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EDITOR'S NOTE

It is our greatest pleasure to present Volume III of the Koç University Undergraduate Psychology Journal. Our goal in creating this journal was to establish a platform in which undergraduate psychology students could share their research with one another, and most importantly we wanted this platform to be available to everyone, not just Koç University students. We are very happy to announce that in this Issue we present you an article from Yeditepe University and from University of Durham. We believe that it is a pleasure to see research from other universities, and hope to include more articles from different universities. While we can only print a small portion of the articles we receive, as the KUUPJ team we are very thankful for those who have submitted their work, and we hope to include these articles in our later Issues.

First of all, I want to thank my wonderful team in their effort to create this issue. Though it was a very busy time period as it was the end of the semester, we all together volunteered hours of our time to review articles and enhance the work of fellow students. I also want to thank our advisors Dr. Fuat Balcı and Dr. Tilbe Göksun. Without their support and guidance this platform would not be established. In addition, I would like to present my gratitude to the Koç University Psychology Department with its entire faculty who supported our journal and this issue throughout the process.

Lastly I want to thank to all authors and undergraduate students who shared their work with us, as their research is the foundation of this journal.

As the journal team we hope that you will enjoy this issue, but more importantly we really hope you to be inspired to share your research with us!

Editor-in-chief
Eylül Turan

Group Activities Differ in Social Interaction of Intellectually Disabled People

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This research study investigates whether group activities, which are experienced with peers, have positive effect on social interaction, which is measured with analysis of problematic behavior, social skills, affective understanding, and social competence for people with intellectual disabilities. Twelve mild intellectually disabled people (two of them have autism spectrum disorder, one of them has Down syndrome, one of them has Williams syndrome and others have only mild intellectual disability) were recruited randomly from The Support Center of Disabled Children and Their Families (EÇADEM). Participants were divided into two groups equally as one group (*n* = 6) participated to group activities whereas the other group (*n* = 6) involved in individual activities. Before and after the experiment, parents took pre-test and post-test which analyzed social interaction level of their children. There was not any significant result of the study due to several limitations including limited experiment time and absence of direct observation of each individual during the experiment. Therefore, based on present study findings, future research should develop effective measurements for intellectually disabled people.

Keywords: intellectual disability, social interaction in disabled people, cooperative learning, cooperation

Social interaction is an essential function of social life for all species. For instance, when people need help to achieve something, they want help from someone with using basic communication tools such as asking something with soft tone, establishing eye gaze, and saying "Thank you!". However, many disabled people especially who have intellectual disabilities (ID) have low levels of social interaction with each other or with other people who have not ID or any different disabilities. On the subject of intellectual disability, it causes difficulties in everyday social skills and these individuals interact with other people less frequently due to the low levels of intellectual capacities that individuals with ID have (Carter & Hughes, 2005). According to Trawick-Smith (2000), research demonstrates that typically developing individuals perceive one's disability more acceptable and interact with that individual more when the disability at stake is visible such as cerebral palsy compared to other disabilities such as autism spectrum disorder (ASD) because abnormal behaviors in disabled people with ID are less understandable compared to other disabilities (as cited in Doherty, 2002). Therefore, people with ID have more difficulties in social interaction and interpreting social cues relative to other people (Carter & Hughes, 2005). That is, lack of social interaction leads

to social exclusion, and prejudicial treatment against these people, therefore their participation in social life becomes more difficult compared to people who have not ID. Besides that, Bengtsson Tops and Hansson (2001) argue that people who have psychiatric disorders experience difficulties regarding social interaction, leading them to have fewer connections compared to people who do not have psychiatric disorders. Correspondingly, increase of participation in social life, which means increase of social interaction, has also increased disabled people's well-beings and self-esteem (Minnes, Perry, Taheri, 2016). For instance, when individuals with ID take an invitation regarding being playmate for their peers, they can invite their friends to be their playmate for the next time because individuals' self-esteem increase in tandem with experiencing acceptance from others even only once.

Since enhancement of social interactions is an essential factor that may contribute to disabled people's psychological development, researchers try to investigate useful ways that may lead to increase in social interactions. One of the possible way of such a contribution is cooperative learning referring to a method in which students learn information with group works such as reviewing material, and giving feedback to each other (Farlow, 1994). Particularly, research of Farlow (1994) indicates that social interaction of disabled people with other people increases when the intervention of cooperative learning is applied to them. In addition, the research reveals that groupwork intervention, which uses social communication and social interaction methods since they are problematic for people with autism spectrum disorder (ASD), changes the level of social interaction positively for people with ASD as ASD is a neurodevelopmental disorder in which individuals have deficits in especially social skills, and emotions (Dunlop, Knott & Mackay, 2007). For these reasons, group works/activities can provide the increase of social interaction of not only typically developing people but also people with ID.

According to Carter and Hughes (2005), peer interaction determines people's social skills especially in adolescents with or without ID. However, people with ID experience difficulties about social interaction among their peers (Doherty, 2002). In order to overcome this difficulty, research of Argentzell et al. (2013) can be taken into consideration as the results of the study indicate that day centers, which includes group activities and communication possibilities with peers for psychiatrically disabled people, affect social interaction positively, and people who attend to day centers regularly are less depressive than individuals who do not attend to day center sessions (Argentzell et al., 2013). With this in mind, Shukla, Kennedy, and Cushing (1998, 1999) compare intervention conditions of adult support and peer support in the context of education through administering assignments to individuals with ID (as cited in Carter & Hughes, 2005). In the study, there are several activities and goals which are planned in accordance with the "Individualized Education Program" about socialization with other students and specific behavior control for both adult and peer conditions. However, in peer condition, these activities are administered by students' peers under the control of "the special educator" while in adult condition, these activities are administered by only "the special educator" (as cited in Carter & Hughes, 2005, p.185). The researchers found that social interactions' quantity which is frequency and duration of communication had increased more in peer support condition relative to adult support

condition due to the possibility that there are more various types of "social support behaviors" in peer support condition than adult support condition (as cited in Carter & Hughes, 2005, p.185). In addition to this, Shukla et al. (1999) argued that social interactions' quality which is social enhancement behaviors had improved in the peer support condition.

Having talked about the social interaction, in this study, the hypothesis that was developed in line with the past research (Argentzell et al., 2014; Dunlop et al., 2007; Farlow, 1994) is that compared with participation of individual activities, when people with ID attend to group activities with their peers who have also similar ID, their social skills can be improved more especially their social interaction level which is operationally measured by looking at the frequency of communication and interaction with each other. Specifically, thanks to cooperativeness which is obtained by group activities, people with ID would develop a sense of belongingness with others, therefore social interaction can be increased. Under these circumstances, people with ID's social integration, in other words their social relations with society, can be ameliorated.

Furthermore, there are three types of ID which are Down syndrome, autism spectrum disorder (ASD), or Williams syndrome (WS) in the present study. Down syndrome is a genetic disorder, which is caused by incorrect cell division and characterized by delayed physical growth, different levels of ID, and characteristic facial features (Matzen & Kuzins, 2014). Moreover, ASD is a neurodevelopmental disorder, which is characterized by different levels of ID, low level of social interaction, difficulties in both verbal and nonverbal communication and stereotypical and repetitive behaviors and interests (American Psychiatric Association, 2013). Last, WS refers to a neurodevelopmental disorder characterized by different levels of ID, facial features, and over friendly attitudes, and individuals with WS have problems in visuospatial and visuomotor abilities (Sparaci, Stefanini, D'Elia, Vicari, & Rizzolatti, 2014). In addition, regarding ID, there are four levels of intellectual disabilities which are mild, moderate, severe, and profound in general. These levels are determined by examining IQ scores; therefore, IQ score of 50 to 70 indicates mild ID, IQ score of 35 to 49 indicates moderate ID, IQ score of 20 to 34 indicates severe ID, and when IQ score is less than 20, the condition is named as profound ID (Gluck, 2016).

Method

Participants

Data were collected from parents of 12 students with mild ID (also some of them have Down syndrome, autism spectrum disorder, or Williams syndrome) from The Support Center of Disabled Children and Their Families (EÇADEM) which aims to decrease care responsibility of mothers who have children with intellectual disabilities between 13-29 ages in Sarıyer region without charging any service fee. These students were selected randomly with institution 's psychologist who has information about their sufficiency of group activities, and the age of participants ranged from 12 to 31 years (M = 19.56, SD = 6.00), and gender was divided equally (6 females, 6 males). Moreover, participants who were students with mild ID were divided randomly into two groups which are experimental group (M_{age} = 20, SD = 5, n = 6) and control group (M_{age} = 21, SD = 5.31, n = 6). Both groups had similar average of age (M = 21), and equal distribution of gender (for each groups 3 females, 3 males). Lastly, data were obtained only from students' parents since students' cognitive reasoning

was not sufficient to answer the questionnaire, and they could not be observed in their natural social context. Also, informed consent was obtained from all parents.

Materials

Pre-test and post-test consisted of four different surveys which were taken from TRIAD Social Skills Assessment that was created in the Department of Pediatrics at Vanderbilt University Medical Center (Brigham et al., 2010). Since the participants' main language was Turkish, questions were adapted to Turkish from English (see Appendix). Particularly, to measure social interaction, questions were classified as four distinct categories, namely, problematic behaviors, social skills, affective understanding, and social competence and questions were provided respectively without any counterbalancing. For problematic behaviors, parents were asked to rate their children on a 5-point Likert scale (1 = not problematic at all, 2 = slightly problematic, 3 = somewhat problematic, 4 = moderately problematic, 5 = very problematic). For other surveys, 5-point Likert scale's values were reversed.

For pre-tests, which were sent to parents through their children, one week was given to parents to complete the questions. However, parents did not complete pre-tests on time and were reminded to complete the surveys. Therefore, post-tests' answers were taken through telephone conversation to prevent any potential delay of post-test answers. Post-tests were administered in 2 days via telephone conversations between the parents and the researcher which lasted 10 to 15 minutes. Specifically, telephone conversations were initiated with introducing the parents regarding the researcher and the aim of the research without providing any confounding information. After the introduction, post-test questions were asked orderly as previously stated. Lastly, the researcher was thanked for their participation to the research.

Procedure

Before the experiment was conducted, parents were informed about the study with written consent form which explains the process without informing them about which group their children belong to, that is, the experimental or the control group. Additionally, pre-test which contains parents' evaluation of their social interaction and problematic behaviors was administered to students' parents. These consent forms and pretest were sent to parents through students when they returned their home from EÇADEM and one week was given to parents to complete the pretest. After consent forms and pre-tests were recruited, experimental group was exposed to two sessions of group activities throughout two weeks. During the group activity of the first week one of the students thought one object or a person in the experimental environment, which is the classroom, without saying any cue about it. Then, after observing the experimental environment for a minute, children were directed to guess about objects around them as they were provided with little cues such as object's material, color and size. That is, other children could not guess objects without cues. Second week's group activity was that students formed a circle and played "ear to ear". During this game, one student says one sentence to other student who sits next to the person in whispers. Then, that student also says to other student in whispers and this follows until the very last student. At the end, last student says loudly what she hears. Moreover, each group activity lasted 30 minutes. Meanwhile, control group participated in individual activities such as painting, and doing puzzle instead of group activities for two weeks. At the end of the experimental process, post-tests which were

identical to pre-tests were administered to parents.

Results

The assessment of the main hypothesis, which argues that group activities increase social interaction of people with ID with each other compared with individual activities, is executed by a one-way analysis of covariance (ANCOVA) to determine a statistically significant difference between experimental condition, which contains group activities, and control condition, which contains individual activities, in terms of social interaction level controlling for pre-test social interaction of both experimental and control groups.

Problem Behaviors

When problematic behavior score of ID individuals during pre-test was controlled, a one-way ANCOVA for both experimental group (M = 57.521, SD = 17.278) and control group *(*M = 70.263, SD = 4.425) showed that the main effect of group activities on problematic behavior was not statistically significant, $F(1,6) = 4.13$, $p = .887$, $\eta^2 = .004$ (see in Appendix B).

