks (Aron & Poldrack, 2005). The literature suggests that individuals with ADHD often display impaired performance on many computerized cognitive tasks, for example, Zhe et al. (2021) conducted a study on ADHD children and disruptive-impulse control and conduct disorder patients, and the researchers found higher reaction time and error scores on the Golden Interference Scores among the ADHD group suggesting an impairment in cognitive control.

On the other hand, cognitive flexibility underlies inattention behaviors in ADHD. According to the cognitive complexity and control theory (CCC), cognitive flexibility refers to the ability to shift between two incompatible prospectives or descriptions of an object and that capacity requires formulating a high-order rule that ground conflicting perspectives under that high-order rule (Jacques & Zelazo, 2005; Zelazo et al., 2003). Thus, the ability to formulate and utilize those rules enables children to engage in more complex behaviors and control their attention. Hence CCC theory predicts that impaired cognitive flexibility underlies inattention (Farrant et al., 2013). Research suggests that such an ability is often compromised in several neurodevelopmental disorders (Dajani & Uddin, 2015).

Specifically, on set-shifting tasks, ADHD children demonstrated significant deficits compared to neurotypical ones (Boshomane et al., 2021).

The current research's goal was to develop and apply cognitive control and flexibility training on ADHD Symptomatic Adolescents to test the feasibility of the cognitive-based intervention in individuals with ADHD symptoms.

Literature Review

The Development of Executive Functions

Executive functions (EF) is a broad term that consists of all cognitive processes necessary for adaptive, goal-directed behavior. It allows one to plan action, sustain attention, inhibit distractions, and monitor performance. For successful human behavior, executive functions are a crucial set of interrelated, high-order, top-down processes that inform the execution of appropriate behavior through internal processes of planning, goal setting, and inhibition (Jurado & Rosselli, 2007; Miyake, A et al., 2000; Altmann & Trafton, 2002). Executive functions are specifically crucial in novel situations that require adaptive flexibility and where automatic, heuristics-based behavior is likely to be maladaptive for the current goal (Blakey, 2016). Studies on adults' executive function suggest a three-factor model of EF, that consists of 1) Working Memory, 2) Inhibitory Control and 3) Cognitive Flexibility (Diamond, 2020).

Working Memory (WM) refers to an active holding and manipulation of key information in the mind for the execution of other multiplex mental processes, such as language comprehension, reasoning, and learning (Baddeley, 1992). WM is argued to be essential for making sense of what one reads or hears, for more than two words of sentences, WM is actively holding what you read earlier in order to make sense of what is being read or heard now (Diamond. 2020).

Inhibitory control allows us to selectively attend to specific information relevant to the current goal/task we are pursuing, while simultaneously inhibiting task-irrelevant information (Peters, 2020). On the contrary, cognitive flexibility requires an adaptive process

of selective updating/switching of mental processes and states to generate appropriate behavioral responses elicited by change/demand in the external world (Dajani & Uddin, 2015). There is an overall consensus among researchers that the development of executive functions is mediated by and correlated with cerebral maturation, specifically in the anterior cerebral structures and prefrontal cortex (Anderson, 2001).

Such perspective has also been endorsed by the evidence that the performance on executive tasks through childhood improves as a function of the outburst growth in the frontal lobes (Levin, H. S et al., 1991; Welsh & Pennington, 1988; Bell & Fox, 1992; Thatcher, 1992). However, the development of executive function as mediated by the frontal cortex growth follows a hierarchical and dependency pattern, since frontal lobes areas receive and process all input from other areas such as the posterior and subcortical cerebral regions, thus growth in terms of dendritic arborization, myelination, and synaptogenesis occurs last in the anterior regions. (Anderson, 2001).

Hence Anderson (2001) suggested that such pieces of evidence reflect that executive function development is dependent on the development of other basic sensory and perceptual functions. Similarly, Stuss (1992) developed an influential model of feedback-feedforward systems of hierarchical development of several cognitive activities. The lowest and the most basic neuropsychological system is primarily concerned with the “routinized activities” of sensation and perception that assist in all kinds of behavior in a constant mode. The second neuropsychological system of cognitive activities, or what is called, the “supervisory” systems of frontal lobes (Stuss & Benson, 1986).

The basic aim of such a system is to monitor and control input received from the lowest sensational and perceptual systems toward a determined goal, such abilities are then further classified as executive functions of control, flexibility, planning, and goal selection. The highest level of the neuropsychological system is consciousness, referred to as

"meta-cognition" which is described as a self-reflective ability on all aforementioned lower levels.

Executive Functions and ADHD

ADHD has long been viewed as a behavioral dysfunction affecting children and adolescents, however, in recent years, a major shift took place in the conceptualization and understanding of the disorder's nature as in essence a cognitive disorder associated with a developmental impairment in executive functions (Brown, 2008). Neuropsychological assessments have long been used to assess executive functions for ADHD, such as the Wisconsin Card Sorting Task, Stroop Task, the Trail Making Test, part B, and the Spatial Span backward from the WISC battery (Brown, 2007).

Lambek and colleagues examined executive function (EF) deficits among school-age children diagnosed with ADHD and compared them with the normal population on eight different EF measures; the researchers found that at a group level, ADHD children performed significantly worse than the control children. Equivalently, Pineda-Alhucema and colleagues found a denoting variation of the ADHD group on three similar neuropsychological tests compared to the normal group. Nonetheless, Brown (2008) noticed that when such traditional measures were used, only 30% of ADHD patients showed significant dysfunction, leading researchers to assume that executive dysfunction is a mere comorbid affecting only one-third of ADHD cases.

Burgess and Rabbitt (1997) suggested such measures do not evaluate the integration of executive functions, despite their importance as a facet of EF. Since the most common feature of all ADHD patients is an executive malfunction, a combination of clinical interviews, self-report and informant measures can be used to assess a patient's ability to manage tasks in daily life (Barkley, 2006, 2008b, 1997; Brown, 2005, 2006, 2000).

Biederman and colleagues used a behavior rating scale to test how it assesses executive dysfunction associated with ADHD, the researchers found that individuals scoring above the 5th percentile were at high risk of serious life-activities dysfunction resulting from their disorder. Similarly, Kooij, J. J, and colleagues tested several self-report measures of ADHD and found that the Adult ADHD Rating Scale and Brown-Attention-Deficit-Disorder Scale (BADDS) predicted clinical diagnosis the best. Neuropsychological studies on ADHD-associated executive dysfunction suggest domain-specific deficits that are most prevalent among individuals with ADHD, namely, response inhibition, working memory (WM), and set-shifting (Doyle, 2006).

Cognitive Control and ADHD

Humans engage in a considerable amount of complex behavior that requires conscious control of sensory-perceptual input to direct behavior toward a target or satisfy an intention. Cognitive control (CC) denotes the capacity to allocate mental resources to focus on information that is currently relevant to accomplishing a particular goal, while simultaneously inhibiting task/goal irrelevant information resulting in successful maintenance of the cognitive representation of the current/ongoing task (Morton et al., 2011; Botvinick & Braver, 2015).

Cognitive control has been measured via two main methods, self-report tools and questionnaires, such as the Cognitive Control and Flexibility Questionnaire (CCFQ) developed by Gabrys, R. L et al., (2018), and other performance-based tasks. The most widely used tests are what is referred to as the continuous performance task (CPT), which contains a continuous presentation of stimuli with specific instructions on which stimuli to respond to, and which to inhibit (Münger et al., 2022). One such performance measure is the Go/No-Go task, the traditional version of it has two trials where a participant has to respond quickly and accurately to the “Go-trial” and refrain from responding to the “No-Go trial”.

The primary dependent measure is commission errors (CE) which is the proportion of unsuccessfully withheld responses, and high errors indicate poor inhibition (Wright et al., 2014).

Research studies propose that the widely known theoretical model of ADHD indicates a specific aspect of cognitive control that is thought to represent a core deficit among ADHD patients, one such area that has been widely researched is response inhibition (Barkley, 1997). Response inhibition is a key element of cognitive control and refers to the cessation of action due to a change in goal (Chin Chiu, 2019).

However, to accurately measure inhibition, the "Go-trials" has to outnumber the "No-Go trials" by establishing a sequence of "Go trials" that result in a strong propensity for a prepotent response, as Nigg (2000) commented that the operationalization of inhibition yields different results, and he suggested that stronger deficits were found when inhibition referred to the suppression of the prepotent responses, especially, tasks like the stop signal and Go-No-Go tasks, and variables findings are found when inhibition referred to suppression of the conflicting response using tasks like Stroop task. Wodka et al., (2007) used the Go-No-Go task to compare ADHD children with normal subjects from the control group and the researchers found that ADHD children committed significantly more commission errors, (which is an index of unsuccessfully withheld responses) compared to the control children, thus supporting Nigg's observation.

Furthermore, a study conducted by Adams et al., (2010) assessed children with ADHD subtypes on both visual and manual stop-signal tasks, and their findings suggested that both ADHD groups were much slower to inhibit responses when compared to control groups. Several meta-analyses have supported Nigg's observation and found an average to large effect size on the stop signal task reaction time of 0.54 - 0.85 SSRT (Oosterlaan et al., 1998; Lijffijt et al., 2005; Willcutt et al., 2005; Harvey et al., 2004).

Cognitive Flexibility and ADHD

Cognitive flexibility (CF) is one of the important human cognitions that is often regarded as an essential feature of intelligent behavior. Cognitive flexibility refers to the adaptive process of selective updating/switching of mental processes and states to generate appropriate behavioral responses elicited by change/demand in the external world (Dajani & Uddin, 2015).

Cognitive flexibility has been also measured using either self-report or performance-based tasks, however, Bunge and Zelazo (2006) developed a hierarchical model of Cognitive flexibility, in which set-shifting tasks are conceptualized as lower cognitive flexibility tasks that involve following one type of rule to complete a task and then shifting to another type of rule, such as the Wisconsin Card Sorting Test.

Separate from the Wisconsin Card Sorting Test, set-shifting has also been measured using the Intra-Extra-Dimensions Set-shifting task (IED) from the Cambridge Neuropsychological Test Automated Battery, which is an attentional shift task that requires the participants to exhibit set-relevant responses and change response when the set is shifted. Each set requires a subject to match shapes either via color or shape. The task comprised three sets; Intra-Dimension Shift contains stimuli has to be matched within the dimension of the color-to-color shift, whereas the Extra-Dimension shift stimuli are to be matched from a color to shape or shape to color, thus requiring an extra-dimension response.

Among several executive functions, set-shifting as an aspect of cognitive flexibility has been substantiated to be associated with ADHD, in a Meta-analysis, Willcutt., (2005) found among several other functions a moderate impairment in set-shifting of a size of 0.43 - 0.69.

In one study conducted by Kercood, S et al., (2017) assessing the cognitive flexibility of individuals with and without ADHD, the researchers found that individuals with ADHD

symptoms had a significant decrease in cognitive flexibility compared to individuals without ADHD. Similarly, Roshani et al., (2019) conducted a study assessing cognitive flexibility and risk-taking among adults with ADHD, using the Cognitive Flexibility Inventory as a self-report measure, the researchers found that as opposed to the control group, ADHD individuals obtained substantially lower scores on cognitive flexibility inventory and on appropriate risk-taking and reaction time. Additionally, Boshomane et al., (2012) found that children with ADHD subtype have committed significantly more total errors on set-shifting tasks than neurotypical comparison group participants. Such results have also been corroborated by Mphahlele et al., (2022) study of 216 positively screened children with ADHD symptoms who were found to exhibit more impaired set-shifting than the matched control group.

Theoretical Framework

To navigate the dynamic nature of the environment, individuals must continuously assess their actions and behaviors, compete between, and select ones that maximize the perceived value of the desired goal they are pursuing, therefore executive Functions (EFs) can be conceptualized as a neurocognitive process that sustain a set of problem-solving methods to achieve the desired future goal (Pennington, 2002). Executive Dysfunction thus refers to the impairments of higher-level cognitive processes like planning, working memory, inhibition, and flexibility (Alvarez, J. A., & Emory, E. 2006; Shallice, T. 2002). These higher cognitive processes regulate and modify lower cognitive processes like memory, language, and learning; thus, Executive Dysfunction Theory suggests that ADHD symptoms arise directly from deficits in the executive functions' domain, specifically, the frontoparietal and frontostriatal neural networks (Willcutt et al., 2005). The basis of the theory lies within the observation that prefrontal lesions sometimes produce ADHD-like symptoms (Fuster, 1997; Stuss & Benson, 1986). In the same meta-analysis conducted by Willcutt et al., (2005) the researchers found the largest effect size difference between the ADHD group and the normal population group on executive functions domains of response inhibition, planning, and vigilance, as measured by continuous performance tasks and set-shifting. Several studies mentioned above indicate a consensus that ADHD is correlated with cognitive control and flexibility deficits, thus, along these lines, the aim of the present study utilized the Go/No-Go paradigm as a response inhibition task to develop progressive training tasks of cognitive control for individuals with predominantly impulsive/hyperactive ADHD symptoms. On the other hand, the Intra-Extra-Dimension Set-Shifting task set-shifting is essentially used as a cognitive flexibility measure, in which training sessions were developed and administered to individuals with predominantly inattentive ADHD symptoms. Individuals with combined symptoms of ADHD were instructed to perform both tasks.