Social Skills

A one way ANCOVA showed that when pretest score of social skills of ID people ($M_{experimental\ group}$ = 6.480 and SD = 1.053, $M_{control\ group}$ = 7.480 and SD = .849) was covaried out, the main effect of group activities on social skills was not statistically significant, $F(1,6) = .543$, $p = .489$, partial η^2 = 083 (see in Appendix B).

Affective Understanding

A one-way ANCOVA found that there is no statistically significant effect of group activities on affective understanding ($M_{experimental\ group}$ = 39.997 and SD = 6.967, $M_{control\ group}$ = 36.219 and SD = 5.660) controlling for pre-test score of affective understanding, $F(1,6) = 2.134$, $p = .194$ partial $\eta^2 = .262$ (see in Appendix B).

Social Competence

When pre-test score of social competence of ID people was covaried out, a one-way ANCOVA for both experimental group (M = 21.761, SD = 2.703) and control group *(*M = 16.625, SD = 2.156) showed that the main effect of group activities on social competence was not statistically significant $F(1,6) = .790$, $p = .408$, partial $\eta^2 = .116$ (see in Appendix B).

Discussion

The main purpose of this experiment is to reveal whether group activities increase social interaction, which consists of social skills, social competence, affective understanding and non-problematic behaviors, among the intellectually disabled people. The findings do not demonstrate significant results about the level of social interaction. In other words, there is not any significant differences between people who experienced group activities and people who were engaged in individual activities in terms of social interaction evaluated by parents. Additionally, there is not any main effect of social interaction components.

In the research of Dunlop et al. (2007) about social interaction of people who have ASD, the researchers only intervened in individuals who have ASD, and they could not have any control group in their research. However, in the present study, there was both experimental and control groups, thus comparison between the experiment condition and control condition was conducted easily. With regards to the research of Dunlop, Knott & Mackay (2007), their intervention about social interaction lasted 12-16 weeks, and the intervention successfully ameliorated the social skills of the participants with ASD. Nonetheless, the present study lasted 2 weeks,

and it does not have any significant result. Therefore, this result might be caused by the short duration of the intervention.

According to Argentzell et al. (2013), peer support has powerful effect on social skills and ability of life control for people who have psychiatric disabilities. By the same token, even there is not any significant results, mean differences of social skills reveal that social skills score increased in experimental group compared to control group. However, these results are not significant because there is time limitation and there are only 12 participants; therefore, such limitations may lead to non-significant results. Additionally, according to Doherty's review (2002), support of peers and common interests encourage children to make new friends. Although such a statement is related to typically developing children, it is also shown in the present study's sample. In other words, people who were exposed to group activities provided higher scores in social skills than control group in the context of social competence, which measure their communication with their friends. Last but not least, Doherty's (2002) observational data shows that disabled children cannot sustain relationships with peers; therefore, they are alone mostly. Conversely, the data which is obtained for the present study indicates that according to parents, their children have friends, and they keep relationship with them constantly. This can be resulted from EÇADEM's structure since EÇADEM provides the necessary opportunity to socialize with peers for a long time such as twelve hours per a week, leading people with ID to make friends easier compared with special education schools which offers individual education program to people with ID in Turkey.

Limitations

The study has several limitations that needs to be considered while referring to nonsignificant results. One of the possible reason why there is no significant result can be small number of participants. In other words, although the present study has 12 intellectually disabled individuals, other studies about social interaction are mostly consist of more than 90 (Argentzell et al., 2013) or even more than 200 participants (Taheri et al., 2016). Therefore, it might be understandable that this small number of participants could not give any significant results. Furthermore, the fact that time was restricted is another limitation of this study. In order to see improvement on effect size, any intervention should last more than one or two months since interventions can give significant results in cases of more than 5 sessions at least (Carter & Hughes, 2005). Specifically, even typically developing people need time for development of social skills, intellectually disabled people require more time to develop in all domains of social cognition especially social interaction because they are more constant due to abnormalities in mental ability. In addition, the study included only the parents' rating of children which can be another limitation of this study. That is, especially at the post-test section, some questions from parents revealed that there could be social desirability bias. For instance, one parent asked whether her child revealed any development from the pre-test times. Therefore, direct observation should be done for future researches. In addition to this, one parent did not want to fill post-test because she thought that there could not be development or change in her child in such a short period. In order to solve this kind of problem, experimenter can explain that participation of every individual is very

important to improve social life conditions of disabled people. Moreover, there can be an external validity problem due to two reasons. First, the sample size is small, which is twelve participants, leading to a low level of statistical power. Second, all participants of the experiment were recruited from the same institution which may lead to sampling bias since participants know each other as they might be more comfortable relative to other groups of participants which are taken from different institutions or schools. In other words, the present study's participants know each other very well because they have been attending to this institution for at least one year. That is, they have some level of social interaction before the experiment; therefore, this situation might create sampling bias for this experiment. In addition to this, there might be some problems about the structure of the intervention. Particularly, the present study's chose of group activity might be problematic. In this experiment, improvement of social skills of ID children was aimed, yet the selected group activities might be weak for this purpose because these activities such as guessing any object with giving cues does not consist of much social interaction. That is, even though this activity aims to develop social interaction, children can play the game without communication with any child. Alternatively, there can be specific social activities which contain social interaction more. For instance, making a puzzle with a group of children has a common goal, and it requires communication, which can be requesting help, or providing help, between children; therefore, their interaction level would increase. Thanks to this activity, children's social skills such as helping behavior and initiating communication can take progress more than present study's group activities' influence. Also, intervention's social activities such as "ear to ear" can be perceived as difficult by intellectually disabled population. For this reason, future research should address the cognitive and social difficulties of children with ID and form the interventions accordingly. Last but not least, another limitation of this study might be forming experiment group with children who have different kinds of intellectual abilities and different age levels. That is, conducting research with same intellectual disability type such as only ASD or only Down syndrome might give different results from the group activities intervention of this study. Also, consisting group of children with same age level can give developmental explanations for this study clearly.

Conclusion

In conclusion, the findings of this research indicate that even there is not any significant main effect of group activities on social interaction of people with ID, there are some non-significant yet observed differences which were talked above sections. Since the present study has limitations, specifically time limitation, group formation, and intervention structure, the hypothesis is not proven statistically. For the future research, the duration of the intervention should be longer, different experimental groups, which consist of participants who do not know each other well, should be included, direct observation should be considered, and different group activities that are appropriate to children's level of cognitive competency should be administered to conduct analysis. From starting with more moderate group activities and continuing with more upper level of group activities like in the present study which is "ear to ear", intervention programs may provide more beneficiary results.

References

American Psychiatric Association, 2013. Diagnostic and statistical manual of mental disorders, (DSM-5®): American Psychiatric Pub.

Argentzell, E., Leufstadius, C. & Eklund, M. (n.d). Social interaction among people with psychiatric disabilities – Does attending a day centre matter?. *International Journal Of Social Psychiatry, 60*(6), 519-527.

Bengtsson-Tops, A., & Hansson, L. (2001). Quantitative and qualitative aspects of the social network in patients with schizophrenia living in the community. Relationships to sociodemographic characteristics, clinical factors and subjective quality of life. *International Journal of Social Psychiatry*, *47*, 67–77.

Carter, E. W., & Hughes, C. (2005). Increasing social interaction among adolescents with intellectual disabilities and their general education peers: Effective interventions. *Research and Practice for Persons with Severe Disabilities*, *30*(4), 179-193.

Doherty, D. R. (2002). *Analysis of Variables Related to Social Interactions in Children with Agenesis of the Corpus Callosum* (Doctoral dissertation, The University of Maine).

Farlow, Leslie, J. (1994). Cooperative Learning To Facilitate the Inclusion of Students with Moderate to Severe Mental Retardation in Secondary Subject-Area Classes.

Filippatou, D., & Kaldi, S. (2010). The Effectiveness of Project-Based Learning on Pupils with Learning Difficulties Regarding Academic Performance, Group Work and Motivation. *International Journal of Special Education, 25*(1), 17-26.

Gluck, S. (2016). Mild, moderate, severe intellectual disability differences. Retrieved from https://www.healthyplace.com/neurodevelopmental-disorders/intellectual-disability/mild-moderate-severe-intellectual-disability-differences/

Matzen, G. M., & Kuzins, R. (2014). Down syndrome and genetics. Salem Press Encyclopedia Of Health,

Shukla, S., Kennedy, C. H., & Cushing, L. S. (1999). Intermediate school students with severe disabilities: Supporting their social participation in general education classrooms. Journal of Positive Behavior Interventions, 1, 130Y140.

Sparaci, L., Stefanini, S., D'Elia, L., Vicari, S., & Rizzolatti, G. (2014). What and why understanding in autism spectrum disorders and Williams syndrome: similarities and differences. *Autism Research*, *7*(4), 421-432.

Stone, W., Ruble, L., Coonrod, E., Hepburn, S., Pennington, M., Burnette, C., & Brigham, N. B. (2010). *TRIAD social skills assessment.* Nashville: Vanderbilt Kennedy Center.

Taheri, A., Perry, A., & Minnes, P. (2016). Examining the social participation of children and adolescents with Intellectual Disabilities and Autism Spectrum Disorder in relation to peers. *Journal of Intellectual Disability Research*, *60*(5), 435-443.

A New Eye-Gazing Behavioral Task for Smartphone Addiction in Relation to Inhibitory Control and its Validation via Stroop Task

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The ultimate aim of this study was to explore the smart-phone addiction and its relation with inhibitory control processes. A sample of 34 undergraduate students (17 women) from various departments of different universities was selected for this study. It is hypothesized that participants who had higher levels of scores in the smart-phone addiction questionnaire would make more mistakes in the Stroop task whereas participants with low levels of addiction scores would not. Interestingly, only women demonstrated this kind of relationship and we did not find any significant correlation between our measures for men. Also, validation study was designed to measure our new eye-gazing behavioral task with Stroop task that is used to measure inhibitory control in the literature. In validation study, it is revealed that long eye-gazing duration as a new behavioral measure (sec), Stroop task (number of errors) and smart-phone addiction scale (high scores on the scale) are positively correlated between each other. Our second hypothesis is that people who get higher scores in smart-phone addiction scale would also demonstrate higher duration length (sec) in their eye-gazing behavioral task. According to the results, again only women indicated this positive correlation between these two variables. Overall, these results that have high positive correlations demonstrate that smart-phone addiction as a behavioral addiction is potentially related with inhibitory control processes in the brain, but specifically for women.

Keywords*:* behavioral addiction, smart-phone addiction, gender difference, inhibitory control

Usage of smartphones has dramatically increased over the last decades in all age groups. According to World Health Organization's report of 2010, approximately 5 billion people in the world were mobile phone users (Riemer, 2011; Allahverdipour et. al, 2014). Pew Research Center also suggested that 46% of smart-phone owners said that smartphone is something "they could not be able to live without." (Smith, 2015; Hawi & Samaha, 2016). Its invention and subsequent developments that came after are strongly influential in people's lives. Nowadays its use exceeded its communication purpose. Previous studies about behavioral addictions such as Internet addiction or gambling addiction investigated why people are engaging in such addictive activities consistently. Their findings generally suggested that behavioral addictions contain reinforcing features and this reinforcement mechanism generally results in addictive inclinations (Widyanto & Griffiths, 2006; Alavi et. al., 2012).

Because of its intrinsically rewarding nature, smartphone usage is a potential source for addictive behaviors. (Widyanto & Griffiths, 2006; Alavi et. al., 2012). For

instance, it is known that behavioral addictions may result in various kinds of maladaptive behaviors ranging from impulsiveness, alterations in mood, lack of tolerance, and abstinence (Gutiérrez et. al., 2016). In behavioral addiction literature, technological addictions are well investigated, especially Internet addiction (IA) (Hawi & Samaha, 2016; Choi et al., 2014; Dong et al.2011). On the other hand, smartphone addiction (SA) can be evaluated within the category of behavioral addictions and can be defined as the inability to control smartphone use. Although smartphone addiction is not listed in DSM-5 yet, its excessive use causes psychological and physiological distress and may turn individuals' adaptive behaviors toward their environments into maladaptive ones. (Boumosleh, & Jaalouk, 2017; Demirci, Akgönül, & Akpinar, 2015; Kwon, Lee et al., 2013.)

SA literature, unlike IA studies, is in need of development because we still do not know about its exact behavioral manifestations and its neural correlates to be able to measure it concretely. Therefore, we developed a new eye-gazing task to measure SA in order to understand its relationship with inhiabition-control (IC) processes that is not investigated in literature yet. Because it is argued that poor inhibitory control is highly characteristic for behavioral addictions such as gambling and IA, that is generally observed in terms of diminished attention, memory and overall impaired executive control functioning (Choi et. al., 2014).

In accordance with the theoretical background that is mentioned above, this study aimed to find important implications that can contribute to addiction and inhibitory control literature. With this ultimate aim, we specifically chose smartphone addiction and developed a new behavioral task for this purpose. Then our study aimed to (1) to validate our new behavioral task by using Stroop task that is also used to measure IC responses behaviorally; (2) and to test our new behavioral task with the following hypotheses; a) people who demonstrate higher duration length (sec) in their eye-gazing behavioral task will also get high scores in smartphone addiction scale; and b) it is expected that same people will make higher levels of mistakes in Stroop task than people who are low in duration length (sec) and smartphone addiction scale.

Method

Participants

There were 34 (17 female, 17 male) participants who were all from Yeditepe University All participants were asked if they are able to differentiate the colors in the Stroop task. Participants' ages range from 19 to 27 (M=22.2, SD=0.35). The sample was selected by using non-probability sampling technique according to accessibility to the researchers.

Procedure

All of the measures were applied individually to participants in a proper setting. Participants first filled the demographics and informed consent forms. The experimenter who is responsible for the behavioral tasks texted phone numbers of the participants to the second experimenter. Then the participants were asked to fill out the SAS-VS questionnaire. After they finished the questionnaire, they performed Stroop task. Before participants were shown the video, they were told that their phones should be on the desk, where they can see and hear in a clear way. During the five-minute documentary session, they were not allowed to look at their phones.

Behavioral Task

The task used in this study aims to look at the link between inhibition processes and smart-phone addiction. To assess this, participants were shown a neutral five-minute documentary, which is Beethoven: The Rebel. This part of the study aimed to attend

participants' attention in one point. The experimenter measured participant's duration of gazing toward their smart-phones with a stopwatch while the participants were watching the documentary. Other experimenter texted to participant's smart-phone. By doing this we aimed to distract participant's attention and make her/him want to look at their phone, while they focused on to documentary. Experimenter who texted to the participant was not in the experiment room. Therefore she was not visible to the participant. In the experiment room there was only one experimenter who carried the tasks and the participant. Also,the participants did not know that the massages were coming from the experimenter.

Smartphone Addiction Scale

In this study the short version of Smartphone Addiction Scale (SAS-SV) which was developed by Kwon et al.(2013) was used for validation of the behavioral task. SAS-SV is a self-report scale and it measured based on Likert Scale. The questionnaire contains 10 items. Each question has 6 point scale. High scores in the questionnaire reveal higher risk of smartphone addiction. The Turkish translation with the reliability and validity of this scale is made by Noyan et al. (2015)

Stroop Task

In this study, we used Stroop task (Stroop, 1935) to measure the participants' inhibition processes. Only the color-word card (in which participants supposed to say the color of the word instead of reading the word) was used from the original Stroop task. For example, the first word was red but it was written with blue color. We gave 45 seconds to the participants to measure the number of words that they said and the number of errors they had done. Karakaş et al. (1999) translated the test into Turkish and did validity and reliability studies. The original task was developed by Stroop (1935).

Statistical Analysis

First, we performed Shapiro-Wilk in order to test normality of data. Because data of the study were not found to be distributed normally, non-parametric statistics were used. To test our hypothesis, we carried out Spearman Correlation Analysis. SAS-SV's internal consistency was also assessed. Mann-Whitney *U* test was conducted to see differences between males and females.

Results

Reliability Analysis of SAS-SV

The Cronbach's alpha analysis for SAS-SV questionnaire demonstrated a very high level internal consistency (10 items, α = .923). Because the internal reliability of the questionnaire was high enough, none of the items were excluded.

Criterion Validity

To establish criterion validity, we correlated our behavioral task measure with SAS-SV questionnaire and Stroop task. Additionally, we correlated the number of errors in the Stroop task and the scores on the SAS-SV. Duration of eye gazing and number of errors in Stroop task was significantly positively correlated (r= .516, p= .003*)*. Duration of eye gazing was also significantly positively correlated with scores on SAS-SV (r= .584, p= .000). There was no significant correlation between number of words that was read in Stroop task and duration of eye gazing (r= .259, p= .153). The Scatter Plot of the correlation between duration of eye gazing and number of errors in Stroop task can be seen in Figure 1-a. The Scatter Plot of the correlation between Duration of eye gazing and SAS-SV Scores can be seen in Figure 1-b.

General analysis of the Stroop task and SAS-SV.

We also found positive correlation between number of errors in the Stroop task and scores on the SAS-SV (r=.458*,* p=.008) and negative correlation between number of words read in the Stroop task and scores on

SAS-SV (*r*=-.*350, p*=.049). However, we could not find any significant correlation between number of errors in Stroop task and number of words read in the Stroop task (*r*=.131, *p*=.474).

Gender differences.

When data was examined only for males, there were not any significant correlation between measures of the study with *r* ranging between .-412 and .341 (*p* =n.s not significant?). Conversely, we found significant correlations in women's data. Number of errors in Stroop task was positively correlated with duration of eye gazing (*r*= .918, *p*= .000), see Figure 2-a. There is also another positive correlation for women between Scores on SAS-SV and Number of Errors in Stroop task (*r*= .724, *p*= .002), see Figure 2-b. Finally we found significant positive correlation between Scores on SAS-SV and duration of eye gazing (*r*= .848, *p*= .000).

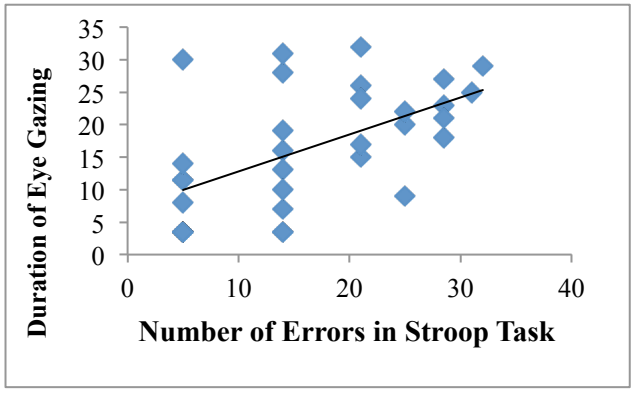

Figure 1-a.

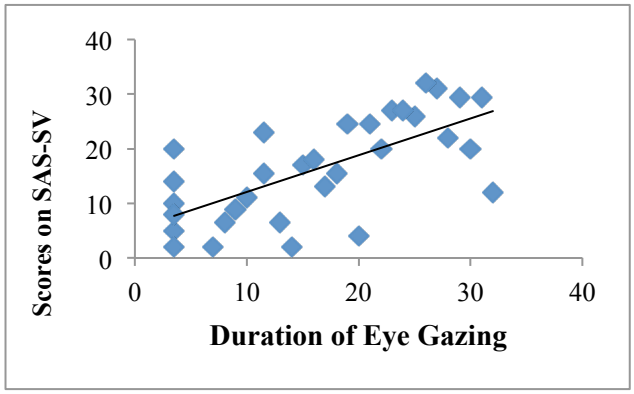

Figure 1-b.

Discussion

It is found that using smartphone potentially produces addictive behavior (Al-Barashdi et. al., 2015). For this reason, the aim of this study was to design a novel behavioral task that measures inhibitory control behavior, particularly smart-phone addiction. We expected that people who have high duration length (sec) on the basis of their eye-gazing behavior will also get high scores in smartphone addiction scale, and also that same people will make more mistakes in Stroop task than people who have low duration length (sec). The results of the study showed a strong consistency with our hypotheses.

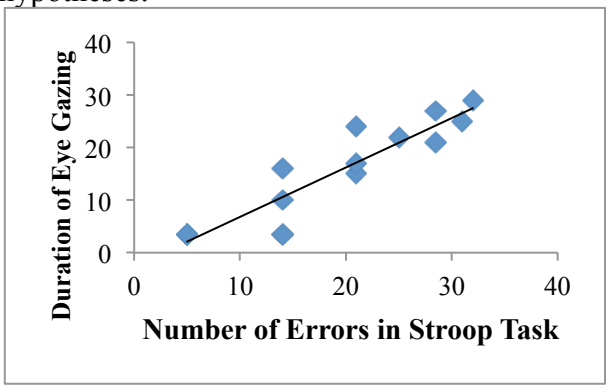

Figure 2-a.

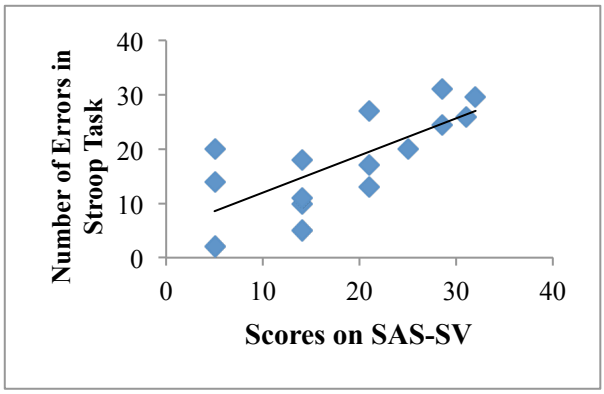

Figure 2-b.

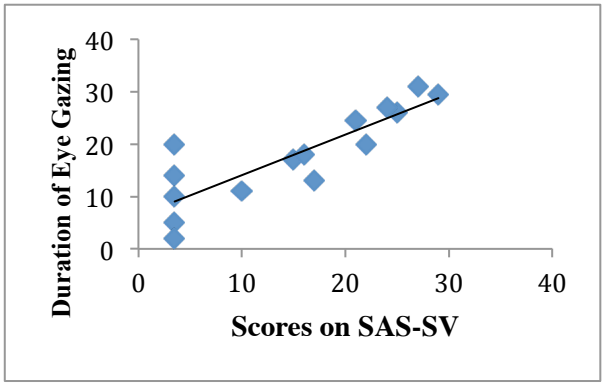

Figure 2-c.

For example, there is a significant positive correlation between duration of eye gazing and SAS-SV scores, meaning that participants who have higher levels of smartphone addiction look at their smartphones more (even if the experimenter says not to do) than the participants who have lower level of addiction that was measured with addiction questionnaire. It is suggested that our behavioral task could successfully differentiate between people who have smartphone addiction and people who do not.

Secondly, we looked for validation of our test by correlating number of errors in Stroop task with duration of eye-gazing. When a closer look is taken, duration of eye gazing and number of errors in Stroop task was positively correlated. It is consistent with the findings of a study looking at the relationship between IA and inhibitory control processes by using Stroop task (Dong et al., 2012). One of the reasons why this correlation was found significant may be pointed out that the observing reflexes are salient measures for inhibitory control processes. Some investigation for inhibitory control processes and indicators of addiction behavior may construct biological and physiological underlying dynamics to explain these concepts in the literature (Gutiérrez et. al, 2016). In our study, eye-gazing as an automatic reflex has significant correlation with other measures. This result may mean that this is a valid measure for this kind of behaviors. It is known that there is not enough measure in the literature for addiction and inhibition behaviors, especially with eye-gazing. Therefore, future researchers may focus on different aspects of addiction and inhibitory control behaviors in a more direct way with our measure.