Rationale

ADHD accompanies several long-term poor social outcomes, as mentioned above, and ample neuropsychological studies in the literature suggest that ADHD is at least associated (if not caused) with several deficits in executive functions (Loe, I. M., 2007). Researchers have also demonstrated that training programs and using various neuropsychological tasks can be used to enhance key executive functions, like working memory and response inhibition. Nonetheless, to the best knowledge of the researcher, there has not been adequate research that draws on such findings and attempts to train individuals with ADHD using the traditional measures to assess its impact on their symptoms through targeting key executive functions. The literature suggests that much research was done on what's referred to as the primary outcomes of executive functions training, that is, improved reaction time, fewer errors, and overall improvement in the performance of various computerized tasks, however, if one were to assume that such tasks reflect cognitive deficits among individuals with ADHD symptoms, then one can test whether behavioral symptoms actually improve too as a result of improvement in relevant task performance. Furthermore, the present study assessed the Executive Dysfunction theory by whether or not targeted training in areas of executive deficits will or will not alleviate ADHD symptoms (Johnson et al., 2009). Thus, the current study aimed to address the gap and test for the development and application of cognitive control and flexibility training in progressive tasks, for individuals with ADHD symptoms. The importance of designing a progressive tasks session becomes evident when the same task paradigms evoke pre-existing ADHD symptoms within a participant, therefore it is crucial to gradually increase difficulty to account for such an issue. Finally, the present study severed to explore further dimensions of ADHD subtypes dysfunctions, as impulsivity and inattention are multifaceted constructs and efforts should be directed to explore which facet is at the essence of ADHD symptoms.

Objectives

Following are the objectives of the study

1. To examine the impact of Cognitive Control Training using the Go-No-Go Tasks on adolescents with predominantly hyperactive/impulsive symptoms of ADHD.

2. To assess the impact of Cognitive Flexibility training using set-shifting on adolescents with predominantly inattentive symptoms of ADHD.

3. To evaluate the impact of Cognitive Control and Flexibility training on adolescents with combined symptoms of ADHD.

4. To translate the Attentional Control Scale for Children (ACS-C) from English to Urdu Language.

Research Questions

1. What is the impact of Cognitive Control Training using the Go-No-Go Tasks on adolescents with predominantly hyperactive/impulsive symptoms of ADHD?

2. What is the impact of Cognitive Flexibility Training using the set-shifting on adolescents with predominantly inattentive symptoms of ADHD?

3. What is the impact of Cognitive Control and Flexibility training on adolescents with combined symptoms of ADHD?

Hypotheses

H1. There would be a significant difference between the pre-and post-cognitive control training scores on impulsiveness among adolescents with predominantly hyperactive/impulsive symptoms of ADHD.

H2. There would be a significant difference between the pre-and post-cognitive flexibility training scores on attentional control among adolescents with predominantly inattentive symptoms of ADHD.

H3. There would be a significant difference between the pre-and-post-cognitive control and flexibility training scores on attentional control and impulsiveness among adolescents with predominantly combined symptoms of ADHD.

Chapter 2

Method

Research Design

To examine the impact of Cognitive Control and Flexibility training on adolescents with ADHD, the study utilized a pre-post-test quasi-experimental design, in which there were two main experimental groups, one comprised of participants with predominantly inattentive ADHD subtype and another group of participants with predominantly combined ADHD subtype.

Population and Sample

Data was collected from two boys' government high schools in Islamabad and Rawalpindi cities. Students from grades 9 to 10 were selected to be in the pool where the sample has been drawn. Initially, females were considered as part of the sample, however, several girls schools denied permitting the researcher due to practical and cultural reasons. Both grade sections were selected randomly to be sections where participants were screened for ADHD symptoms. A total of N= 142, participants aged between 13-18 years were screened for ADHD symptoms, and among the total screened participants, n=21 participants positively met the scoring requirements for the significant existence of ADHD symptoms. Those were further divided into experimental groups, and no control group was taken due to practical and time-related constraints that made additional screenings from schools impossible.

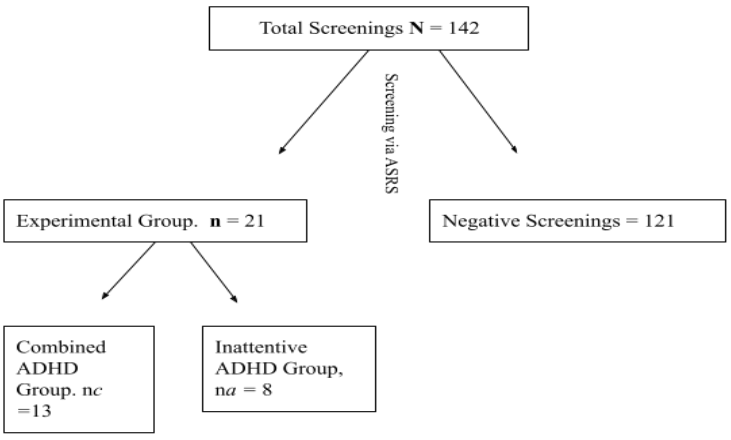


Figure A

An illustration of the sampling procedure

ADHD Subtypes Experimental Groups

Among the total of 21 positively screened participants, 8 participant screening results qualified them to be grouped under the Inattentive ADHD Subtype, while on the other hand, 13 participants indicated high scores on both subscales and thus were designated under combined ADHD subtype.

Sampling Procedure/Technique

As part of convenient sampling, schools were selected on the basis of the researcher's prior contact with schools' principals. Students were recruited on a similar basis, except for those who met the exclusion criteria.

Inclusion Criteria for Intervention Qualification

1. Participants aged between 14-17 years.
2. Participants positively screened for ADHD symptoms

Exclusion Criteria Intervention Qualification

1. Participants who have any kind of physical or mental disabilities that hinder their successful participation in either questionnaires reading or performing the intervention are excluded.
2. Participants who are currently or have received any kind of psychological/cognitive-based therapies from professional providers were excluded.

Measures/Instruments

Demographic Sheet

The demographic information sheet is comprised of two main sections, the first is related to an individual's personal and familial information, such as name, age, gender, grade, living with both or one parent, and parental occupation. The other section is the Family Affluence Scale. Also, questions prompting a participant about their history of taking

psychological therapies were added to rule out confounding effects of uncontrolled therapies with the intervention. All questions were written in Urdu language.

Family Affluence Scale (FAS-II)

The family affluence scale has been used to assess socioeconomic status among children and adolescents who are living with their families, since children may not be able to give accurate income and parent occupation-related information about their family. (Currie et al., 1997). As a result of such difficulty, the family affluence scale has been used in WHO-Health Behavior in School-aged Children (HBSC) survey. WHO-Health Behavior in School-aged Children (HBSC) survey. The Family affluence scale consists of four items, which are then summed to produce a total score. A score of 0-2 equals low affluence, a 3-5 is medium affluence, and a 6-9 score represents high affluence (Boyce et al., 2006). In this study, an Urdu version of the FAS was used.

Go-No-Go Task Paradigm

GNG measures the response inhibition component of cognitive control, using a continuous performance task where participants are given a sequence of stimuli whereupon instruction they only respond to certain stimuli and refrain from responding to others. The number of go-trials always exceeds the number of no-trials to elicit prepotency (Zeeuw & Durston, 2017). The main dependent variable is “commission error” (making a “Go” on the “No-Go trial”) where fewer errors indicate better response inhibition.

A total of 5 sessions along with the practice session were created using the PsyToolkit open-source software to design the Go-No-Go task. (Stoet, 2010, 2017). Sessions were designed to increase difficulty. All sessions had a total of 130 trials, 30 of No-Go, and 100 of Go trials, however, the response window decreased by 200ms with every session, starting with 1100ms in session 1 and 300ms in session 5. The stimulus shapes were changed in sessions to prevent practice effects.

Task Instructions and Translation: participants were given a practice session to familiarize themselves with the nature of the task. Instructions were translated into Urdu by bilingual psychology students. At first, participants were shown two types of stimuli, green and red color shapes. They were instructed to only respond to green color shapes by clicking the space bar on the keyboard and refrain from responding when they see the red color shape. All these instructions were shown on the first screen in the practice session.

Intra-Extra Dimension Set-Shifting (IED)

Set-shifting is regarded as a lower-level task, consisting of two sets of shifts and stay trials, where participants are required to follow sets of changing rules, in order to complete the task. (Yerys et al., 2015). Intra-Extra Dimension Set-Shifting (IED) task presents the subject with three stimuli on one trial, two on the top and one at the bottom, and participants were instructed to match the bottom shape with any of the two shapes at the top. The stimuli have to be matched on either dimension of color or shape matching. There was a total of 36 stimulus shapes, 6 shapes, (triangle, circle, pentagon, diamond, trapezoid, and a wide hexagon) and 6 different colors (brown, purple, red, yellow, blue, and green) combined to produce 36 trials. The task was designed to be self-paced and only advanced to the next trial when participants gave a response. A total of 3 sessions were given to the participants, (6, 12, and 18 trials respectively) which contained two main types of shifts, an easy shift also called intra-dimension shift refers to the matching criteria changes within the dimension of the color-to-color match. Hard shifts are called Extra-Dimension where the matching criteria change between dimensions from color to shape or shape to color.

IED Task Instructions and Translation: Participants were provided with a practice session to understand the rules. Within one trial, there were three different shapes with different colors, and participants were instructed to match the bottom shape (either color or shape match) with either of the top two shapes. And in case the matching top shape happen to

be on the right, they were asked to respond by pressing the key button "B" on the keyboard, and in case the match happened with the left top shape they would respond by pressing the "V" key button on the keyboard. Finally, in non-shift trials, i.e. no match trials, they were asked to respond by pressing the "N" key button on the keyboard. All these instructions were translated into the Urdu language by a bilingual psychology student and were shown as the first image on the screen in the practice session.

Adult ADHD Self-Report Scale (ASRS)

The ASRS is a self-reported measure developed by Kessler et al., (2005) based on DSM-IV-TR assessing symptoms of ADHD among adults, consisting of part A, assessing items 1-6, and Part B measuring 7-18 items. Items are scored as 1= Never, to 5=Always. Part A of the ASRS is referred to as a screener, and part B items are called symptom checklists that were devised according to DSM-4TR. The ASRS demonstrated good psychometric properties, where it has a Cronbach alpha of 0.88 (Adler et al., 2006). The ARSR is also a valid measure for adolescents (Adler & Newcorn, 2011). In the current study, Urdu-translated version of the instrument was used.

Re-translation of the Adult ADHD Self-Report Scale: The ASRS was originally translated on behalf of World Health Organization composite international diagnostic interview advisory committee by various researchers from Pakistani universities. In the current study, the translated ASRS was simplified into a more basic Urdu to suit adolescents.

Barratt Impulsiveness Scale BIS-11

The BIS-11 developed by Patton, J. H et al., (1995) to measure impulsivity, is a 30-item self-report tool. Each item is scored 1-4, 1 never/rarely, 4 almost always/always. The BIS-11 has an internal consistency and retest reliability of 0.78 and 0.89 respectively in a non-clinical sample (Fossati, 2001). The BIS has three components/factors of impulsiveness. Attentional impulsiveness measured by items (5, 9*, 11, 20*, 28, 6, 24, 26). Motor

Impulsiveness was measured by items; 2, 3, 4, 17, 19, 22, 25, 16, 21, 23, 30*). Non-Planning Impulsiveness items were measured by items (1*, 7*, 8*, 12*, 13*, 14, 10*, 15*, 18, 27, 29*). All subscales then are summed to produce a total score of impulsiveness. An Urdu-translated version by Jafri and Yousaf (2013) was used in this paper.

Attentional Control Scale Children (ACS-C)

The ACS is a 20-item self-rated tool developed by Derryberry and Reed, (2002) to assess sustaining and shifting of attention. Items are scored on a 1 to 4 Likert scale, in which 1 indicates "almost never", and 4 indicates "always". After reverse scoring higher scores indicate stronger attentional control. Items 1-9 of the ACS measure attentional focusing, and items 11-20 measure attentional shifting. The ACS has been adapted for the children/adolescent population reported Cronbach alpha value for ACS-C is 0.72 (Muris et al., 2003). The instrument has been translated into Urdu for the purpose of the present study.

Translation of the Attentional Control Scale for Children

Among the questionnaires used in this study, only the Attentional Control Scale for Children was not available in Urdu translation. Following are the steps that were taken to translate the Attentional Control Scale for Children from English to Urdu language.

Forward Translation. for the purpose of translating the ACSC, two independent bilingual translators were contacted, with bachelor's degrees in translation and interpretation, and each of them independently provided two forward translations (English to Urdu) copies for the instrument.

Review of Forward Translation. After the initial translations, it was reviewed by the supervisor of this research for mistakes in the translation, actual and contextual meaning, and conceptual equivalence. It was also important to replace difficult words with relativity easier ones suitable for the adolescent population.

Backward Translation. For backward translation, the researcher selected two students with a psychology background who were perceived and judged to have more knowledge of the Urdu language, and each was given the instruments back from Urdu to English. Following their provision of translated copies, the researcher then compared both translations and selected the items from both copies that reflect semantic equivalence with the original items to form a final draft for backward translation.

Review of Backward Translation. After producing one final draft for backward translation, it was then reviewed by the supervisor of this research. Each item was manually reviewed one by one using Oxford English and Urdu dictionaries.