When looking at sex differences, we found differences between males and females when we did correlation analyses separately. Similarly, Kwon et al. (2013) found gender differences on SAS-SV when they established the reliability and the validity of this scale. Controversially, the one study that examined smartphone addiction with university students failed to find any significant differences between males and females (Hawi & Samaha, 2015; Noyan et al. 2015). These differences on findings may arise from the age differences between samples. In the study that is conducted by Kwon et al. (2013), the average age was 14.5 and their sample was composed of adolescent population. On the other hand, the study that was done by Hawi & Samaha had ages ranged from 17 to 26; also their sample was composed of university students. Another study that is done by Noyan and his colleagues (2015) examined the university students similar with our study. In terms of gender differences, there are also different and controversial views in the addiction literature. For example, MacLeod (1991) found that there are no significant differences between genders on Stroop test. However, Elst et al.(2006) found significant differences between males and females with females doing better than males on the test. Further research may shed light on these inconsistencies between these findings.

Interestingly, we could not find any correlation in males. In contrast, all of the correlations we found in the study were detected only in females with higher correlation coefficients. This finding is crucial because the studies that examine the relationship between inhibitory mechanisms and IA found correlation only with male participants (Dong, Zhou & Zhao, 2011; Dong et al., 2010).

Also, we found significantly positive correlation between numbers of errors in Stroop task and scores on SAS-SV and significantly negative correlation between number of words read in Stroop task and scores on SAS-SV. These findings may determine the exact relationship between the addiction of smart-phones and inhibitory control processes. Also they are coherent with

past studies that had examined relationship between addictions and inhibitory control. (Jentsch & Pennington, 2014; Dong et al., 2010; Choi et al., 2014)

Limitations

As it is pointed out before, our study has lots of limitations. We wanted to discuss our limitation in a separate section so that further researchers would pay attention obstacles that may occur. If this study could be repeated again, our primary suggestions to researchers would be about experimental design and data collection process. In this process, we asked to get participants' telephone numbers; it is normally uncommon in psychological or any other studies. Therefore, some participants asked its purpose and predicted that their numbers will affect their results. Besides, we showed documentary about Beethoven, some participants who are highly interested in music did not pay attention to our actual experimental design and watched the documentary. Another point we want to discuss is about the measurement of the eye-gazing behavior. In this study we measured the behavior by observing the participants behavior and counting it. However this was not a reliable measure and may affect the results of the study. For these reasons, it can be suggested that other researchers willing to design such an experiment can avoid these confounding variables (e.g satisfactory explanation for the purpose of getting their telephone numbers, using more neutral documentary, finding a more reliable measure for the behavioral task). Additionally, we had just 34 participants (17 female) so that the number of participants was not enough to represent and generalize to whole population. Additionally, age range of the participants was not wide enough. Because our population consisted of college students, further researches can create different age groups to reflect all population using smart-phones, such as looking the difference between teenagers and college students. Besides, this topic is relatively new for the science of psychology so that we could not find enough research in the literature to support or compare with our hypotheses. Criterion validation studies were also not found to compare our results. For this reason, new measures may not be valid enough to demonstrate the exact behavior that measure inhibitory control and addiction tendency.

Smart-phones are products of 21st century technology. Therefore, the availability of prior research investigating smart-phone addiction is limited. This quite new topic in psychology literature should be well defined and studied properly. Our study tried to define and measure these concepts, although it has some limitations. This first attempt may be beneficial for the other studies wanting to investigate and support addiction literature. More comprehensive models that include different tasks for cognitive abilities and variables such as broader range of age, sex or even cultural differences will definitely contribute well to addiction literature.

References

Alavi, S.S., Ferdosi, M., Jannatifard, F., Eslami, M., Alaghemandan, H. and Setare, M. (2012). Behavioral addiction versus substance addiction: correspondence of psychiatric and psychological views. *International Journal of Preventive Medicine*, 3(4), 290-294.

Allahverdipour, H., Pourraazavi, S., Matlabi, H., & Jafarabadi, A. M. (2014). A socio-cognitive inquiry of excessive mobile phone use. *Asian Journal of Psychiatry*, 10(1), 84-89.

Boumosleh, J. M., & Jaalouk, D. (2017). Depression, anxiety, and smartphone addiction in university students-A cross sectional study. *PLoS one*, 12(8), e0182239.

Choi, S. J., Park, M. S., Roh, S. M., Lee, Y. J., Park, B. C., Hwang, Y. J., Gwak R. A., & Jung, Y. H. (2014). Dysfunctional inhibitory control and impulsivity in Internet addiction. *Psychiatry Research*, 215(1), 424-428.

Demirci, K., Akgönül, M., & Akpinar, A. (2015). Relationship of smartphone use severity with sleep quality, depression, and anxiety in university students. *Journal of behavioral addictions*, 4(2), 85-92.

Dong, G., DeVito, E. E., Du, X., & Cui, Z. (2012). Impaired inhibitory control in 'internet addiction disorder': a functional magnetic resonance imaging study. *Psychiatry Research: Neuroimaging*, *203*(2), 153-158.

Dong, G., Zhou, H., & Zhao, X. (2011). Male Internet addicts show impaired executive control ability: evidence from a color-word Stroop task. *Neuroscience letters*, *499*(2), 114-118.

Gutiérrez, D. J., Fonseca, R. F. & Rubio, G. (2016). Cell-phone addiction: A review. *Frontiers in Psychiatry,* 7(175), 1-15.

Karakaş, S., Erdoğan, E., Sak, L., Soysal, A., Ulusoy T., & Alkan S. (1999). Stroop testi TBAG formu: Türk kültürüne standardizasyon çalışmaları, güvenirlik ve geçerlik. *Klinik Psikiyatri*, 2(1), 75-88.

Kwon, M., Kim, D. J., Cho, H., & Yang, S. (2013). The smartphone addiction scale: development and validation of a short version for adolescents. *PloS One*, 8(12), e83558.

Kwon, M., Lee, J. Y., Won, W. Y., Park, J. W., Min, J. A., Hahn, C., Gu, X., Choi, J. H. & Kim, D. J. (2013). Development and validation of a smartphone addiction scale (SAS). *PloS One*, 8(2), e56936

MacLeod, C. M. (1991). Half a century of research on the Stroop effect: an integrative review. *Psychological Bulletin*, 109(2), 163.

Noyan, C. O., Enez Darçın, A., Nurmedov, S., Yılmaz, O., & Dilbaz, N. (2015). Akıllı Telefon Bağımlılığı Ölçeğinin Kısa Formunun üniversite öğrencilerindeTürkçe geçerlilik ve güvenilirlik çalışması. *Anatolian Journal of Psychiatry/Anadolu Psikiyatri Dergisi*, *16*.

Riemer, V. (2011). Tracking Resources for Women's and Children's Health Available from: http://www.who.int/mediacentre/multimedia/podcasts/2011/acc_20110202/en/

Samaha, M., Hawi, S. N. (2016). Relationship among smartphone addiction, stress, academic performance and satisfaction with life. *Computers in Human Behavior,* 57(1), 321-325.

Smith, A. (2015). US smartphone use in 2015. *Pew Research Center*. Retrieved from: http://www.pewinternet.org/files/2015/03/PI_Smartphones_0401151.pdf.

Stroop, J. R. (1935). Studies of interference in serial verbal reactions. *Journal of experimental psychology*, 18(6), 643.

Van der Elst, W., Van Boxtel, M. P., Van Breukelen, G. J., & Jolles, J. (2006). The Stroop Color-Word Test influence of age, sex, and education; and normative data for a large sample across the adult age range. *Assessment*, 13(1), 62-79.

Widyanto, L. L., Griffiths M. (2006). Internet addiction: a critical review. *International Journal of Mental Health Addict*, 4(1), 31–51.

The Implicit and Explicit Approaches to Measuring Stereotypes

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This paper reviews previous studies which have shown the influence of stereotypical attitudes and possible reasons behind its occurrence. Furthermore, this paper appreciates the potential of stereotypes and aims to evaluate the applicability of current methods measuring stereotypes. Two approaches in particular are examined: Explicit Measures and Implicit Measures. Explicit measures target the thought process at a conscious level and use self-report questionnaires. The paper criticizes explicit measures in terms of their generalizability (whether they are dependent on a sociocultural period), applicability (whether they are dependent on a contextual factor) and validity (whether the answers reflect their own ideas or their desire to be in line with the cultural norms). The point of questionable validity for explicit measures may be seen as acting as a catalysis in the formation of implicit measures. Implicit measures are dependent on the uncontrolled (automatic) cognitive thought processes as they measure the reaction time in their techniques (IAT, priming). However implicit studies are also criticized in terms of their validity as the extent of cultural influence registered within one's cognitive process is by no means absolute.

Keywords: implicit memory, explicit memory, measurement

Paulo Coelho famously stated 'you are what you believe yourself to be' (The Witch of Portobello, 2006), whether this has a psychological foundation that can be empirically supported is of interest. Arguably, this saying can be explained in term of 'attitudes'. Attitudes are used as psychological tendencies in the processes of determining a degree of preference towards others (Eagly, & Chaiken, 1993). The functionality of attitudes may come from their advantage in processing information easier and more efficiently as forming a general tendency leads to savings on cognitive effort (Hinton, 2017). However, colouring everyone with the same brush by associating the impressions of groups with particular characteristics (e.g. appearance, interests, activities), to other individuals who show similar characteristics (Eagly & Mladinic, 1989; Hamilton et al, 1985) may lead to the formation of 'stereotypes'. Even though the accuracy of stereotypical associations is hard to determine (Bordalo, Coffman, Gennaioli & Shleifer, 2016), the influence they have on daily life is inevitable. For instance, a study conducted by Shih et al (1999) showed that Asian American female undergraduate students performed better in a math test if they were implicitly reminded of their ethnic identity yet performed worse if their 'gender identity' was called upon. Both remarks of identity were associated with common stereotypes; however, remarks were regarded as either a strength (the 'Asian' ethnicity having superior quantitative skills compared to other ethnic groups) or a deficiency (the 'female' sex having less quantitative skills

compared to men). Hence suggesting that influence to perform well was placed upon stereotypical beliefs more than personal identity. Notably, this potential of stereotypes emerged an interest in the field of social psychology where more psychologists wanted to investigate how stereotypes could be measured. This paper aims to evaluate the applicability of implicit and explicit measures of stereotypes by outlining the limitations and addressing different areas of interest that each measure is concerned with.

Once a stereotypical attitude is formed, it manifests on two levels: explicitly and implicitly. Stereotypical attitudes that are explicit underlie a deliberate thought process, which operates consciously (Echabe, 2013) and are often contrived based on observation of ones' surroundings (Dryden, 2013). This observation may lead to the reinforcement of the stereotype in question. For example, one would buy their nephew a Lego instead of a doll if they had previously seen boys playing with Legos instead of dolls. Moreover, this observation may lead to the formation of an inference that involves additional information such as a character trait (Wang & Yang, 2017). For example, boys are good with tools (e.g. handy) and girls are good with children (e.g. affectionate). However, using cognitive resources in such a manner (observing, categorizing and inferring) may lead to one not being fully aware of this very process is forming an attitude which is stereotyped (Carlsson, 2008). The most straightforward and rapid way to operate an explicit measure (EM) is simply asking people through traditional self-reports.

One of the benchmark studies that were used to gauge explicit stereotypes was the Katz & Braly (1933) study. The study asked 100 college students to select words from a list (check-list procedure) of 84 adjectives, which they believed would describe ten sociocultural groups in the most reflective manner. Participants were also allowed to add further adjectives if they felt that the given adjectives for a typical group characteristics were not appropriate. The results (Katz & Braly, 1933) suggested a strong degree of agreement among students in assigning characteristics to different races (e.g. Germans scientifically minded 78 %, African Americans superstitious 84 %). Even though the usage of the 'check-list' procedure as an EM provides data on 'stereotype measure content', its applicability is limited, as it cannot assess the 'strength of stereotype'. In other words, this type of EM does not show how important these stereotypes are for the individual and whether they would act upon their stereotypical beliefs in their daily lives.

Furthermore, the Katz and Braly 1933 study was based in the United States. This brings into question the ways in which cultural norms may influence the perception of a group that ultimately leads to the formation of stereotypes. Does the perceived stereotype change dependent on the country and the value that is of relevance? Stephan et al., (1993) revisited the Katz & Braly (1933) study by conducting participants from both America and Russia. In their study (Stephan et al., 1993), they asked participants to analyse the stereotypes, which applied to other groups, as well as the stereotypes they believed they (the participants themselves) would be subjected to. 267 American and 186 Russian university students were recruited to participate in this experiment. The comparisons made between the stereotypes of American citizens and Russian citizens were collected, as well as the most popular adjectives used by the participants to describe these two cultural groups. Three measuring techniques were relied upon: a checklist procedure (asking about the characteristics that best describe the group), a percentage ratio (asking participants to estimate the percentage of people possessing certain traits) and a diagnostic ratio technique (asking participants to give a ratio of people

possessing certain traits to the rest of the population) with two additional techniques: prototypes and pathfinder (a network model of information processing).

The results (Stephan et al., 1993) suggested that there was a considerable level of agreement between both nations' stereotypes. The implication of these results is that the participants must have utilized similar cognitive functions in order to complete the set tasks. That being said, the results taken from the pathfinder technique were to the contrary. These results placed a much larger emphasis on the strength of the relationship of closer traits amongst the stereotypes. According to the pathfinder technique, although Russian students agreed on American stereotypes, American students did not reach an agreement on Russian stereotypes. Russians were found to have a complex structure of stereotypes within themselves. Stephan et al., (1993) suggested that this could be the case due to the time period of the study. The 1993 study of Stephan et al., took place in as Russia was in the midst of being formed, following on from the dissolution of the Soviet Union. Therefore, the self-perception Russian students had may be worse than the self-perception that American students had. However, the applicability of these findings (Stephan et al., 1993) cannot be exaggerated, as the results are limited to their own sociocultural period. Since culture is entrenched in our cognitive processes (Bondebjerg, 2017), and it will always act as an influence therefore EM's should be treated with caution before any generalisations are made.

Another time-period based factor in the change of personal attitude leading to the manipulation of self-reports for EM came after World War II. During this period, the civil rights movement led to restrictive social norms. Not only was it socially unacceptable to have generalized prejudices inflicted on a subset of the population but laws were also established as 'incitement to hatred' against any national, racial or religious groups (e.g. the 1959 Volksverhetzung laws in Germany, Bohlander, 1998, paragraph 130, section 1). This has been identified as a limitation since it creates a 'socially desirable' filter in explicit studies (Fazio & Olson, 2003). As society began to reject discrimination in an overt manner through media (e.g. political correctness), judicial systems (e.g. the Civil Rights Movement) and education (e.g. Civil Rights Movement (1956) giving African American citizens access to higher education systems) the tendency to hide socially unacceptable thoughts may have increased. Consequently, the ability to detect these stereotypical beliefs through self-reports may have decreased. For example, in America, groups with Jewish ethnicity were stereotyped as 'religious' and 'uneducated' at the beginning of the 20th century and as 'high achievers' at the beginning of the 21st century (Madon et al., 2001). There is reason to believe that the pressures to mould verbal responses for the purpose of social desirability may have in fact distorted responses. Indeed, Fiske and Taylor (2013) claim that now only ten percent of the population in Western democracies expresses stereotypes openly. However, there is also reason to believe that these changes in society may have been truly reflective of a change in attitude that was consistent with the viewpoints of the general population. Theoretical basis for predicting that as changes in social role distribution occur, changes in stereotypical attitude will follow in accordance ('The Social Role Theory', Eagly, 1987; Eagly & Wood, 2012). For example, the changes in the roles of women in the society as occupying new roles in different fields (e.g. medicine, law, management) may have altered people's beliefs about the qualities of women and shift to match these

new realities (Haines, Deaux & Lofaro, 2016).

Another issue regarding the lack of introspection that EM studies embody (Echabe, 2013) is that these results will be influenced by contextual factors. In the experiment demonstrated by Fazio et al. (1995) the participants' responses were found to be influenced by the experimenter's race. Participants showed higher scores of prejudice when the experimenter was a member of a different race. However, calling upon prejudice opinions can also encourage participants to try to cover up by expressing overly positive judgements for the opposing race (Harber, 1998). It appears that implicit results will diverge from explicit self-reports to a greater degree if the topic is more socially sensitive (Dovidio, Kawakami & Beach, 2001). Thus, nonverbal indicators of measurement became more convenient (Crosby et al., 1980) to adapt to the latest century.

Implicit measure (IM) of stereotypes underlies an unconscious process of thought where an automatic activation of stereotypes is investigated. For example, according to the General Medical Council in the United Kingdom, doctors are expected not to discriminate unfairly against patients or colleagues by letting personal views influence their treatment and diagnosis ('Good Medical Practice', 2013). Whether stereotypes unconsciously influence the thought process of health care professionals in their professional setting was investigated (Moskowitz, Stone & Childs, 2012). A priming task, which had two stages to it, was used. In the first stage participants had to assess disease & treatments with African Americans and in the second stage there was a computer task where subliminal images of African American and White men appeared prior to each word and reaction times were recorded. The results (Moskowitz et al., 2012) suggested that doctors reacted more quickly to a stereotypical disease when shown an African American face. Therefore, faces that they didn't have sufficient time to consciously process altered their performance on medical diagnosis.

Unlike the (un) intentionally biased self-report of EM's, IM's are assumed to prevent any controllable response by using less cognitive resources (since it is quicker one does not have enough time to evaluate their response by any means) than EM (Echabe, 2013). In other words, EM cannot distinguish whether your responses are direct or controlled in many levels of cognitive thinking. IM, on the other hand, measures cognitive processes one is not consciously aware of by using association measures (Implicit Association Test), memory measures (e.g. priming tasks) and physiological measures (e.g. skin conductance responses, EEG measures of facial muscles).

Association measures in IM are based on the notion that a participant's response time will be significantly less (i.e. they will respond more quickly) if there is a strong general association between the information they are presented with (Beattie & Ellis, 2017) such as sharing a common semantic structure (Collings & Luftus, 1975). For example, the likelihood of phrases such as 'birds can sing' (associated information) being linked automatically is significantly higher than phrases such as 'birds have skins' (unassociated information). This correlation may be because a large majority of the general population tend to associate 'birds' with the act of 'singing', more so than they do 'birds' with 'skin'. Furthermore, a person's response time will be significantly reduced (i.e. they will respond more quickly) when the material they encounter is more stereotypically congruent (Stangor & Lange, 1994). The application of these findings is extensive, and have been used to shed some light on countless other sub-sections within the field of stereotypes, one of the most prime

examples of this is with regards to priming. Priming is where participants are briefly presented with a stimulus followed by a negative or positive target word, they are then asked to decide which stimuli and target words go together as quickly as possible. Due to the pressure placed on the participants by such time constraints, any associations they make are undertaken in an automatic manner. One shortcoming of the applicability of priming in IM is that the complex method does not give a clear account of what goes into association. Priming is not highly correlated with EM (Olson & Fazio, 2001) therefore is more influenced by a blend of personal attitudes and cultural associations.

The foundation of Implicit Associations Task (IAT) by Greenwald et al., (1998) was provided by adopting sequential priming task in the notion that participants will be quicker and more accurate when information is preferable. In order words response latency is dependent on the preference of information. The logic behind this experiment was that words can be mapped more easily and quickly if they share the same response key (e.g. dog and cat both refer to animals therefore it is easier to recall cat after dog than cat after orange). In the experiment (Greenwald et al., 1998) participants were given a list of names of people and were required to categorize them into either proper names for Black people (BN) or proper names for White people (WN) by pressing the left response button for BN or the right response button for WN. In the second task participants were asked to categorize words as either pleasant by pressing the left-hand side button or unpleasant by pressing the right-hand side button. In the third task the first and second conditions were combined as when participants were given a BN with a pleasant word they would press left side-button and WN with an unpleasant word they would press right side-button. BN and WN were then put in a reversed condition where for BN participants pressed the right side-button and for WN they pressed the left. Finally, the combined task was reversed as well as being BN and unpleasant word with the right side-button and WN and pleasant word with the left side button. The results (Greenwald et al., 1998) demonstrated that: participants were quicker at pressing the appropriate button for the BN and unpleasant word combination than the respective combination (BN and pleasant word). From these results one can infer that participants seem to have had a greater difficulty with associating the concept of pleasantness with black people (Greenwald et al., 1998).

A strength IAT has is being a flexible type of measure in which the attribution dimension could be contrasted with any pairs (e.g. Sexual preference (Homosexuality versus Heterosexuality) and pleasant/unpleasant stimuli, Sex (Male versus Female) and pleasant/unpleasant stimuli). However, the temptation of assuming that the IAT is measuring 'real' attitudes may overshadow the fact that it could be measuring knowledge towards the stimuli rather than personal attitudes. Although IM studies measure automatic responses, for these responses to be automatic they must have at one point been explicitly learned. Service's dissociation model (1986) states that automatic responses reflect socially shared cultural stereotypes, which are then internalized. In other words it may not be the case that the automaticity of the response rules out any effects of cultural norms. With the constant practice of cultural information since early stages of cognitive development (e.g. language), such influences may have been so closely knit with the cognitive processes (e.g. long-term memory) that they eventually become automatized. IM could still be measuring cultural knowledge but only the ones that have been altered into the cognitive process in a deeper level.

A shortfall for both IAT and priming techniques of IM's come from their nature of being as prone to contextual influences as EM's (Sritharan & Gawronski, 2010). A study done by Wittenbrink, Judd & Park (2001) gathered 87 American participants of which most had the ethnicity of White followed by Asian and African to take part in this experiment. The study had three levels in which the first one was done as the baseline of IAT. In the second condition half of the participants were shown a clip where African American men were placed in a negative stereotype context (e.g. a gang incident) and the other half of the participants were shown a clip where African American men were placed in a positive context (e.g. a family barbeque or a church). Following the clip, participants had to write an essay about the events depicted in the clip. In the third condition both participants who were shown positive stereotypes and negative stereotypes of African American men had to do the IAT. The speculation given by Wittenbrink et al., (2001) as category references to African American people may trigger different memory contents depending on the nature of references (positive or negative) was indeed found to be the case. The results showed positive associations to African American men shown in positive contexts and negative associations to the same black men placed in negative contexts. The results may be explained in terms of the categorization process of cognitive resources (Kite & Whitley 2016). Environmental context may have influenced which aspect of a stereotype becomes activated as 'the family member' versus the 'ghetto' African American person (Devine & Baker, 1991).

The measurement and very nature of stereotypes are often as challenging and multifaceted as each other. As the process of absolute introspection is in no way possible, EM studies aim to unravel to some degree the controlled thought process that underlies stereotypes. Although EM are appealing because they are straight-forward and rapid, their validity is often challenged as (a) people may be unwilling to admit their thoughts by any means they find necessary to do so (e.g. to conform to socially desirable beliefs) or (b) may not be aware of such beliefs are stereotypical because to some degree it occurs from observations. This concern has acted as a catalyst for the development of indirect measurement procedures. Although IM's can be used to rule out social desirability by emphasizing on the automaticity of answers its applicability is limited to the unknown variables contributing what one thinks as 'real attitudes'. These may take the form of stored knowledge as opposed to a personally held stereotype. Therefore, knowing which mechanisms of thought processes psychologists are interested in may lead them to put weight on a certain measure accordingly.

References

Amodio, D. M. (2014). The neuroscience of prejudice and stereotyping. *Nature Reviews Neuroscience 15,* 670–682.

Beattie, G. & Ellis, A. W. (2017). The Psychology of Language and Communication. United Kingdom: Routledge

Biernat, M., & Crandall, C. S. (1994). Stereotyping and contact with social groups: Measurement and conceptual issues. *Eur. J. Soc. Psychol*., 24, 659–677.

Bohlander, M.(1998). Bundesministerium der Justiz und für Verbraucherschutz: German criminal code [Federal Ministry of Justice and Consumer Protection: German Criminal Code]. Federal Ministry of Justice, Germany, para. 130 sec. 1.

Bondebjerg, I. (2017). The creative mind: cognition, society and culture. Palgrave Communications.