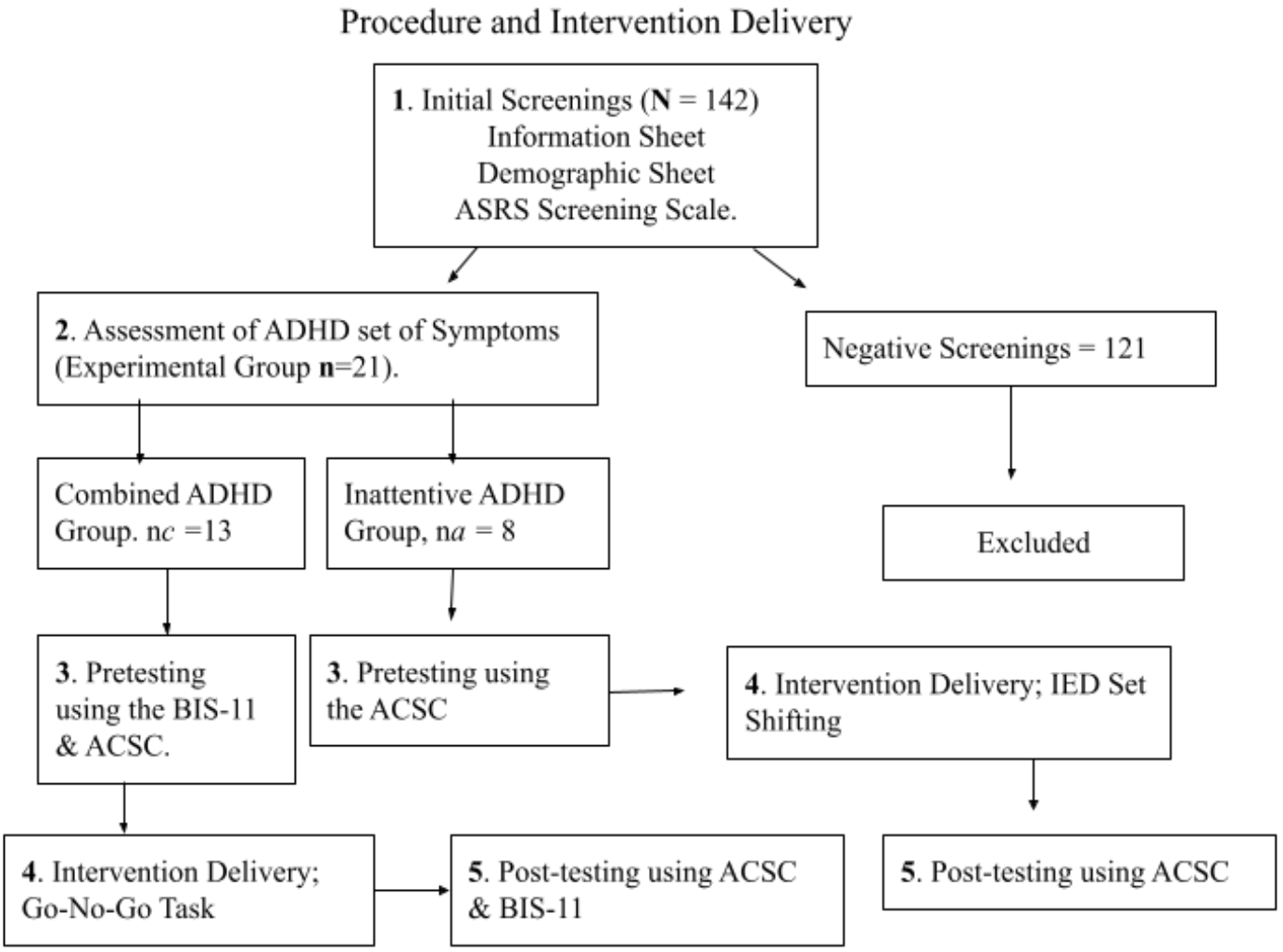
Procedure

Participants were recruited from government public schools in 9th grade. They were initially screened for ADHD symptoms using the ASRS and upon analyzing their results in terms of an ADHD-specific set of symptoms. 21 participants were qualified for the intervention, (G1: Inattentive group=8, G2: Combined group=13). For G1, each participant was given the ACS-C instrument to further explore their symptoms and to establish a pre-test baseline on which a comparison can be made later. Following their pre-testing. Each participant underwent a total of 4 training sessions of set-shifting tasks individually for a duration of 10-15 minutes administered by the researcher. Finally, after the successful completion of all training sessions. Participants were post-tested using the ACS-C instrument.

G2 participants were provided with the ACS-C and BIS-11 to further assess their combined ADHD symptoms, and following their pre-testing, each participant underwent a total of 9 training sessions, five of which were of Go-No-Go tasks and four were of set-shifting, for the duration of 15-20 minutes administered by the researcher. Lastly, participants were post-tested using both the ACS-C and BIS-11. The following graph represents the steps taken for data collection and intervention delivery.

Figure B

Steps of Data Collection and Intervention Delivery



Ethical Considerations

In addition to obtaining formal approval from the university, permission and written approval were also taken from school principals. Furthermore, an information sheet was prepared to include details related to the nature of the study, duration of participation, rights to privacy and confidentiality, protection of data, and potential harm and benefits of participation. Additionally, informed consent was also attached to information, that included both parental and participant assent. Both forms were made according to the APA code of ethics guidelines and were approved by the supervisor of this research.

Data Analysis procedure

All data were entered, cleaned, and processed using the Statistical Package for Social Science-25 (SPSS V-25). Following entry and cleaning, descriptive statistics of total screenings, and scale reliability testing were performed, followed by a descriptive analysis of the experimental group. Finally, inferential statistics were used to test the hypotheses of this study.

Chapter 3

Results

The current research examined the impact of cognitive control and flexibility draining using the Go-No-Go task and Intra-Extra Dimension set-shifting on impulsivity and attention among individuals with ADHD symptoms. The following chapter presents the results of analyzing the obtained data.

Demographic Characteristics of the Total Sample Screenings

In this research, the demographic characteristics of the screened individuals (N=142) are age, gender, living arrangements, parental occupation, and family affluence. All demographic variables were at the categorical level, except for age and family affluence, which are continuous variables. First the categorical variables descriptives are presented in the next table.

The following table illustrates the demographic outlook of the total screening sample.

Table 1

Frequencies and Percentages of Categorical Demographic Variables.

Variables	***F***	***%***
Gender		
Male	142	100
Female	0	0
Living Arrangements		
Parents & Siblings	106	76.6
Family & Relatives	31	21.8
Other	5	3.5
Socioeconomic Status^		
High Affluence	17	12
Middle Affluence	77	54.2
Low Affluence	46	32.4

Note: *F* = Frequencies, % = Percentages. ^ = 2 missing values.

For the purpose of data cleaning, missing values were recorded into out-of-range values (-5) for socioeconomic status. However, none of the two missing cases were assigned a new series mean-based value, due to the nature of the FAS as a self-report of facts about the presence of physical objects indicative of one's affluence.

Table 2

Descriptives Statistics and Normality Testing of Age Variable

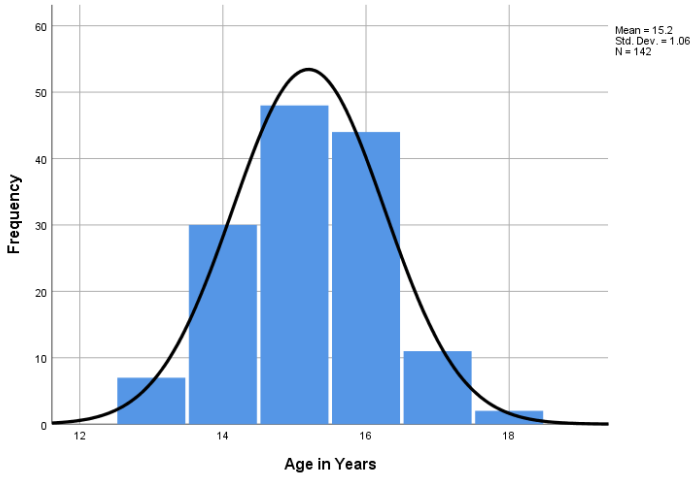
Variable	*M*	*MDN*	*MO*	*SD*	Skewness	Kurtosis	*K-S*	*p*
Age in Years	15.20	15.00	15	1.06	.031	-.237	.177	.000

Note: M= mean, MDN= Median, MO= Mode, SD= Standard Deviation, K-S= Kolmogorov-Smirnov normality test. P = Significance Alpha.

Participants ages ranged from 13 to 18 years (M = 15.20 years, SD = 1.06). However, the normality test suggests a non-normal distribution, with skewness of .031 and -.237 kurtosis value (K-S = .177, p = .000).

Figure 1

Histogram of age variable along with plotted normal curve (N = 142) No missing values.



Scales and Subscales Reliabilities

In this study, four scales were used, and Cronbach's Alpha was used to access each scale and its subscale's reliability.

Table 3

Psychometric Properties of the family Affluence Scale, Adult ADHD Self-report Scale Barratt Impulsiveness Scale, and Attentional Control Scale for Children and their subscales.

Scales	*Items*	*M*	*SD*	Actual Range	Potential Range	*a*
ASRS	18	45.62	10.84	18-76	18-90	.776
ASRS-IN	10	25.65	6.58	10-43	10-50	.675
ASRS-HY	8	19.96	5.33	8-34	8-40	.572
ACSC	20	52.33	7.40	34-63	20-80	.682
ACSC-AF	9	22.76	3.68	16-31	9-36	.501
ACSC-AS	11	29.57	4.55	17-36	11-44	.582
BIS	30	67.36	11.97	56-91	30-120	.745
BIS-AI	8	17.75	4.76	10-27	8-32	.645
BIS-MI	11	24.30	5.46	18-34	11-44	.537
BIS-NP	11	26.16	5.96	20-42	11-44	.665
FAS	4	3.19	1.73	0-8	0-9	.459

Note: M = mean, SD = Standard Deviation. a= Cronbach Alpha ASRS = Adult ADHD Self-Report Scale, ASRS-IN = Adult ADHD Self-Report Scale Inattentive subscale, ASRS-HY = Adult ADHD Self-Report Scale-Hyperactivity/Impulsivity, ACSC = Attentional Control Scale for Children, ACSC-AF = Attentional Control Scale for Children-Attentional Focusing subscale, ACSC-AS = Attentional Control Scale for Children-Attentional Shifting, BIS = Barratt Impulsiveness Scale, BIS-AI = Barratt Impulsiveness Scale Attentional Impulsiveness subscale, BIS-MI = Barratt Impulsiveness Scale-Motor Impulsiveness, BIS-NP = Barratt Impulsiveness Scale-Non-Planning Impulsiveness.

All four scales utilized in the study were of Urdu language, and overall, total items scales were shown to have acceptable/good reliability. However, the Adult ADHD Self-Report Scale was shown to have the best alpha reliability which might be due to the fact that it was used for the total sample, whereases the Attentional Control Scale for Children and

Barratt Impulsiveness Scale was used for pre-post intervention testing on the experimental group (n=21).

Descriptive Statistics of Scales Used in Sample Screening

Table 4

Descriptives, And Normality Testing of Scales and Subscales Used in Screening.

Scales and Subscales	*M*	*MDN*	*MO*	*SD*	Skewness	Kurtosis	*K-S*	*p*
FAS^	3.19	3.00	3	1.73	.299	-.262	.130	.000
ASRS	45.62	46.00	39.00	10.84	.112	-.318	.060	.200*
ASRS-IN	25.65	26.00	19.00	6.58	.086	-.321	.065	.200*
ASRS-HY	19.96	20.00	23.00	5.33	.027	-.345	0.65	.200*

Note: M = Mean, SD = Standards Deviation, MDN = Median, MO = Mode, K-S= Kolmogorov-Smirnov normality test. P = Significance Alpha. FAS^ = Family Affluence Scale with 2 missing values. ASRS= Adult ADHD Self-Report Scale. ASRS-IN=Inattentive Subscale, HY= Hyperactive/Impulsive Subscale.

On the total screenings, there were only two scales applied, the family affluence scale and Adult ADHD Self-Report Scale. Normality testing suggests that FAS is not normally distributed (K-S = .130, p = .000) while the ASRS scale follows a normal distribution (K-S = .060, p = .200*). Below are graphs with superimposed normal curves to illustrate.

The ASRS had contained five missing values prior to cleaning, however, all missing values were first recorded into out-of-range value (-5) and then assigned a new series mean value.

Figure 2

Histogram of family affluence scale variable along with plotted normal curve (N = 140) two missing values.

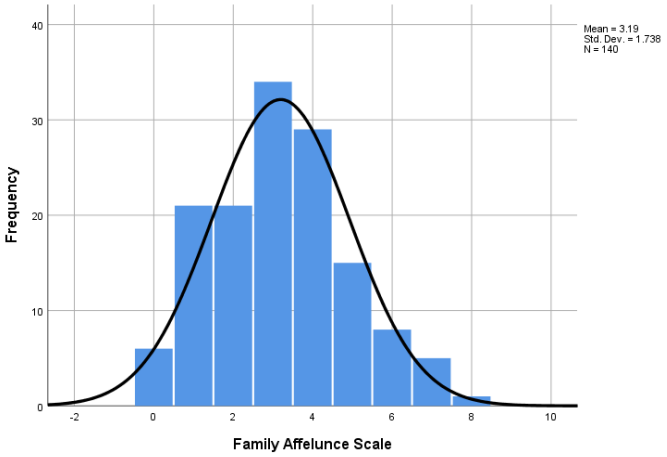
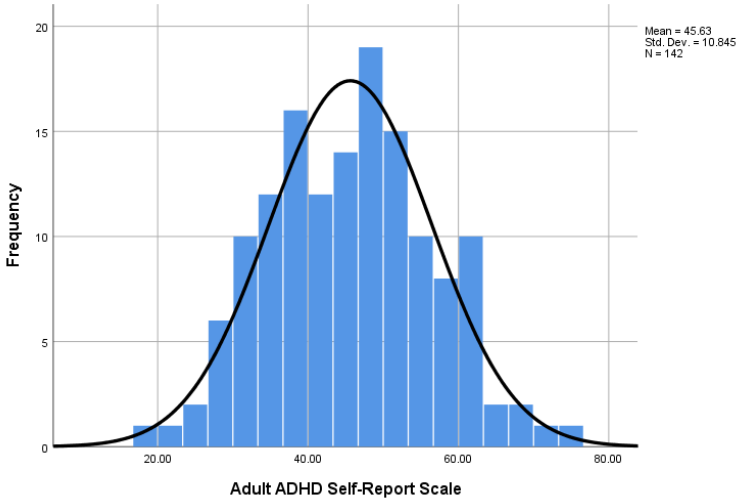


Figure 3

Histogram of Adult ADHD Self-Report Scale variable along with plotted normal curve (N = 142) two missing values.



Descriptive Statistics of Experimental Group

In the following section, descriptives of the experimental group (n= 21) are presented, followed by inferential statistics of pre- and post-intervention testing.

Table 5

Frequencies and Percentages of Categorical Demographic Variables of Experimental Group

Variables	***F***	***%***
Living Arrangements		
Parents & Siblings	15	71.6
Family & Relatives	5	23.8
Other	1	4.8
Socioeconomic Status		
High Affluence	0	0
Middle Affluence	15	71.4
Low Affluence	6	28.6

Note: F = Frequencies, % = Percentages.

Table 6

Descriptives Statistics and Normality Testing of Age Variable in Experimental Group

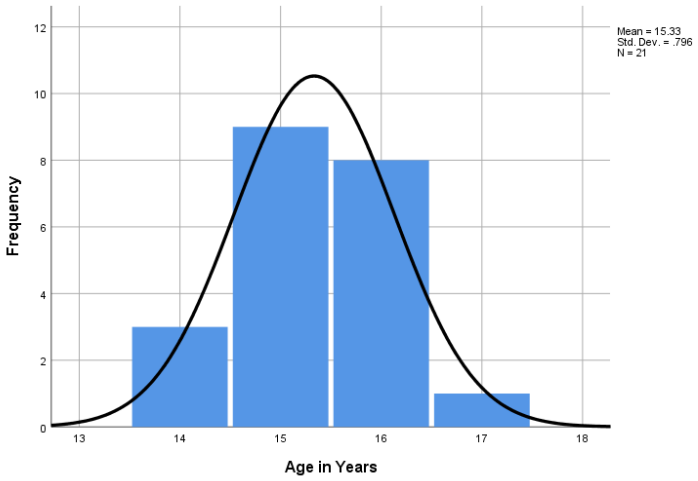
Variable	***M***	***MDN***	***MO***	***SD***	**Skewness**	**Kurtosis**	***K-S***	***p***
Age in Years	15.33	15.00	15	.796	-.048	-.032	.234	.004

Note: M= mean, MDN= Median, MO= Mode, SD= Standard Deviation, K-S= Kolmogorov-Smirnov normality test. P = Significance Alpha.

Participants' age ranged from 14-17 within the experimental group (n=21, M = 15.33, SD = .796). The result of normality testing for the age indicates a non-normal distribution for age with K-S = .234, p = .004.

Figure 4

Histogram of age variable along with plotted normal curve (n = 21) No missing values.



Descriptives of Scales and Subscales Pre-Intervention

Table 7

Descriptives, Skewness, Kurtosis, and Normality Testing of Scales and Subscales.

Scales & Subscales	*M*	*MDN*	*MO*	*SD*	Skewness	Kurtosis	*K-S*	*p*
ACSC	55.33	53.00	57.00	7.40	-1.03	.725	.190	.045
ACSC-AF	22.76	23.00	22.00	3.68	.050	.268	.132	.200*
ACSC-AS	29.57	31.00	31.00	4.55	-1.10	1.43	.147	.200*
BIS	67.36	63.00	63.00	10.93	1.32	.937	.269	.011
BIS-AI	17.75	18.00	14.00	4.56	.204	.225	.127	.200*
BIS-MI	24.30	23.00	18.00	5.46	.522	-1.11	.210	.121
BIS-NP	26.16	25.00	23.00	5.71	1.96	4.68	.269	.011

Note: M = Mean, MDN = Median, SD = Standard Deviation, MO = Mode, K-S = Kolmogorov-Smirnov normality test. *p* = significance alpha. ACSC = Attentional Control Scale, ACSC-AS = Attentional Shifting subscale, ACSC-AF =Attentional Focusing. BIS= Barratt Impulsiveness Scale, BIS=AI= Attentional Impulsiveness, BIS-MI = Motor Impulsiveness, BIS-NP = Non-Planning Impulsiveness.

The descriptive statistics of scales and subscales and normality testing before intervention show that the Attentional Control Scale for children doesn't follow a normal distribution (K-S = .190, p = .045). However, the attentional focus and shifting subscales tend to exhibit a normal distribution with values of K-S = .132, .147, p = .200*, and .200* respectively.

Figure 5

Histogram of Attentional Focusing Subscale (Pre-Intervention) variable along with plotted normal curve (n = 21) No missing values.

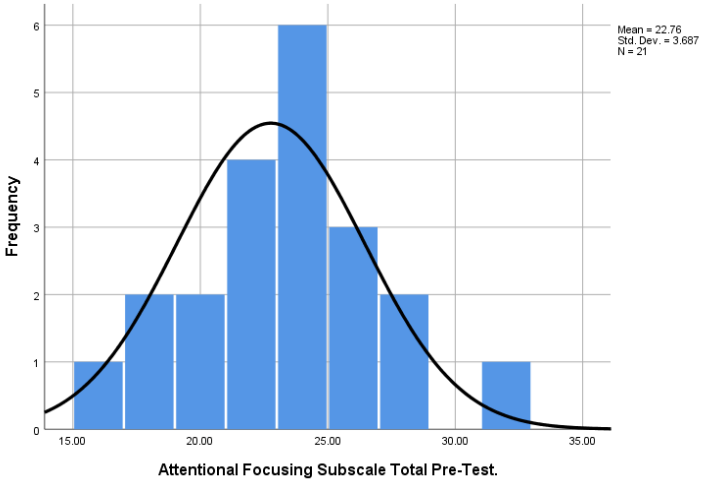


Figure 6

Histogram of Attentional Shifting Subscale (Pre-Intervention) variable along with plotted normal curve (n = 21) No missing values.

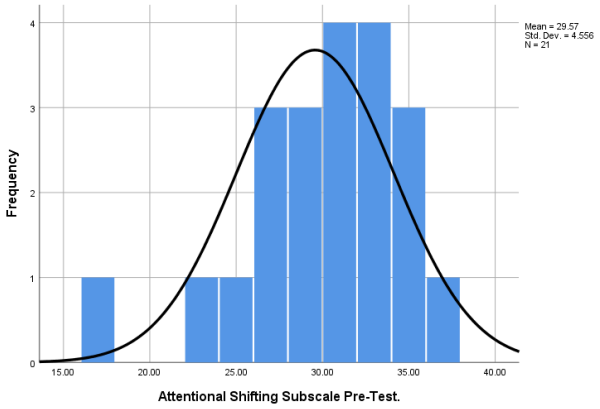


Figure 7

Histogram of Attentional Control Scale for Children (Pre-Intervention) variable along with plotted normal curve (n = 21) No missing values.

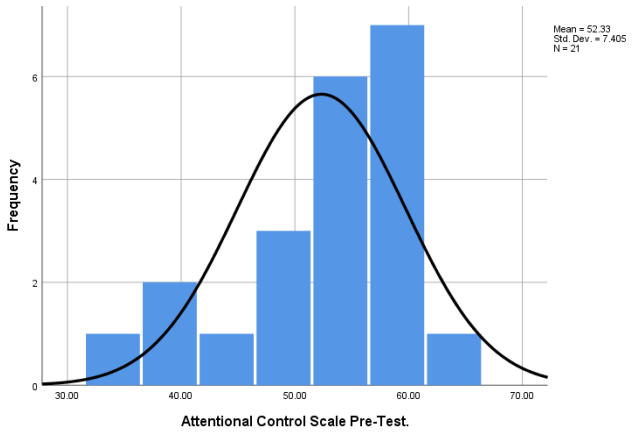


Figure 8

Histogram of Attentional Impulsiveness subscale (Pre-Intervention) variable along with plotted normal curve (n***c*** = 13) No missing values. ***c*** = Experimental Group with Combined set of ADHD Symptoms.

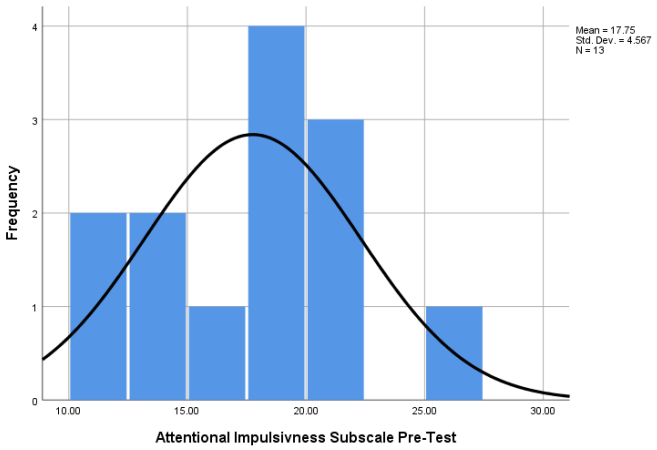


Figure 9

Histogram of Motor Impulsiveness subscale (Pre-Intervention) variable along with plotted normal curve (n*c* = 13) No missing values.

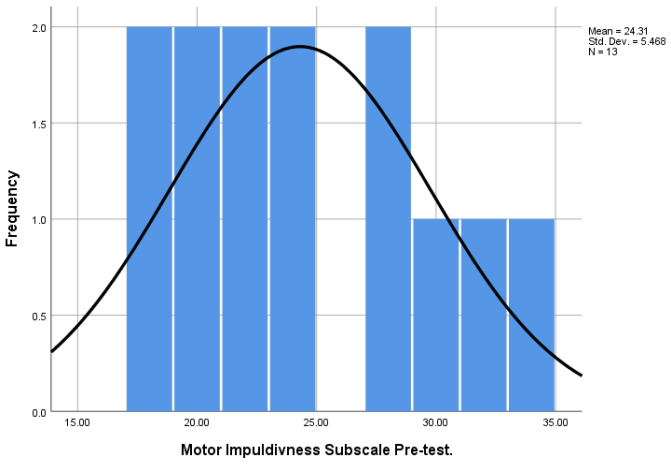


Figure 10

Histogram of Non-Planning Impulsiveness subscale (Pre-Intervention) variable along with plotted normal curve (n*c* = 13) No missing values.

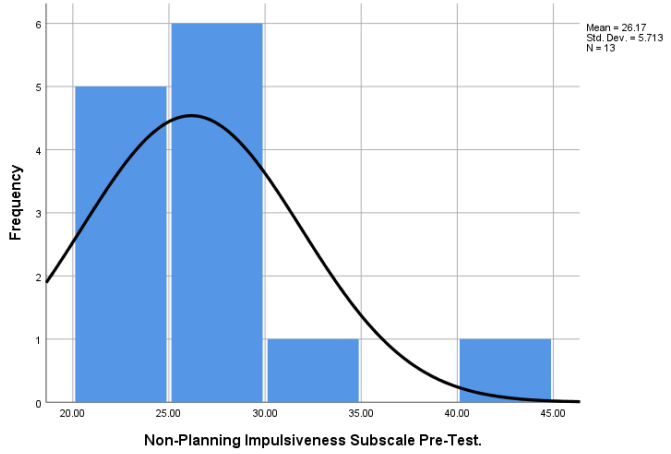
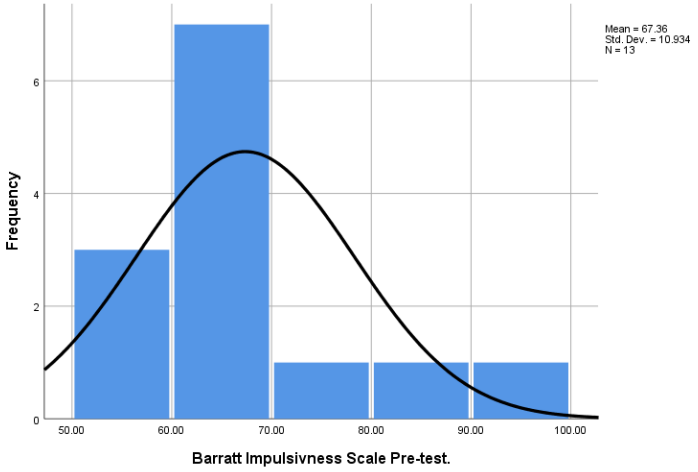


Figure 11

Histogram of Barratt Impulsiveness subscale (Pre-Intervention) variable along with plotted normal curve (n*c* = 13) No missing values.



Descriptives and Parameters of Go-No-Go Task Paradigm.

In this and the following two sections are tables representing each participant's performance on the intervention tasks. Tables are made according to each group's ADHD subtype. Below is a table showing descriptives of the GNG Task.

Table 8

Descriptives, Mean Reaction Time, Commission, Omission, and Total Errors of First and Last Session of Combined ADHD Subtype Experimental Group on the Go-No-Go Task Paradigm. (nc=13)

Participants Code	Session	*MRT*	*CE*	*OE*	*TE*
13	1	685.5 ms	1	1	2
	5	239.6 ms	16	23	39
19	1	564.6 ms	2	1	3
	5	399.6 ms	1	1	2
26	1	363.5 ms	8	6	14
	5	263.5 ms	22	25	47
35	1	346.8 ms	6	4	10
	5	256.6 ms	16	22	38
51	1	564.0 ms	3	8	11
	5	210.3 ms	19	25	44
52	1	519.0 ms	2	1	3
	5	264.8 ms	6	2	8
55	1	803.5 ms	1	8	9
	5	403.0 ms	1	5	6
57	1	510.2 ms	6	1	7
	5	375.4 ms	11	6	17
71	1	523.7 ms	3	0	3
	5	331.7 ms	7	3	10

108	1	479.6 ms	5	1	6
	5	378.9 ms	8	12	18
109	1	481.2 ms	7	0	7
	5	357.8 ms	5	3	8
110	1	537.5 ms	1	0	1
	5	350.7 ms	2	2	4
111	1	418.7 ms	4	0	4
	5	270.5 ms	5	34	39

Note: MRT = Mean Reaction Time, CE = Commission Errors, OM = Omission Errors. TE = Total Errors. ms= Milliseconds.