Bordalo, P., Coffman, K., Gennaioli, N. & Shleifer, A. (2016). Stereotypes. *Quarterly Journal of Economics, 131(4*), 1753-1794.

Carlsson R. & Björklund F. (2010). Implicit stereotype content: mixed stereotypes can be measured with the implicit association test. *Soc Psychol., 41(4),* 213–222.

Coelho, P., & Costa, M. J. (2007). *The witch of Portobello: A novel*. New York: Harper Collins Publishers.

Collins, M. A. & Loftus, E. (1975). A Spreading Activation Theory of Semantic Processing. *Psychological Review., 82,* 407-428.

Crosby, F., Bromley, S., & Saxe, L. (1980). Recent unobtrusive studies of Black and White discriminatin and prejudice: A literature review. *Psychological Bulletin, 87,* 546–563.

Devine, P. G. (1989). Stereotypes and prejudice: Their automatic and controlled components. *Journal of personality and social psychology*, *56(1),* 5.

Devine, P.G. & Elliot A. J. (1995). Are Racial Stereotypes Really Fading? The Princeton Trilogy Revisited. *Personality and Social Psychology Bulletin, 21(11*), 1139-1150.

Dovidio, J., Kawakami, K., & Beach, K. (2001). Implicit and explicit attitudes: Examination of the relationship between measures of inter- group bias. In R. Brown & S. L. Gaertner (Eds.), *Blackwell handbook of social psychology: Vol. 4. Intergroup relations* (pp. 175–197). Oxford, England: Blackwell.

Dovidio, J. F., Kawakami, K., & Gaertner, S. L. (2002). Implicit and explicit prejudice and interracial interaction. *Journal of personality and social psychology*, *82(1),* 62.

Dryden, K. L. (2013). Implicit and explicit gender stereotypes and their relationship to self-concept. University of North Caroline at Chapel Hill.

Eagly, A. H., & Chaiken, S. (1993). The psychology of attitudes. Orlando, FL: Harcourt Brace Jovanovich College

Eagly, A. H., & Mladinic, A. (1989). Gender Stereotypes and Attitudes Towards Women and Men. *Personality and Social Psychology Bulletin*, *15 (4),* 543 – 558.

Echabe, A. E. (2013). Relationships Between Implicit and Explicit Measures of Attitudes: The Impact of Application Conditions. Europe's Journal of Psychology, 9 (2).

Fazio, R. H., Jackson, J. R., Dunton, B. C., & Williams, C. J. (1995). Variability in automatic activation as an unobtrusive measure of racial attitudes: A bona fide pipeline? *Journal of Personality and Social Psychology, 69,* 1013–1027.

Fazio, R. H., & Olson, M. A. (2003). Implicit measures in social cognition research: Their meaning and uses. *Annual Review of Psychology, 54*, 297-327.

Fiske, S. T., & North, M. S. (2014). Measures of stereotyping and prejudice: Barometers of bias. In G. J. Boyle, D. H. Saklofske, & G. Matthews (Eds.), *Measures of personality and social psychological constructs* (pp. 684-716). London: Academic Press.

Fiske, S.T. &Taylor, S.E. (2013). Social Cognition: From Brains to Culture. 2nd edn, Sage: London.

Greenwald, A. G., McGhee, D. E., & Schwartz, J. L. (1998). Measuring individual differences in implicit cognition: the implicit association test. *Journal of personality and social psychology*, *74*(6), 1464.

Haines, E. L., Deaux, K. & Lofaro, N. (2016) The Times They Are a-Changing… or Are They Not? A Comparison of

Gender Stereotypes, 1983-2014. *Psychology of Women Quarterly.*

Hamilton, D. L., Dugan, P. M., & Trolier, T. K. (1985). The formation of stereotypic beliefs: Further evidence for distinctiveness-based illusory correlations. *Journal of Personality and Social Psychology, 48*(1), 5-17.

Harber, K. D. (1998). Feedback to minorities: evidence of a positive bias. *Journal of personality and social psychology*, *74*(3), 622.

Hinton, P. (2017). Implicit stereotypes and the predictive brain: cognition and culture in "biased" person perception. Palgrave Communications, 3.

Hofmann, W., Gawronski, B., Gschwendner, T., Le, H., & Schmitt, M. (2005). A meta- analysis on the correlation between the implicit association test and explicit self-report measures. *Personality and Social Psychology Bulletin, 31*(10), 1369-1385.

Katz, D., & Braly, K. (1933). Racial stereotypes of one hundred college students. *The Journal of Abnormal and Social Psychology*, *28*(3), 280.

Kite, M. E. & Whitley, B.E. (2016). Psychology of Prejudice and Discrimination. (2nd edn). Belmont, CA: Wadsworth.

Macrae, C., Stangor, C. & Milne, A., (1994). Activating Social Stereotypes: A Functional Analysis. *Journal of Experimental Social Psychology, 30,* 370–389.

Madon, S., Guyll, M., Aboufadel, K., Montiel, E., Smith, A., Palumbo, P. & Jussim, L. (2001). Ethnic and National Stereotypes: The Princeton Trilogy Revisited and Revised. *Personality and Social Psychological Bulletin, 27(8),* 996 – 1010.

Moskowitz, G. B., Stone, J., & Childs, A. (2012). Implicit Stereotyping and Medical Decisions: Unconscious Stereotype Activation in Practitioners' Thoughts About African Americans. *American Journal of Public Health, 102(5*), 996–1001.

Nosek, B. A. (2005). Moderators of the relationship between implicit and explicit evaluation. *Journal of Experimental Psychology: General, 134(4),* 565-584.

Nosek, B. A., Smyth, F. L., Hansen, J. J., Devos, T., Lindner, N. M., Ranganath, K. A., Smith, C. T., Olson, K. R., Chugh, D., Greenwald, A. G., & Banaji, M. R. (2007). Pervasiveness and correlates of implicit attitudes and stereotypes. *European Review of Social Psychology, 18,* 36-88.

Olson, M. A., & Fazio, R. H. (2001). Implicit attitude formation through classical conditioning. *Psychological Science, 12,* 413–417.

Reis, H.T., & Judd, C. M. (2014). *Handbook of research methods in social and personality psychology* (2nd edition). New York: Cambridge University Press.

Shih, M., Pittinsky, T. L., & Ambady, N. (1999). Stereotype susceptibility: Identity salience and shifts in quantitative performance. *Psychological Science, 10(1),* 80-83.

Spencer, S.J., Steele, C.M. & Quin D. M. (1999). Stereotype Threat and Women's Math Performance. *Journal of Experimental Social Psychology 35***,** 4–28.

Sritharan, R., & Gawronski, B. (2010). Changing implicit and explicit prejudice: Insights from the associative-propositional evaluation model. *Social Psychology*, *41*(3), 113-123.

Stephan, W., Ageyev, V., Stephan, C., Abalakina, M., Stefanenko, T., & Coates-Shrider, L. (1993). Measuring Stereotypes: A Comparison of Methods Using Russian and American Samples. *Social Psychology Quarterly, 56*(1), 54-64.

Stangor, C. & Lange, J. E. (1994). Mental representations of social groups: Advances in understanding stereotypes and stereotyping. In M. Zanna (Ed.,), *Advances in experimental social psychology, 26*, 357-416. New York: Academic Press

Stolier, R. M. & Freeman, J. B. (2016). Neural pattern similarity reveals the inherent intersection of social categories. *Nature Neuroscience, 19,* 795-797.

Wang, M. & Yang, F. (2017). The Malleability of Stereotype Effects on Spontaneous Trait Inferences: The Moderating Role of Perceivers' Power. *Social Psychology, 48,* 3-18.

Wittenbrink, B. (2001). Spontaneous prejudice in context: Variability in automatically activated attitudes. *Journal of Personality and Social Psychology*, 85(5), 815-827.

Wittenbrink, B., & Judd, C. M. (2001). Spontaneous Prejudice in Context: Variability in Automatically Activated Attitudes. *Journal of Personality and Social Psychology*, *81(5),* 815-827.

Mindfulness Interventions for ADHD Populations To Improve Executive Functions: A Literature Review

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The present paper reviewed the literature on mindfulness practices as an intervention to increase executive functioning and to decrease positive and negative symptoms of Attention Deficit and Hyperactivity Disorder (ADHD). 7 studies revealed decrease in externalizing behavior, hyperactivity and impulsivity related to ADHD. Attentional processes, inhibition, emotion regulation and planning are observed to improve after intensive mindfulness treatments. No significant improvement was found for working memory and cognitive flexibility. Treatments appear to have increased self-reported quality of life for all experimental group participants, regardless of being in ADHD or healthy groups.

Keywords: meditation, mindfulness, attention, executive functions, ADHD

Mindfulness

Mindfulness is a relatively new subject that attracts many researchers who wish to apprehend this Eastern practice's potential benefit for people's minds and everyday lives. Often, meditation exercises are used to achieve this state of being present (Bueno et al., 2015). The practices consist of establishing a neutral, nonreactive stance before thoughts, emotions and sensations. The practitioner watches cognitions as they come and pass; thoughts are not actively sought or avoided (Haydicky et al., 2012). In its essence, one needs to be open and accepting of experiences, without a judgmental tone or an act of suppression. It is the effortful direction of attention to both the daily activities and the occupations of the mind. As the practitioner meditates and reaches a mindful state, attention is directed within the body and somatic arousal decreases (Zylowska et al., 2008).

In order to achieve a mindful state, there are several practices that can be carried out. The individual requires an anchor to serve as a safe base from distractions (Zylowska et al., 2008). Throughout the practice, attention should be sustained on the anchor; when and if distraction occurs, the individual should recognize the distraction without judging, accept it without dwelling on it, and direct attention back to the anchor. This can be a breath, a mantra to be repeated out loud, an object to look at, or a mental imagery (Tang, Yang, Leve, Harold, 2012). As any new skill, practice is required to strengthen the neural pathways that facilitate sustaining attention with each session. The practices are not limited to the routine place and time of official meditation; they should be carried out daily by willfully attaining to daily activities

such as driving, eating, listening etc. by recognizing each moment and being present with them (Haydicky et al., 2012).

ADHD and Executive Functions

Attention Deficit and Hyperactivity Disorder is a disorder of maximum onset of age 12 where patients report troubles in sustaining attention, using working memory, regulating emotions and inhibiting responses (American Psychiatric Association, 2013). According to Zylowska et al. (2008), individuals with ADHD are impulsive in their actions because of difficulties in planning and investing in the future. Problems with sustained attention make it hard for them to focus on lengthy activities, follow through on scholarly or occupational duties, set and pursue goals, and inhibit distractions (American Psychiatric Association, 2013). In addition to hyperactivity and impulsivity, externalizing problems might include oppositional defiance and conduct problems such as interrupting and intruding on others, refusing to wait and remain in place (American Psychiatric Association, 2013). Patients with internalization problems might report depression, anxiety and withdrawal from social activities (American Psychiatric Association, 2013). ADHD shows comorbidity with mood disorders and substance abuse (Tang, Yang, Leve, Harold, 2012). Furthermore, antisocial behaviors and academic failures might accompany this disorder. Fleming et al. (2015) found that college students who were diagnosed with ADHD as children have lower GPAs, more academic probations, more use of tobacco and alcohol, more psychological distress alongside depressive symptoms and poorer self-reported life quality. Many of the problems stated are interconnected with the executive functions (EF) which refers to "high-level cognitive processes that enable individuals to regulate their thoughts and actions during goal-directed behavior" (Friedman & Miyake, 2016, p.86). Attention in itself is a component of EF; hyperactivity and impulsivity are deficits of response inhibition, the problems that prevent from being goal-oriented suggest deficits of working memory, and when impulsive actions have an emotional component, they can be regarded as self-regulation or emotion regulation problems.

Mindfulness' Place in Executive Functions Research

Mindfulness practices help the individual work at directing and sustaining attention. The nonjudgmental nature of these practices prevents additional anxiety when the individual battles with constant mind-wandering and distractions. Researchers have been intrigued to explore whether mindfulness would be a beneficial intervention for ADHD populations due to its EF activation, it being an alternative to chemical substances, and it providing patients with a sense of agency in their treatment process.