The above table shows a summary of participants' performance on the Go-No-Go Task. It can be noticed that, on average, mean reaction time has improved among participants while they committed on average more errors. Furthermore, it’s also shown that more participants committed more commission errors than omission errors with the exception of a few cases, which is indicative of overall poor inhibition as opposed to insufficient attention.

Table 9

*Descriptives, Mean Reaction Time, and Total Errors of Inattentive ADHD Subtype Experimental Group on Intra-Extra Dimensional Set-Shifting. (n**i**=8)*

Participants Code	*IDE*	*MRT*	*TE*
11	Intra-Dimension	2849.2 ms	16
	Extra-Dimension	3046.5 ms	
15	Intra-Dimension	1569.6 ms	3
	Extra-Dimension	1427.6 ms	
20	Intra-Dimension	2223.2 ms	14
	Extra-Dimension	2478.2 ms	
29	Intra-Dimension	1155.9 ms	5
	Extra-Dimension	952.8 ms	
50	Intra-Dimension	4028.3 ms	12
	Extra-Dimension	2837.1 ms	
68	Intra-Dimension	1734.2 ms	9
	Extra-Dimension	3226.4 ms	
106	Intra-Dimension	1122.1 ms	5
	Extra-Dimension	1149.5 ms	
107	Intra-Dimension	2108.6 ms	6
	Extra-Dimension	2178.0 ms	

Note: IDE = Intra-Extra-Dimensional Set-Shifting. MTR = Mean Reaction Time, TE = Total errors. n***i*** = Inattentive ADHD subtype type.

The table above presents participants' performance on the Intra-Extra-Dimensional Set-Shifting. It can be noticed that on such tasks, there were more errors committed, and on average participants took longer time when responding to hard shift/extra-dimension trials versus easy/intra-dimensional trials.

Table 10

Descriptives, Mean Reaction Time, Commission, Omission, and Total Errors of First and Last Session of Combined ADHD Subtype Experimental Group on the Intra-Extra Dimensional Set-Shifting.

Participant Code	IDE	MRT	TE
11	Intra-Dimension	2619.5 ms	4
	Extra-Dimension	2788.6 ms	
19	Intra-Dimension	1690.4 ms	14
	Extra-Dimension	1598.5 ms	
26	Intra-Dimension	1340.4 ms	6
	Extra-Dimension	1586.2 ms	
35	Intra-Dimension	1006.8 ms	12
	Extra-Dimension	1675.5 ms	
51	Intra-Dimension	1039.0 ms	5
	Extra-Dimension	1208.3 ms	
52	Intra-Dimension	1877.5 ms	6
	Extra-Dimension	2233.6 ms	
55	Intra-Dimension	2673.0 ms	3
	Extra-Dimension	1748.3 ms	
57	Intra-Dimension	2328.2 ms	11
	Extra-Dimension	3037.2 ms	
71	Intra-Dimension	1363.3 ms	8
	Extra-Dimension	1579.7 ms	

108	Intra-Dimension	1336.6 ms	5
	Extra-Dimension	1507.2 ms	
109	Intra-Dimension	2431.2 ms	7
	Extra-Dimension	1859.5 ms	
110	Intra-Dimension	2715.6 ms	5
	Extra-Dimension	3351.6 ms	
111	Intra-Dimension	2901.1 ms	12
	Extra-Dimension	1834.6 ms	

Note: IDE = Intra-Extra Dimensional Set-Shifting, MRT= Mean Reaction Time, TE = Total Errors.

Similarly, this table also shows participants' performance of the IDE, and a similar observation can be made regarding increased errors and time for extra-dimensional shift trials.

Descriptives of Scales and Subscales Post-Intervention

Table 11

Descriptives, Skewness, Kurtosis, and Normality Testing of Scales and Subscales.

Scales & Subscales	*M*	*MDN*	*MO*	*SD*	Skewness	Kurtosis	*K-S*	*p*
ACSC	51.86	51.00	49.00	7.51	-.398	-.220	.114	.200*
ACSC-AF	22.61	23.00	20.00	4.24	.379	.501	.112	.200*
ACSC-AS	29.30	29.00	28.00	4.43	-.418	1.08	.147	.200*
BIS^	72.00	72.00	72.00	6.13	-.207	-.894	.127	.200*
BIS-AI	18.92	19.00	18.00	3.01	-.151	-.700	.149	.200*
BIS-MI	26.00	25.00	23.00	4.96	.376	-.564	.118	.200*
BIS-NP^	27.08	26.00	23.00	5.29	.616	-.032	.164	.200*

Note: M = Mean, MDN = Median, SD = Standard Deviation, MO = Mode, K-S = Kolmogorov-Smirnov normality test. *p* = significance alpha. ACSC = Attentional Control Scale, ACSC-AS = Attentional Shifting subscale, ACSC-AF =Attentional Focusing. BIS= Barratt Impulsiveness Scale, BIS=AI= Attentional Impulsiveness, BIS-MI = Motor Impulsiveness, BIS-NP = Non-Planning Impulsiveness. ^ = missing replaced with series mean. * = significance.

The above table shows descriptives of scales and subscales post-intervention along with normality testing, which indicates that all subscales and scales are normally distributed ($p > 0.05$). The following below are histograms with superimposed normal curves for each scale and subscale.

Figure 12

Histogram of Attentional Focusing Subscale (Post-Intervention) variable along with plotted normal curve (n = 21) No missing values.

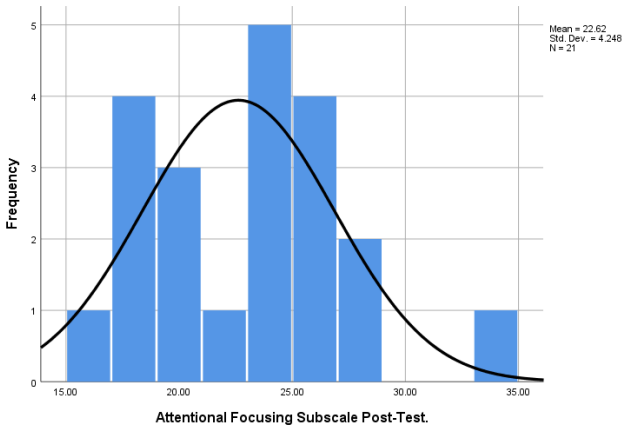


Figure 13

Histogram of Attentional Shifting Subscale (Post-Intervention) variable along with plotted normal curve (n = 21) No missing values.

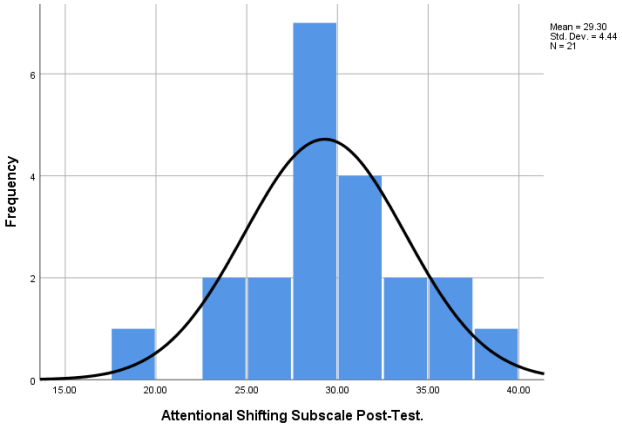


Figure 14

Histogram of Attentional Control Scale (Post-Intervention) variable along with plotted normal curve (n = 21) No missing values.

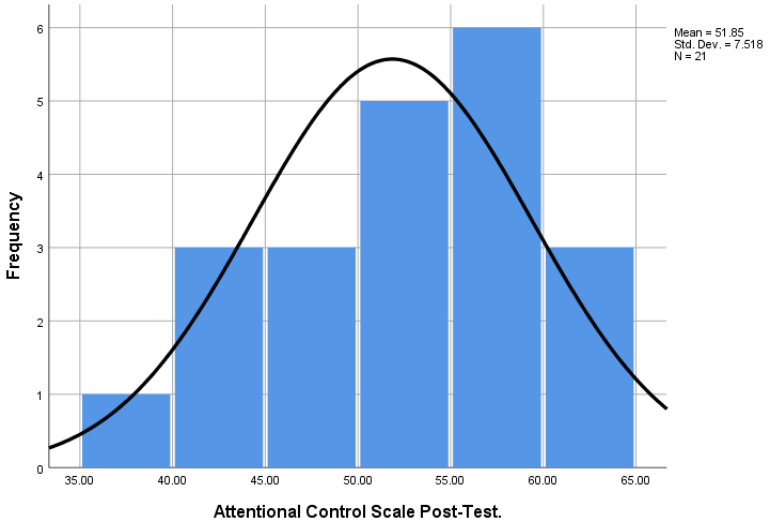


Figure 15

Histogram of Attentional Impulsiveness subscale (Post-Intervention) variable along with plotted normal curve (n*c* = 13) No missing values. *c* = Experimental Group with Combined set of ADHD Symptoms.

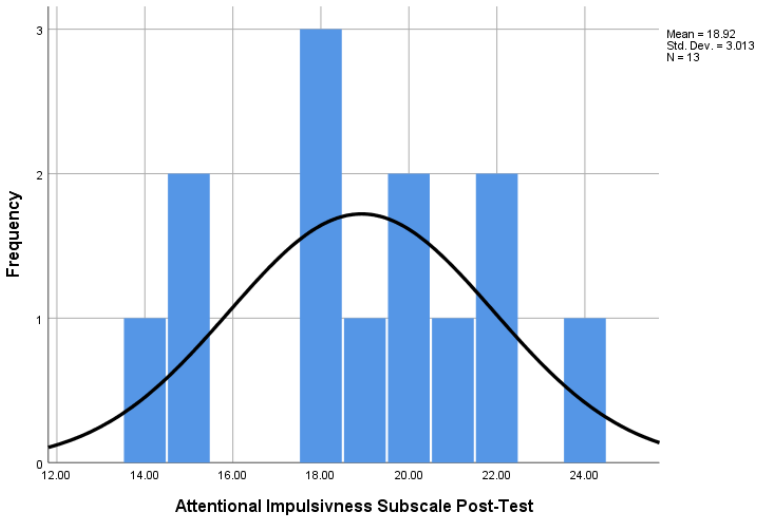


Figure 16

Histogram of Motor Impulsiveness subscale (Post-Intervention) variable along with plotted normal curve (n*c* = 13) No missing values

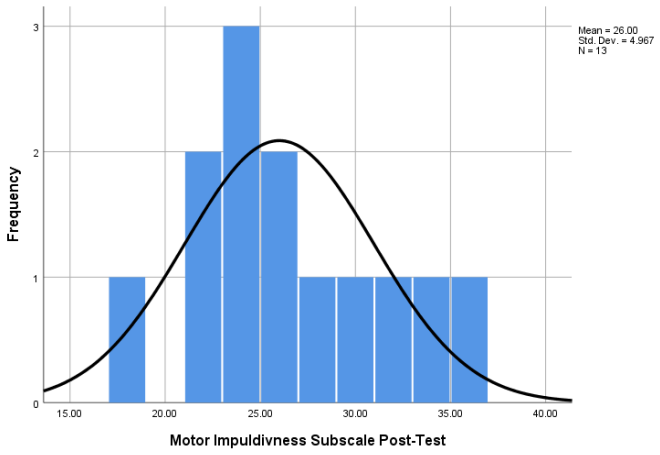


Figure 17

Histogram of Non-Planning Impulsiveness subscale (Post-Intervention) variable along with plotted normal curve (n*c* = 13) No missing values.

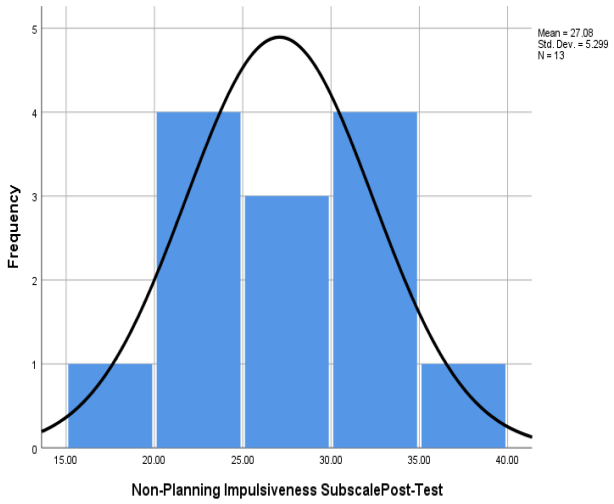
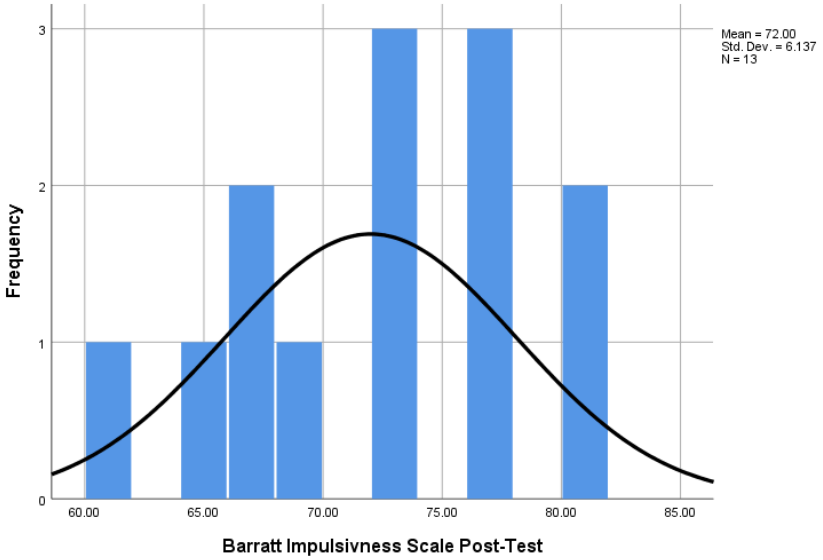


Figure 18

Histogram of Barratt Impulsiveness Scale (Post-Intervention) variable along with plotted normal curve (n*c* = 13) No missing values.