Practices require activation control to initiate the meditation in the first place, inhibiting external distractions to focus on the inner state as well as possible, shifting when mind wanders off to pull it back to the anchor. Working memory is required for the individuals to keep in mind the goal of achieving a mindful state, to not chase after the thoughts and dwell on feelings, and to recall what their anchor is. Alongside these EF components that are trained each time the individual practices mindfulness, the anxiety and stress that accompany ADHD should subside when a calm mind state is achieved and the individual accepts herself and the cognitions as they are.

ADHD is often treated with pharmacologic interventions but Zylowska et al. (2008) explains that mindfulness practices

can be beneficiary for patients who experience medication side effects (e.g. dizziness, adherence, blurred vision, nausea; Kosse et al., 2017) do not respond to the medication or require additional modalities to alleviate symptoms. Additionally, especially for adolescents, pharmacological treatments might be stigmatizing, changing external and internal perceptions about the patient, and leading to self-fulfilling prophecies (Haydicky et al., 2012). It is this risk of stigma that has inspired meditation as an alternative to medication.

Lastly, people's desire to be in control and solve their own problems without relying on substances is relatable. Mindfulness might induce feelings of autonomy and self-efficacy in patients. These cognitions prevent the self-perceptions of weakness, victimization and internalization of mental disorder stigmas. For all abovementioned reasons, mindfulness is a worthy intervention to explore when tackling at EF deficits that are observed in ADHD populations.

Study Reviews

For the sake of this review, 7 studies have been investigated in respect to their contribution to the literature on mindfulness' beneficiary nature on executive functions. The expectations of these researches can be summarized as EF improvements, decreased ADHD symptoms and increased life quality. The EF components that were under analysis were attentional processes, inhibition, shifting, working memory and emotion regulation. On occasion, findings conflict with each other, but at most, it was found that a component did not significantly improve in comparison with the control groups; mindfulness did not detriment any EF component, lower life quality, nor did it increase ADHD symptoms.

Attentional processes were the most researched component in mindfulness field, due to the inherent need to direct and sustain the attention during practices. Zylowska et al. (2008) conducted Attentional Network Test (ANT) to measure attentional conflict and found better performance on ADHD patients' post-test after going under 8 weeks of Mindful Awareness Practices (MAP). ANT measures alerting, orienting and executive control by asking test takers to determine the direction of the central arrow after providing them with a fixation point and later a congruent, incongruent or neutral flanker. MAP has been utilized in many replication studies that followed Zylowska and colleagues' research. MAP sessions included 2.5 hours of group meditation once a week for 8 weeks, home practices guided by CDs and mindful awareness in daily life. Tang, Yang, Leve and Harold (2012) used the same task in healthy undergraduate students and observed better performance than the non-meditating control group after 5 days' worth of Integrative Body Mind Training (IBMT) that focused on body relaxation and mental imagery alongside mindfulness training. Fleming et al. (2015) assigned participants to Dialectical Behavior Therapy which included mindfulness practices and observed a decrease in inattention compared to the control group which underwent 8 weeks of self-guided skills training. The DBT included psychoeducation, planning, emotion regulation as well as mindfulness; whereas the participants that were exposed to the self-guided training received pamphlets on the topics covered in DBT except for mindfulness. Bueno et al. (2015) employed four groups: ADHD control and meditation, healthy control and meditating groups. Their results revealed that both groups that meditated had better EF performance when compared to their own pre-tests and their non-meditating counterparts. The tasks given were ANT and Conner's Continuous Performance

Test (CPT) that measured attention and inhibition by asking patients to initiate or inhibit motor responses to visual stimuli.

Inhibition is closely linked to mindfulness practices because mind-wandering needs to be prevented as much as possible and the prepotent response of following thoughts, as they occur in mind, needs to be inhibited. Zylowska et al. (2008) used the Stroop test to measure difference in inhibition after mindfulness treatment and observed that participants performed better after the treatment. Kiani, Hadianfard and Mitchell (2016) sampled from Iranian adolescent females who were all diagnosed with ADHD and assigned them to either meditation or control group, building on Zylowska et al. (2008); adding a control group and a non-Westernized sample for generalizability purposes. The Stroop task was given and the results, similar to Zylowska and colleagues' (2008), indicated that the treatment group performed better. In the study of Mitchell et al. (2013) ADHD participants either underwent 8 weeks of MAP or were assigned to the control group. Through an application called Ecological Momentary Assessment, they prompted participants at random moments throughout the day, requested self-reports on current behavior related to inattentiveness, hyperactivity and impulsivity. It was observed that meditators performed better in self-reported inhibition and response inhibition measured by Conner's Continuous Performance Test (CPT). Tang, Yang, Leve and Harold (2012) sampled toddlers and used Event Related Potentials (ERPs) and go/no go tasks to explore inhibition difference and found improving quality of mindfulness. Contrarily, Fleming et al. (2015) found that participants undergoing DBT did not differ in the CPT than their control group counterparts.

Shifting was measured to a lesser extent in the researches that were reviewed. Zylowska et al. (2008) used Trail Making test to compare pre and post-performance of ADHD MAP participants and found an improvement in shifting. In test A of Trail Making, test takers were asked to connect dots of consecutive numbers (i.e. 1-2-3…); and test B asked them to alternate between connecting consecutive numbers and letters (1-A-2-B-3…). Mitchell et al. (2013) administered the Trail Making Test and found no significant difference between the treatment and control groups. During mindfulness practices, the individual inhibits intrusive thoughts to shift back to the anchor, but it is a rather constant shifting to the same concept. It is possible that to enhance cognitive flexibility, an activity should prompt shifting to different rules/concepts each time and discourage habituation to this shifting.

Mindfulness requires the practitioner to keep certain goals in mind. While this activates the short term memory, not enough manipulation and cognitive evaluation is done on the processed information to activate the working memory significantly. This might explain why none of the reviewed studies found a significant improvement in working memory tasks after a mindfulness manipulation. Digit span and letter-number sequencing were some of the tasks that were given by Zylowska et al. (2008), Kiani, Hadianfard and Mitchell (2016) and Mitchell et al. (2013) and no improvements were observed in the performance of working memory. The problem of task impurity in EF research needs to be mentioned; because although in the mentioned tasks working memory improvement was not observable, surely other EF components tasks require working memory activation as well. Therefore it would not be wise to limit

performance improvement to only one domain of executive functions.

Since EF employs resources and skills relevant to regulating emotions, it is also necessary to examine the possible effect of emotion regulation. ADHD patients often experience problems in this domain and engage in impulsive actions. Kiani, Hadianfard and Mitchell (2016) administered Difficulties in Emotion Regulation Scale (DERS) to the patients and observed better post-test outcome for the meditators. Mitchell et al. (2013) also observed better results in DERS and Distress Tolerance Scale (DTS). Tang, Yang, Leve and Harold (2012) demonstrated better autonomic nervous system regulation in healthy participants. Moreover, Haydicky et al. (2012) observed a decrease in externalizing problems in male ADHD adolescents after 20 weeks of mindfulness treatment and inferred that this could be due to increased self-monitoring and thus, self-regulation. The last EF component was planning, which was measured by Kiani, Hadianfard and Mitchell (2016), with the Tower of London tasks and the researchers observed an improvement.

Alongside the EF implications of mindfulness, the clinical sample required measuring ADHD symptoms after the manipulations. Zylowska et al. (2008) found that 80% of the participants reported a decrease in their ADHD symptoms as well as decreased depression and anxiety symptoms for the adult sample within the study. Mitchell et al. (2013) found decreased ADHD symptoms as did Bueno et al. (2015) who observed decrease in hyperactivity and impulsivity. Additionally, Haydicky et al.'s (2012) study sampled adolescents with learning difficulties, which co-occurred with ADHD, and had common deficits in EF with ADHD. In the study, the researchers employed Mindfulness Martial Arts and found decreased oppositional defiance and conduct problems although no improvements in EF tasks were found significant. Lastly, life quality of participants was measured (Fleming et al., 2015; Bueno et al., 2015) and it was found that meditating groups reported higher life quality than their non-meditating counterparts. Overall, mindfulness practices seem to have benefitting impact on daily life and cognitive processes.

As shown above, research on mindfulness sought after changes in quality of life, symptoms related to ADHD and six EF components. All treatment groups reported higher quality of life on self-reports. ADHD groups that received treatment showed decreased externalizing behaviors, depression, anxiety, hyperactivity and impulsivity and oppositional defiance. The research presents a noteworthy improvement in attentional processes, inhibition, emotion regulation and planning components of EF. Shifting and working memory appear to not benefit from mindfulness interventions, but the interventions were not detrimental either. Certain explanations for the conflicting findings between researchers have been discussed in the limitations section.

Limitations

The studies that have been reviewed above are not without limitations. While some limitations could have been avoided, others inevitably accompany the area of study.

Small sample sizes have been used in Bueno et al. (2015), Zylowska et al. (2008), Mitchell et al. (2013), which can be a limitation since larger samples are advantageous for having statistical power in the research. Second, blind testing is difficult to ensure in studies of this nature where participants are aware whether they are in ADHD or healthy group, or whether they are receiving meditation manipulation or not. Similarly, the researchers are aware of the

distinction between the groups. This limitation applies to Bueno et al. (2015), and Mitchell et al. (2013). Third, when conducting EF tasks, there is always the risk that participants will perform better at post-test because of the practice effect, independent from the manipulation/treatment they received. This was stated within the limitations in Bueno et al. (2015) study to explain the ANT performance improvement. Similar concerns can be held for Stroop and Trail making tasks where repetitive practice might result in permanent learning.

Random sampling and random assignment to treatment or control groups are near impossible with clinical populations and interventions as intensive as the ones chosen. When meditation retreats lasted for more than a few weeks, undergoing the manipulation was based on volunteerism within the sample. Participants, who had time, means and motivation, took part in the study; which can confound the results of the studies. Kiani, Hadianfard and Mitchell's (2016) participants only included Iranian female adolescents. Although it was a study to explore generalizability of the previous studies to an Eastern population, the sample was restricted in terms of gender and age. When dealing with a clinical population, control groups should be waitlist groups that will receive the treatment after validating its effectiveness; because if mindfulness significantly decreases ADHD symptoms, withholding this treatment from patients would be unethical. Meanwhile, patients cannot be obstructed from seeking other treatments. These limitations are valid for all studies exploring disorder treatments.

When dealing with clinical populations, controlling for other disorders and medication can be problematic. Although most studies tried to control for the medication use and exclude individuals with comorbid disorders such as mood disorders and substance abuse, the analyses were done in a self-report manner and they might not reflect the participants' actual conditions.

When Zylowska et al. (2008) conducted their experiment, it was a pre-post experiment with all ADHD participants who all underwent MAP intervention. The replication studies gradually increased the group numbers, but in order to infer causality four groups are necessary: two ADHD groups in which one constitutes of treatment whereas the other does not, and healthy groups undergoing treatment and providing control. However, many of the studies of this review, with the exception of Bueno et al. (2015) relied on lesser number of groups, that is, some studies lacked healthy groups others lacked a non-meditator group.

The studies have shown improvement in life quality, some EF skills or both; but the post-test for these components were conducted closely after the experiments, therefore the sustainability of these effects in the long term is debatable.

Haydicky et al. (2012) revealed improvement in ADHD symptoms and self-monitoring but no improvement in EF tasks given. A hypothesis was stated that perhaps mindfulness nurtures a monitoring of cognitions and attention that is not represented with the current nature of EF tasks, pointing to a need for newer tasks. Another possible limitation is that the training given to the participants did not help achieve mindful states, either resulting from the practice itself or the participants' inability to follow and perform the mindfulness guidelines. When MAP or MMA practices were conducted with group leaders, their self-conduct becomes of importance; whether they guided different groups in the same manner, performed the same activities and displayed any difference for ADHD and healthy participants.