Inferential Statistical Analysis of the Experimental Group

In this section, the results of inferential statistics of pre- and post-intervention comparisons are discussed below.

Table 12

Wilcoxon Signed-Rank Test of Attentional Control Scale and Barratt Impulsiveness Scale Pre- and Post-Intervention Assessment.

Measure	Ranks	N	Mean Rank	Sum of Ranks	*Z*	*p*
ACSC	Negative	10	10.15	101.50	-.702	.483
	Positive	8	8.69	69.50		
BIS	Negative	2	10.50	21.00	-1.71	.08
	Positive	11	6.36	70.00		

Note: z =z-score. *p*= significance alpha.

To evaluate the effectiveness of cognitive control and flexibility training on attention and impulsivity, a Wilcoxson Signed-Rank Test revealed a statistically insignificant difference in attention and impulsivity following the intervention, z = -.702 & -1.71, p = .484 and .08 for impulsivity respectively.

However, looking at the negative ranks of the attentional control scores, it is revealed that 10 participants scored lower in the post-test than in their pre-intervention score, which indicates improved attentional control, nonetheless a non-significant one, in comparison with 8 participants who scored higher in post-intervention which indicates reduced attentional control. On impulsiveness scores positive ranks, 11 participants out of 13 in the combined ADHD group had scored higher than on their pre-intervention assessment, which indicates a non-significant increase in impulsivity, compared to only two participants who experienced a reduction in impulsivity.

Chapter 4

Discussion

The purpose of the current study was to test the feasibility of applying cognitive control and flexibility to improve individuals' attention and hyperactivity/impulsivity symptoms of ADHD, however, when it comes to cognitive-based interventions, there are primary outcomes that aim to improve individuals performance on the measurement tasks, on the other hand, secondary outcomes are behavioral outcomes that reflect improved performance on certain measurement tasks, so for example, if an individual performance improved on the Go-No-Go task, can we expect a behavioral change in terms of reduced impulsivity in that individual?

In this study, the Go-No-Go Task was designed and used to target the response inhibition component of cognitive control which corresponds to impulsivity among individuals with ADHD. It was found that, in aggregate, participants' mean reaction time had decreased compared to their first and last session, which is in line with Jodo and Insoune (1990) who found a decrease in reaction following six days of training. However, participants' No-go errors were increased with an increase in difficulty, (300ms) which is supported by Benikos et al., (2013) investigation of different difficulty levels of the Go-No-Go task and its relation to increased errors.

Additionally, to measure cognitive flexibility, the Intra-Extra Dimensional Set-Shifting was designed and used to target attentional focusing and shifting, on which the task consists of stay and set shift trials. The literature suggests that participants usually have increased reaction time on extra-dimension due to shifts in rules, however, this wasn't as apparent in this research, Magodama et al., (2018) suggested that age is an important factor and that for children, it's equally cognitively demanding to respond to both intra and extra-dimensional trials, thus creating a little to no difference in mean reaction time, however,

such difference starts to emerge with adults more. Given the current results, this study aimed at exploring the feasibility of attaining secondary outcomes of improved attention and impulsivity using self-report measures. H1 was found to be non-applicable since none of the participants were exhibiting impulsivity /hyperactivity symptoms exclusively. The findings on H2 also seem to reject it since it indicates a non-significant result. The literature suggests that a more targeted impulsive-behavior Go-No-Go training could be beneficial, for example Chen and colleagues (2018) found that by presenting undesirable food items as a No-Go stimulus, individuals would then devalue that item, which in turn helps achieve a greater secondary outcome of of regulating ones eating behavior. Similarly, Food-specific Go-No-Go training can help obese individuals in reducing high-calorie food along with an actual reduction in body wight (Yang et al., 2021). Finally, H3 also seems to be rejected, and the literature suggests that the IDE task paradigm is most effectively used in assessing set-shifting but doesn't help to improve it. Sadeghi and colleagues (2022) have used the IDE as pre and post intervention for computerized cognitive training, and the researchers suggested a significant difference exists in participants attention and planning after the training.

The analyses indicate non-significant results between pre- and post-intervention scores on attention and impulsiveness. Nonetheless, there was an overall difference in mean scores between pre-and post-intervention scores. One of the reasons for such a non-significant result could be due to the nature of the procedure used since the intervention tasks were administered to individuals within their classroom setting and engaging a minority of students (screened) while leaving others unsupervised always created a sense of curiosity among the majority who interfered with the process of either intervention delivery or scale administration or both. Another reason for such a non-significant result can be due to the small sample size used in the study, and the fact that sessions were delivered once instead of

distributed over period of time, finally, a follow-up assessment was not taken from participants which would have made a difference in conclusion that is drawn.

Conclusion

The current study aimed at testing the feasibility of using targeted cognitive control and flexibility computer-based training tasks to improve the symptoms of adolescents with ADHD, primarily inattention, and hyperactivity/impulsivity. The results of the study suggest a difference in the mean score of attention and impulsiveness before and after the intervention, however, it is a statistically insignificant difference. It is concluded that given the small sample size, the quasi-experimental design used and overall, less control over extraneous factors, and the suboptimal procedure used were potential causes for such a result and further investigation is needed.

Limitations and Recommendation

1. This study has a relativity small sample to determine the effects of an intervention and its applicability to the wider population.
2. This study lacked the presence of a control group that could provide more rigor to the design.
3. The environment in which the intervention was delivered was not optimal for the delivery of such an individual-based intervention.
4. The study did not incorporate neurophysiological data such brain imagining during intervention delivery to determine the level of activation of the area involved in cognitive control and flexibility.
5. Future research can be directed towards developing more behavior-specific intervention instead of a general impulsivity or inattention.

Implications

Among the implications of this study is to inform the applicability of such a computer-based intervention or such intervention type to deal with individuals suffering from ADHD symptoms, and whether it can be used within more specific clinical populations. However, this study can also inform its usage in community-based samples or with less severe individuals, but in order to infer any such applicability, its crucial to further examine it with larger samples with a control group using more randomized sampling and assignment approaches.

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Appendices

Appendix 1 Information Sheet, Parental Consent and Participant Assent

معلوماتی فارم

تحقیق: طلباء کے رویے اور توجہ پر ذہنی سرگرمیوں کے اثرات

Impact of Mental Activities on Students' Attention and Behavior in Classrooms

میں عبدالہادی طارق، کیپٹل یونیورسٹی آف سائنس اینڈ ٹیکنالوجی میں شعبہ نفسیات کا طالب علم ہوں، اور میں آپ کو (آپ کے بچے) کو ایک تحقیق میں حصہ لینے کی دعوت دینا چاہتا ہوں۔ آپ کو فیصلہ کرنے سے پہلے یہ سمجھنے کی ضرورت ہے کہ تحقیق کیوں کی جارہی ہے اور اس میں کیا کرنا ہو گا۔

برائے مہربانی! مندرجہ ذیل معلومات کو احتیاط سے پڑھیں۔ اگر آپ مزید جاننا چاہتے ہیں تو آپ سوالات پوچھ سکتے ہیں۔ آپ اس تحقیق میں شرکت کا فیصلہ کرنے کے لیے وقت لے سکتے ہیں۔

تحقیق کا مقصد

اس تحقیق کا مقصد ایسے طالب علموں کی مدد کرنا ہے جن کو کلاس روم میں توجہ دینے میں مشکل ہوتی ہے یا ہائپر ایکٹو ہوتے ہیں۔ ان کے لیے مختلف سرگرمیاں فراہم کی جائیں گی جن میں ذہنی صلاحیتوں کا استعمال ہو گا اور عام طور پر ان سرگرمیوں کا مقصد ان طلباء کی کلاس روم میں توجہ اور رویوں کو بہتر بنانا ہے۔

شرکت کے لیے درکار وقت: اس تحقیق میں شرکت کے لئے پانچ دن روزانہ سیشن ہوں گے (ایک سیشن 10-5 منٹ کی سرگرمیوں پر مشتمل ہو گا).

میرے بچے کو (مجھے) تحقیق میں حصہ لے کر کیا کرنا ہو گا؟

اس تحقیق میں حصہ لینے کے لیے بچے کی رضامندی کے ساتھ ان کے والدین کی رضامندی ضروری ہے۔ اس کے بعد کچھ بنیادی معلومات کا فارم (Demographic Sheet) اور سوال نامے (Questionnaires) بھرنے ہو گے۔

انفرادی طور پر بچوں کے سیکھنے کے لیے سرگرمیاں مسلسل پانچ دن دی جائیں گی۔

اس تحقیق کی معلومات کس طرح کام آئیں گی؟

طلباء سے حاصل کردہ تمام معلومات تحقیق مکمل ہونے تک دونوں شکلوں (کاغذ اور کمپیوٹر والی کاپی) میں خفیہ اور محفوظ رہے گی۔ اس کے علاوہ نتائج کے شائع ہونے پر طالب علم کی شناخت کو کسی بھی شکل میں ظاہر نہیں کیا جائے گا۔

سوالات یا مزید معلومات کے لئے مجھے کس سے رابطہ کرنا چاہئے؟

کسی بھی سوال یا مسئلے کی صورت میں آپ یہاں رابطہ کر سکتے ہیں:

(Ext: 178):051-111-555-66

sabahat.haqqani@cust.edu.pk

یا

bsp191014@cust.pk

Department of Psychology, Capital University of Science and Technology

مدد گاراداروں کا پتہ:

اگر اس تحقیق میں حصہ لینے سے آپ کسی بھی قسم کی ذہنی پریشانی محسوس کریں تو آپ مندرجہ ذیل جگہوں سے مدد حاصل کر سکتے ہیں۔

Well-Being center

آپ یہاں رابطہ کر سکتے ہیں:

(Ext: 296).051-111555666

یا

wbc@cust.edu.pk

یہاں پر آپ صبح 9 سے 5 بجے تک جاسکتے ہیں۔

پتہ: کیپٹل یونیورسٹی آف سائنس اینڈ ٹیکنالوجی، کہوٹہ روڈ اسلام آباد

یوتھ ہیلپ لائن

0800-22444 اس نمبر پر زیادہ تر فون لائن سے مفت رابطہ کر سکتے ہیں (موبائل سے عام ریٹ کے حساب سے بھی کال ملائی جاسکتی ہے)۔ یہ صبح 10 بجے سے رات 8 بجے تک میسر رہتی ہے۔

والدین یا سرپرست کی رضامندی کا فارم

میں اس بات کی تصدیق کرتا / کرتی ہوں کہ میں نے معلوماتی فارم میں پروگرام کی نوعیت، مقصد اور اس میں میرے بچے کے لیے ہونے والی سرگرمیوں کو پڑھا اور سمجھا ہے۔

میں یہ تصدیق کرتا / کرتی ہوں کہ مجھے پروگرام کے بارے میں مناسب معلومات دی گئی ہیں تاکہ میں فیصلہ کر سکوں۔ میں اپنے بچے کو رضاکارانہ طور پر اجازت دیتا / دیتی ہوں اور وہ بغیر کسی فائدے یا نقصان کے اس تحقیق میں شرکت سے دستبردار ہونے کا فیصلہ کر سکتا / سکتی ہے۔

میں سمجھتا / سمجھتی ہوں کہ میرے بچے کی معلومات خفیہ رہیں گی اور صرف تحقیقی پروگرام کے مقاصد کے لئے استعمال کی جائیں گی۔

میں اپنے بچے کو اس تحقیق میں حصہ لینے کی اجازت دیتا / دیتی ہوں۔

دستخط _____

تاریخ _____

طالب علموں کی رضامندی کا فارم

میں اس بات کی تصدیق کرتا / کرتی ہوں ہے کہ مجھے اس پروگرام کے بارے میں اور اس میں ہونے والی سرگرمیوں اور طریقہ کار کے بارے میں معلومات فراہم کی گئی ہیں۔ میں جانتا / جانتی ہوں کے میری شرکت رضاکارانہ ہے اور میں کسی بھی وقت بغیر کسی فائدے یا نقصان کے اپنی شرکت ختم کرنے کا حق بر قرار رکھتا / رکھتی ہوں۔

میں سمجھتا / سمجھتی ہوں کے میری معلومات خفیہ رہیں گی اور صرف تحقیقی پروگرام کے مقاصد کے لئے استعمال کی جائیں گی۔ میں یہ بھی جانتا / جانتی ہوں کے نتائج کے شائع ہونے کے دوران میری شناخت کسی بھی طرح ظاہر نہیں کی جائے گی۔ میں اس تحقیق میں حصہ لینے کے لئے رضامند ہوں.

دستخط _____

تاریخ _____

Appendix 2 Demographic Sheet

1۔	آپ کا کیا نام ہے؟	
2۔	آپ کی تاریخ پیدائش کیا ہے؟	
3۔	آپ کی عمر کتنی ہے؟	
4۔	آپ کونسی جماعت میں پڑھتے ہیں؟	
5۔	آپ کی جنس کیا ہے؟	لڑکا ☐ لڑکی ☐
6۔	آپ کس کے ساتھ رہتے ہیں؟	☐ صرف آپکے ماں باپ اور آپ کے بہن بھائی۔ ☐ آپ کے دادا دادی، ماں باپ اور آپ کے رشتہ دار۔ ☐ کوئی اور
7۔	آپ کے والد کا پیشہ کیا ہے؟	
8۔	آپ کی والدہ کا پیشہ کیا ہے؟	

صحیح جواب کے گرد دائرہ لگائیں۔

9۔	کیا آپ کے خاندان کے پاس سواری ہے مثلاً موٹر بائیک کار ہے، وین یا ٹرک (جیسے ڈبل کیبن کار یں)؟	نہیں	ہاں، ایک	جی ہاں، دو یا اس سے زیادہ	واضح کریں
10۔	کیا آپ کے پاس اپنے لئے اپنا بیڈ روم ہے؟	نہیں	ہاں، ایک	جی ہاں، دو یا اس سے زیادہ	واضح کریں
11۔	پچھلے 12 مہینوں کے دوران، آپ کتنی مرتبہ اپنے گھر والوں کے ساتھ چھٹیاں گزارنے گئے ہیں؟	نہیں	ہاں، ایک	جی ہاں، دو یا اس سے زیادہ	واضح کریں

12۔	آپ کے گھر میں کتنے کمپیوٹر ہیں؟	نہیں	ہاں، ایک	جی ہاں، دو یا اس سے زیادہ	واضح کریں

13۔	کیا آپ کو ڈاکٹر نے کبھی بھی صحت کا کوئی مسئلہ یا بیماری بتائی ہے؟ (اس میں عام یا موسمی بخار شامل نہیں ہے)۔	☐ نہیں ☐ ہاں	اگر ہاں تو کون سی؟ _____
14۔	کیا آپ نے گزشتہ 3 ماہ میں کوئی نفسیاتی مدد حاصل کی ہے؟	☐ نہیں ☐ ہاں	اگر ہاں، تو کس قسم کی؟ _____

Appendix 3 Adult ADHD Self-Report Scale

ہدایات :ذیل میں آپ کے روز مرہ محسوسات اور برتاؤ کے بارے میں چند سوالات درج ہیں۔ آپ سے درخواست ہے کہ آپ ہر سوال کو غور سے پڑھیں اور گزشتہ چھ ماہ سے آج تک کے عرصہ کو ذہن میں رکھتے ہوئے صرف اس خانے پر جو کہ صحیح ہو (✓) کا نشان لگائیں۔

نمبر شمار	سوالات	کبھی نہیں	اتفاقاً	اکثر	کبھی کبھار	اکثر اوقات
۱	جب آپ کسی کام کا مشکل مرحلہ طے کر لیتے ہیں تو پھر اس پروجیکٹ کی آخری تفصیلات سمیٹنے میں کتنی دفعہ پریشانی ہوتی ہے۔					
۲	جس کام میں ترتیب دینے کی ضرورت ہوتی ہے، اس کو کرتے وقت آپ کو کتنی بار چیزوں کو ترتیب دینے میں مشکل ہوتی ہے۔					
۳	آپ کو ملاقات کا ٹائم یا ذمہ داریوں کو یاد رکھنے میں کتنی بار پریشانی کا سامنا کرنا پڑتا ہے۔					
۴	جب آپ کے پاس کوئی ایسا کام ہو جس میں بہت زیادہ سوچنے کی ضرورت ہو تو آپ کتنی مرتبہ اس کام کو شروع کرنے میں دیر کرتے ہیں یا ٹال دیتے ہیں۔					
۵	جب آپ کو زیادہ وقت کے لیے کہیں بیٹھنا پڑے تو آپ کے ہاتھوں اور پیروں میں کتنی مرتبہ ہلچل یا بے چینی ہوتی ہے۔					

نمبر شمار	سوالات	کبھی نہیں	اتفاقاً	اکثر	کبھی کبھار	اکثر اوقات
۶	آپ کتنی مرتبہ اپنے آپ کو حد سے زیادہ چست اور کام کرنے کے لیے مجبور محسوس کرتے ہیں جیسے کہ آپ کسی موٹر کے ذریعے چلائے جا رہے ہوں۔					
۷	جب آپ کو کوئی بور ہونے والا یا مشکل کام کرنا پڑتا ہے تو آپ کتنی دفعہ لا پرواہی میں غلطیاں کرتے ہیں۔					
۸	آپ کو کتنی مرتبہ اپنی توجہ قائم رکھنے میں مشکل کا سامنا کرنا پڑتا ہے جب آپ کوئی بور ہونے والا یا دہرایا جانے والا کام کرنا پڑے۔					
۹	کتنی مرتبہ آپ کو جو لوگ کہہ رہے ہیں اس پر توجہ قائم رکھنے میں مشکل پیش آتی ہے۔ جبکہ وہ آپ ہی سے براہ راست بات کر رہے ہیں۔					
۱۰	آپ گھر یا کام پر کتنی مرتبہ چیزیں غلط جگہ پر رکھ دیتے ہیں یا آپ کو ڈھونڈنے میں مشکل پیش آتی ہے۔					
۱۱	اپنے ارد گرد ہونے والی سرگرمیوں یا شور کی وجہ سے آپ کا دھیان کس حد تک بٹتا ہے					

نمبر شمار	سوالات	کبھی نہیں	اتفاقاً	اکثر	کبھی کبھار	اکثر اوقات
۱۲	آپ کتنی مرتبہ میٹنگ اور دوسری صورتحال کے دوران اپنی کرسی چھوڑ کے چلے جاتے ہیں، جبکہ آپ کا وہاں بیٹھے رہنا ضروری ہو۔					
۱۳	آپ کس حد تک بے چینی یا بے قراری محسوس کرتے ہیں؟					
۱۴	آپ کو کس حد تک فرصت کے لمحات میں بھی پر سکون ہونے اور راحت محسوس کرنے میں مشکل ہوتی ہے۔					
۱۵	سماجی (ملنے جلنے کے) موقعوں پر آپ اپنے آپ کو کس حد تک بہت زیادہ بولتا ہوا پاتے ہیں.					
۱۶	جب آپ گفتگو کر رہے ہوتے ہیں تو آپ کتنی بار اپنے آپ کو ان لوگوں کے جملے کو مکمل کرتے ہوئے پاتے ہیں جن سے آپ بات کر رہے ہوں اس سے پہلے کہ وہ خود انہیں مکمل کر سکیں۔					
۱۷	ایسے حالات میں جہاں آپ کو باری کا انتظار کرنا پڑے. کتنی مرتبہ آپکو اپنی باری کے انتظار میں مشکل ہوتی ہے۔					
۱۸	جب دوسرے مصروف ہوں تو آپ کتنی مرتبہ مداخلت کرتے ہیں۔					

Appendix 4 Barratt Impulsiveness Scale

ہدایات: ہر سوال کو پڑھیں اور صفحے کے دائیں جانب مناسب بلاک میں (×) کا نشان لگائیں۔ کسی جملے پر بہت زیادہ وقت نہ لگائیں۔ جلدی اور ایمانداری سے جواب دیں۔

نمبر شمار	سوالات	شاذو نادر / کبھی نہیں(1)	بعض اوقات (2)	اکثر اوقات (3)	تقریبا ہمیشہ / ہمیشہ(4)
1۔	میں کاموں کی احتیاط سے منصوبہ بندی کرتا / کرتی ہوں۔				
2۔	میں چیزوں کو سوچے سمجھے بغیر کرتا / کرتی ہوں۔				
3۔	میں جلدی ذہن بنالیتا / لیتی ہوں۔				
4۔	میں خوش قسمت ہوں۔				
5۔	میں توجہ (دھیان) نہیں دیتا / دیتی۔				
6۔	مجھے تیزی سے سوچیں آتی ہیں۔				
7۔	میں وقت سے پہلے ہی دورے کی منصوبہ بندی کرلیتا / لیتی ہوں۔				
8۔	مجھے خود پر کنٹرول / قابو ہے۔				
9۔	میں آسانی سے توجہ مرکوز کر (رکھ) لیتا / لیتی ہوں۔				
10۔	میں باقاعدگی سے بچت کرتی / کرتا ہوں۔				
11۔	مجھے لیکچر یا کھیل میں تلملاہٹ / بے چینی ہوتی ہے۔				
12۔	میں بڑی احتیاط کے ساتھ سوچتا / سوچتی ہوں۔				
13۔	میں نوکری (کام) کے تحفظ کے لئے منصوبہ بندی کرتا / کرتی ہوں۔				
14۔	میں بغیر سوچے سمجھے بول دیتا / دیتی ہوں۔				
15۔	میں پیچیدہ (مشکل) مسائل کے متعلق سوچنا پسند کرتی / کرتا ہوں۔				
16۔	میں نوکریاں (کام) بدلتا / بدلتی ہوں۔				

17۔	میں فوراً عمل کرتا / کرتی ہوں۔				
18۔	میں سوچ بچار والے مسائل حل کرتے ہوئے آسانی سے اکتا جاتی / جاتا ہوں۔				
19۔	میں غور کئے بغیر عمل کرتا / کرتی ہوں۔				
20۔	میں ایک متوازن سوچ کا / کی مالک ہوں۔				
21۔	میں رہائش تبدیل کرتی / کرتا ہوں۔				
22۔	میں جلد بازی میں اشیاء خریدتا / خریدتی ہوں۔				
23۔	میں ایک وقت میں صرف ایک چیز کے بارے میں سوچ سکتا / سکتی ہوں۔				
24۔	میں مشاغل (شوق) تبدیل کرتا کرتی ہوں۔				
25۔	میرا خرچ کمائی سے زیادہ ہے۔				
26۔	سوچنے کے دوران مجھے اکثر بیرونی سوچیں آتی ہیں۔				
27۔	میں مستقبل کے مقابلے میں حال میں زیادہ دلچسپی رکھتا / رکھتی ہوں۔				
28۔	میں ڈراموں یا لیکچرز کے دوران بے چین ہوتا / ہوتی ہوں۔				
29۔	مجھے بھول بھلیاں / معمہ (پہلیاں) حل کرنا اچھا لگتا ہے۔				
30۔	میں مستقبل میں رجحان رکھنے والا / والی ہوں۔				

Appendix 5 Attentional Control Scale for Children

ہدایات : یہاں کچھ مختلف طریقے بیان کیے گئے ہیں جو لوگ کام کرنے اور توجہ برقرار رکھنے کے دوران محسوس کرتے ہیں، براہ کرم اس بات کی نشاندہی کریں (✓) کہ ہر بیان آپ پر کس حد تک لاگو ہوتا ہے۔

نمبر شمار	سوالات	تقریباً کبھی نہیں (1)	کبھی کبھار (2)	اکثر اوقات (3)	ہمیشہ (4)
۱	اگر کلاس میں بہت شور ہو تو میرے لئے مشکل سبق پر توجہ رکھنا بہت مشکل ہے۔				
۲	اگر مجھے ریاضی کے ایک مشکل سوال پر توجہ دینی ہے اور اسے حل کرنا ہے تو مجھے فوکس (Focus) کرنے میں مشکل ہوتی ہے۔				
۳	جب میں کسی چیز پر سخت محنت کر رہا/رہی ہو تو پھر بھی میرے ارد گرد چلنے والی چیزوں سے میری توجہ بٹ جاتی ہے۔				
۴	اگر کوئی میوزک آن کرتا ہے تب بھی میری توجہ دینے کی صلاحیت اچھی ہے۔				
۵	جب میں خود سے فوکس (Focus) کرتا/کرتی ہوں تو مجھے پتا نہیں چلتا کہ میرے کمرے میں آس پاس کیا ہو رہا ہے۔				

نمبر شمار	سوالات	تقریباً کبھی نہیں (1)	کبھی کبھار (2)	اکثر اوقات (3)	ہمیشہ (4)
٦	جب میں کلاس میں پڑھ رہا / رہی ہوتا / ہوتی ہوں تو دوسرے بچوں کے آپس میں بات کرنے سے آسانی سے پریشان ہو جاتا / جاتی ہوں۔				
۷	جب میں خود سے فوکس کرتا / کرتی ہوں تو مجھے دوسری چیزوں کے بارے میں نہ سوچنا مشکل لگتا ہے۔				
۸	جب میں کسی چیز کے بارے میں پُرجوش ہوں تو مجھے خود سے فوکس کرنے میں مشکل ہوتی ہے۔				
۹	جب میں متوجہ (توجہ قائم کرتا ہوں) ہوتا / ہوتی ہوں تو مجھے بھوک پیاس کا پتا نہیں چلتا۔				
۱۰	جب میں کچھ کر رہا / رہی ہوں تو میں آسانی سے رک سکتا / سکتی ہوں اور کسی اور کام کو کر سکتا / سکتی ہوں۔				
۱۱	جب مجھے کوئی نیا کام شروع کرنا ہوتا ہے تو مجھے اس میں مکمل طور پر دلچسپی لینے میں تھوڑا وقت لگتا ہے۔				

نمبر شمار	سوالات	تقریبا کبھی نہیں (1)	کبھی کبھار (2)	اکثر اوقات (3)	ہمیشہ (4)
۱۲	جب ٹیچر کوئی چیز سمجھاتا ہے تو مجھے اسے ایک ہی وقت میں لکھنے اور سمجھنے میں مشکل ہوتی ہے۔				
۱۳	جب ضروری ہو تو میں بہت جلد کسی نئے ٹاپک (موضوع) میں دلچسپی لے سکتا/سکتی ہو۔				
۱۴	جب میں کسی سے ٹیلی فون پر بات کر رہا/رہی ہوں تو بھی میرے لیے پڑھنا یا لکھنا آسان ہے۔				
۱۵	مجھے ایک ہی وقت میں دو طرح کی گفتگو میں حصہ لینے میں مشکل ہوتی ہے۔				
۱۶	مجھے نئے خیالات (Ideas) کو جلدی سے سوچنے میں مشکل ہوتی ہے۔				
۱۷	توجہ بٹنے یا ہٹنے کے بعد میں آسانی سے اپنی توجہ اس طرف واپس لا سکتا /سکتی ہوں جو پہلے کر رہا تھا /رہی تھی۔				
۱۸	جب میں خیالی پلاؤ پکا رہا/رہی ہوں یا مجھے پریشان کن خیالات آ رہے ہوں تو میرے لئے اس کام پر واپس جانا آسان ہوتا ہے جو مجھے کرنا ہے۔				

نمبر شمار	سوالات	تقریبا کبھی نہیں (1)	کبھی کبھار (2)	اکثر اوقات (3)	ہمیشہ (4)
۱۹	میرے لئے دو مختلف کاموں میں سے ایک سے دوسرے کام پر جانا آسان ہے۔				
۲۰	مجھے کسی چیز کے بارے میں سوچنے کے اپنے طریقے کو چھوڑنا اور اسے مختلف انداز میں دیکھنا مشکل لگتا ہے۔				

Appendix 6 Approval Letter for Data Collection

C.U.S.T.

Capital University of Science & Technology
Islamabad

Islamabad Expressway, Kahuta Road,
Zone - V, Islamabad, Pakistan
Telephone : +92-51-111-555-666
: +92-51-4486700
Fax : +92-51-4486705
Email : info@cust.edu.pk
Website : www.cust.edu.pk

Ref. CUST/IBD/PSY/Thesis-168
October 5, 2022

TO WHOM IT MAY CONCERN

Capital University of Science and Technology (CUST) is a federally chartered university. The university is authorized by the Federal Government to award degrees at Bachelor's, Master's and Doctorate level for a wide variety of programs.

Mr. Abdul Hadi Tariq, registration number **BSP191014** is a bona fide student in BS Psychology program at this University from Spring 2019 till date. In partial fulfillment of the degree, he is conducting research on "Impact of cognitive control and flexibility training among ADHD symptomatic adolescents". He is required to collect data from your institute.

Your cooperation is highly appreciated. Please feel free to contact undersigned, if you have any query in this regard.

Best Wishes,

Dr. Sabahat Haqqani
Head, Department of Psychology
Ph no. 111-555-666 Ext: 178
sabahat.haqqani@cust.edu.pk

Appendix 7 Principal Approval (1)

Study: Impact of Cognitive Control and Flexibility Training Among ADHD Symptomatic Adolescents

I am Abdul Hadi Tariq student of Capital University of Science and Technology, currently enrolled in BS Psychology. I am conducting research on the **"Impact of Cognitive Control and Flexibility Training Among ADHD Symptomatic Adolescents"**

The purpose of this study is to provide mind-related learning activities for students who have difficulty paying attention or are hyperactive in the classroom and to help them improve their focus and attention and vigilant behavior in the classroom in general. The expected duration of participation will be seven daily learning sessions, where each will consist of 3-5 minutes of training.

The research requires the recruitment of adolescents aged 15-17 years from 10th-12th Grade students. . The research involves 7 daily sessions delivered individually. The participation of students in the study is voluntary. To conduct the study, I request permission from your school to deliver the training sessions.

There will be no harm to your school and the students in the research. The information obtained from the participants will be kept anonymous. In terms of reporting findings, results will be reported collectively not individually. This research is the first step in helping adolescents in their crucial developmental periods. Your cooperation is highly appreciated.

After reading the above-mentioned information, you may ask the researcher in case of any further queries.

I would be most grateful if you grant me permission by signing below.

I Mazhar Iqbal principal of school GHS Tench Bhatta Rawalpindi confirm that I have read and understand the above-mentioned information. I have been given the opportunity to ask questions.

The permission granted to conduct research in school is voluntary. I understand that the information obtained from the school students will be kept confidential.

I permit the participation of students of the school in this study.

Mazhar Iqbal
Headmaster
Govt. High School
Tench Bhatta, Rawalpindi.
Date: 22-12-2022

Appendix 8 Principal Approval (2)

Study: Impact of Cognitive Control and Flexibility Training Among ADHD Symptomatic Adolescents

I am Abdul Hadi Tariq student at Capital University of Science and Technology, currently enrolled in BS Psychology. I am conducting research on the "**Impact of Cognitive Control and Flexibility Training Among ADHD Symptomatic Adolescents**"

This study aims to provide mind-related learning activities for students who have difficulty paying attention or are hyperactive in the classroom and to help them improve their focus and attention and vigilant behavior in the classroom in general. The expected duration of participation will be five daily learning sessions, each consisting of 10-5 minutes of training.

The research requires the recruitment of adolescents aged 15-17 years from 10th-12th Grade students. The research involves 5 daily sessions delivered individually. The participation of students in the study is voluntary. To conduct the study, I request permission from your school to deliver the training sessions.

There will be no harm to your school and the students in the research. The information obtained from the participants will be kept anonymous. In terms of reporting findings, results will be reported collectively not individually. This research is the first step in helping adolescents in their crucial developmental periods. Your cooperation is highly appreciated.

After reading the above-mentioned information, you may ask the researcher in case of any further queries.

I would be most grateful if you would grant me permission by signing below.

I **Dr. Faiz Sultan** principal of school **IMCB Islamabad Model College, Humak**

confirm that I have read and understand the above-mentioned information. I have been given the opportunity to ask questions.

The permission granted to conduct research in school is voluntary. I understand that the information obtained from the school students will be kept confidential.

I permit the participation of students of the school in this study.

Dr. Faiz Sultan
Principal
Islamabad Model College for Boys
Humak, (FA) Islamabad.

Date: 21/11/

Appendix 9 Translation and Author Permission

Muris, Peter (PSYCHOLOGY) <peter.muris@maastrichtuniversity.nl> Thu, 24 Nov 2022, 16:32

to me

Dear Abdul
You have my permission
All the best Peter Muris

<J Clin Psychol - 2016 - Melendez - Attentional Control Scale for Children Factor Structure and Concurrent Validity Among.pdf>

Aasma Yousaf <aasma.ccpsy@pu.edu.pk> Tue, 30 Aug 2022, 14:47

to me

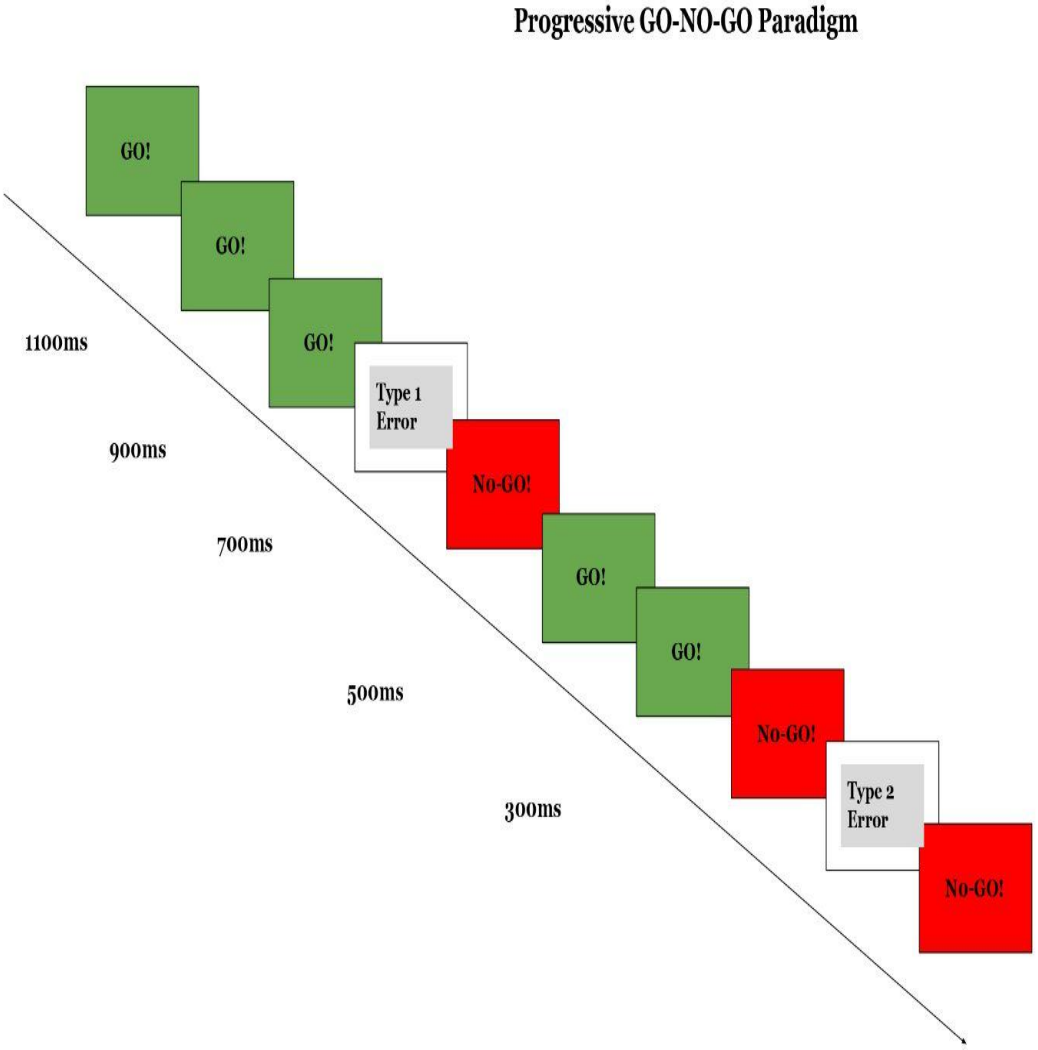
W.A

Here I have attached 2 versions long and short. You can decide accordingly. Good Luck

Aasma Yousaf
Assistant Professor &
Consultant Clinical Psychologist
Centre for Clinical Psychology,
University of the Punjab, Lahore, Pakistan.

2 Attachments • Scanned by Gmail

Appendix 10 Go-No-Go Paradigm



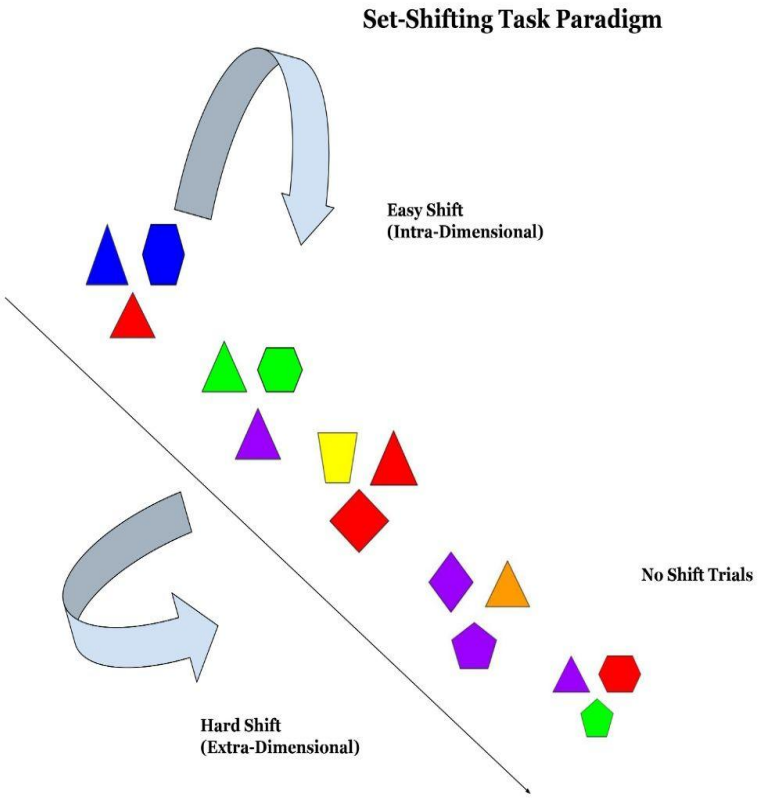
Appendix 11 Go-No-Go Task Instructions

درج ذیل سرگرمیوں میں، اگر آپ کو یہ تصویر نظر آتی ہے تو اسپیس کا بٹن دبائیں۔

اگر آپ مندرجہ ذیل تصویر دیکھتے ہیں تو کچھ نہ دبائیں۔

اب شروع کرنے کے لیے space کا بٹن دبائیں!

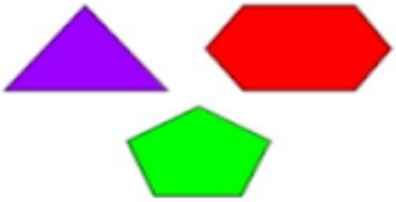
Appendix 12 Intra-Extra Dimensional Set-Shifting



Appendix 13 IED Task Instructions

مندرجہ ذیل سرگرمیوں میں آپ کو ایک ایسی تصویر دکھائی جائے گی جس کی تین مختلف شکلیں ہیں۔ آپ کو نیچے دی گئی شکل کو اوپر دی گئی دو شکلوں میں سے کسی ایک کے ساتھ (رنگ یا شکل کے ذریعے سے) ملانا ہوگا۔

اگر اشکال ایک جیسی ہیں (جیسے رنگ یا شکل میں) تو B یا V کا بٹن دبائیں۔



اگر اشکال ایک جیسی نہیں تو "N" کا بٹن دبائیں۔

اب شروع کرنے کے لئے "A" کا بٹن پر دبائیں!

Appendix 14 Turnitin Plagiarism Report

report

ORIGINALITY REPORT

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