The general limitations of the reviewed studies have been revealed above. Some of them were related to the intensive training that mindfulness required and special conditions that were brought by studying clinical populations. Further research will also struggle to solve those limitations; but they should take into consideration the need for several control groups, sampling as wide as possible so that patients can be excluded due to not meeting ADHD criteria or unfitting to go under training. This would also facilitate random assignment into groups and minimize individual differences that might be interfering with causal relationships driven. Ensuring that the participants are practicing mindfulness, neuropsychological assessment tools such as fMRIs can be used. Hatchard et al.'s (2017) literature review revealed prefrontal cortex and anterior cingulate cortex activation following mindfulness interventions, as well as thicker cerebral areas related to attention compared to control groups. Treatment group also showed reduced emotion activation, which hints at neural enhancement of emotion regulation. Furthermore, different EF tasks that would activate similar domains as mindfulness can be developed if lack of working memory relationship was due to tasks incongruence. Prior studies have already demonstrated that mindfulness is an area of study worth exploring both in clinical and non-clinical populations due to being more present in life and enjoying it while using cognitive functions to a greater extent (Bueno et al., 2015). Future research should replicate the prior studies and take into consideration the limitations mentioned.

References

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th Ed.). Arlington, VA: American Psychiatric Publishing.

Bueno, V. F., Kozasa, E. H., Silva, M. A., Alves, T. M., Louzã, M. R., & Pompéia, S. (2015). Mindfulness Meditation Improves Mood, Quality of Life, and Attention in Adults with Attention Deficit Hyperactivity Disorder. *BioMed Research International, 2015*, 1-14. doi:10.1155/2015/962857

Fleming, A. P., Mcmahon, R. J., Moran, L. R., Peterson, A. P., & Dreessen, A. (2014). Pilot Randomized Controlled Trial of Dialectical Behavior Therapy Group Skills Training for ADHD Among College Students. *Journal of Attention Disorders, 19*(3), 260-271. Doi:

Friedman, N. P., & Miyake, A. (2017). Unity and diversity of executive functions: Individual differences as a window on cognitive structure. *Cortex, 86*, 186-204. doi:10.1016/j.cortex.2016.04.02310.1177/1087054714535951

Hatchard, T., Mioduszewski, O., Zambrana, A., Ofarrell, E., Caluyong, M., Poulin, P. A., & Smith, A. M. (2017). Neural Changes Associated with Mindfulness-based Stress Reduction (MBSR): Current knowledge, limitations, and future directions. *Psychology & Neuroscience, 10*(1), 41-56. doi:10.1037/pne0000073

Haydicky, J., Wiener, J., Badali, P., Milligan, K., & Ducharme, J. M. (2012). Evaluation of a Mindfulness-based Intervention for Adolescents with Learning Disabilities and Co-occurring ADHD and Anxiety. *Mindfulness, 3*(2), 151-164. Doi: 10.1007/s12671-012-0089-2

Kiani, B., Hadianfard, H., & Mitchell, J. T. (2016). The impact of mindfulness meditation training on executive functions and emotion dysregulation in an Iranian sample of female adolescents with

elevated attention-deficit/hyperactivity disorder symptoms. *Australian Journal of Psychology*. doi:10.1111/ajpy.12148

Kosse, R. C., Bouvy, M. L., Philbert, D., de Vries, T. W., & Koster, E. S. (2017). Attention-Deficit/Hyperactivity Disorder Medication Use in Adolescents: The Patient's Perspective. *Journal of Adolescent Health*, *61*(5), 619. doi:10.1016/j.jadohealth.2017.05.027

Mitchell, J. T., McIntyre, E. M., English, J. S., Dennis, M. F., Beckham, J. C., & Kollins, S. H. (2013). A Pilot Trial of Mindfulness Meditation Training for ADHD in Adulthood: Impact on Core Symptoms, Executive Functioning, and Emotion Dysregulation. *Journal of Attention Disorders*. Doi: 10.1177/1087054713513328

Tang, Y., Yang, L., Leve, L. D., & Harold, G. T. (2012). Improving Executive Function and Its Neurobiological Mechanisms Through a Mindfulness-Based Intervention: Advances Within the Field of Developmental Neuroscience. *Child Development Perspectives*. doi:10.1111/j.1750-8606.2012.00250.

Zylowska, L., Ackerman, D. L., Yang, M. H., Futrell, J. L., Horton, N. L., Hale, T. S., Smalley, S. L. (2008). Mindfulness Meditation Training in Adults and Adolescents With ADHD: A Feasibility Study. *Journal of Attention Disorders, 11*(6), 737-746. doi: 10.1177/1087054707308502

Parallels Between the Early Development of Musical and Linguistic Processing

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In the past, music and language have been linked to each other structurally on the grounds that "they are both auditory (with the exception of signed languages), highly patterned, and internally consistent" (Saffran, 2003, p. 1). On the neural level, the existence of the use of shared neural processors for both linguistic and musical input has also been suggested and supported by evidence. The shared syntactic integration resource hypothesis (SSIRH) (Patel, 2003) comprises the core of this idea. One of the most important implications of such a system is that it may be possible for training or learning in one domain to augment performance in the other (Patel, 2008). In line with this, Saffran (2003) also suggests that a process of statistical learning facilitates learning in both domains. Supporting the claim for shared learning mechanisms, researchers have demonstrated that children with Specific Language Impairment (SLI) also display problems in pitch and rhythm perception while identifying music as a "useful indicator of language processing difficulties" and an equally useful tool in "exploring skills that are prerequisites of successful language perception" (Sallat & Jentschke, 2015, p. 8). Thus, it is not unlikely that language abilities and music abilities should follow similar patterns in development and rely on similar or shared neural structures for development. This work will argue in favour of a more inclusive definition of music and suggest that a universal developmental pattern that can be classified as *auditory development* underlies early learning processes in both music and spoken language.

Keywords: language, music, development

Defining Language and Music

Language, in the simplest way, is defined as a symbolic medium that uses consistent syntaxes to organize lexicons and convey meaning, which it does mostly through sound (Brandt et al., 2012). Contrasting the well-established definition of language, music often comes across as a more abstract concept that is quite difficult to define. For example, while Western music relies on a standard system of keys and harmonies, some Eastern musical systems make use of finer pitch intervals (e.g., the *Maqamat* system in Arabic music uses quarter-tone intervals whereas Western music uses only whole-tone and semi-tone intervals) and more *asymmetrical* or *unusual* rhythmic structures (e.g., 7/4 or 7/8 rhythmic patterns that are commonly found in Balkan music) (Deutsch, 1998). On the extreme end of this spectrum are Aboriginal tribes who assimilate musical behaviour into everyday life seamlessly, with no standardized systems of pitch, harmony or rhythm, sometimes with

instruments that are specifically designed to sound different when played by different people (e.g., the Didgeridoo) (Tarnopolsky et al., 2005).

Pointing at the difficulty in defining music, Cross and Morley (2008) state that modern definitions of music, for uses within and outside the scientific field, are "seriously unsatisfactory" (p. 6) on account of the fact that they are based on culturally established principles which, they emphasize, are prone to change. Therefore, a rigorous operational definition of music is necessary for a healthy comparison between the developmental courses followed by infants within these two domains. Such a definition needs to account for the variance of music across cultures, the evolving nature of musical practices, the subjectivity and the resulting obscurity of music, and most importantly, the "potential of every sound to be treated musically" (Brandt et al., 2012, p. 2).

One definition inclusive and meticulous enough to avoid being violated by the variance in the understanding of music exemplified in the previous paragraph is proposed by Brandt et al. (2012), which asserts that music is simply "creative play with sound" (p. 3). The authors argue that a definition as elementary as this is also necessary for understanding the importance of sound, free from any symbolic meaning, in linguistic development. Their suggestion is that it would be more beneficial from a developmental perspective to treat language as a product of music as opposed to treating music as a product of language. Indeed, with their definition of music, all features of language that are available to infants younger than 12 months come across as being musical. Thus, they take into account music's unique social and communicative role within a given culture for its operationalization.

Comparisons of Developmental Patterns

One of the first questions to ask when investigating the parallels between infants' developmental paths followed in these two domains is whether newborns use separate neural circuits to process musical and linguistic input. It has been demonstrated that within the first few hours of life, with minimal input and almost no development, infants display a right hemispheric dominance for music-related processes while distributing linguistic input to be processed in both hemispheres of the brain (Perani, 2012). However, this evidence for music's lateralization at birth doesn't necessarily translate into evidence for modularity or a rejection of shared neural mechanisms for musical and linguistic development. In fact, the same research underlines that brain regions associated with language processing in infants, which are drastically underdeveloped when compared to the average adult's brain, rely on the structures directly associated with music processing which are already matching the structures found in adult brains (Perani, 2012). Supporting this claim, damage to the right hemisphere of the brain in the earlier stages of life has been shown to be more devastating than damage to the left hemisphere for some core skills of language (e.g., comprehension) (Bates et al., 1997). The implication of these studies is that language uses solely the auditory features of language in the earliest stages of development, using the more developed (i.e., more adult-like) and directly sound-related circuitry in the brain to get itself to a level at which the referential features of language can become the focus of development.

A Period of Susceptibility (0-6 Months of Age)

Like language development, music development in the first year of life is characterized by the gradual constriction of

perceptual abilities. 6 months of age is the threshold after which infants cannot distinguish between all the different phonemes of all languages (Rivera-Gaxiola et al., 2005), pointing at the first hints of this constriction. At this age, infants also seem to detect pitch changes in music without any bias for their own language (Lynch et al., 1990). Similarly, the ability to track rhythm and meter remains intact. Infants in Western culture also seem to have no trouble following rhythm changes that would be considered 'odd' or 'uneven' by Western adult listeners (Hannon and Trehub, 2005; Soley & Hannon, 2010).

A Period of Culture-Specific Constriction of Inputs (6-12 Months of Age)

In contrast with the first 6 months of life, the following period between 6 and 12 months of age is characterized by the first rapid narrowing of inputs for both language and music (Jusczyk et al., 1999; Polka & Werker, 1994). However, during this period, infants still use the more musical (or simply auditory) features of language without much consideration for the social and referential aspects of language. For example, 7-8-month-old English speaking infants show a bias for words that are pronounced with the same stress pattern as English words (Jusczyk et al., 1999). It's also been demonstrated that infants prefer languages with word order rules similar to theirs, even when dealing with artificial languages (Gervain et al., 2008). This suggests that infants still view languages as simply combinations of stress patterns, rhythmic meters and prosodic markings; features that can all be considered musical with the definition offered by Brandt et al. (2012).

The overall trend of constriction and culture-specific adjustment persists in both domains. Just as they begin to lose the ability to distinguish between foreign vowel contrasts at 6-8 months and consonant contrasts at 10-12 months (Polka & Werker, 1994; Werker & Tees, 1984), infants lose the ability to identify out-of-key notes in musical scales built on foreign musical systems (Lynch & Eilers, 1992) and the ability to make sense of complicated rhythmic structures in foreign music (Hannon & Trehub, 2005) at roughly 12 months of age.

The Social Aspects of Language and the Display of Emergent Modularity

Infants utter their first words at about 12 months of age. After this point, the social and pragmatic aspects of language begin to take over its development (Brandt et al., 2012). Nevertheless, the proposed common *auditory development* retains its effects to some degree. For example, Western infants' age of gaining syntax competence in their native language (2-3 years) corresponds to the age of acquiring the understanding of the harmonic structure and key membership components of music which constitute the core syntax of Western music (Trainor & Corrigall, 2009). The mastery of the former linguistic ability (i.e., syntax) occurs at about 5-6 years of age (Nuñez et al., 2011) while the latter, which is musical, similarly matures at 6 years of age (Trainor & Corrigall, 2010).

It is after maturity in linguistic syntax is obtained that a more severe separation between the two domains occurs and that the musical qualities of language seem to become subordinate to its social benefits in the context of development. Even then, the ages at which children reach adult level maturation in already acquired skills are similar across domains. For instance, both adult level susceptibility to different harmonic structures and adult level understanding of syntactic structures typically appear at 11 or 12 years of age (Brandt et al., 2012). Thereby it is not irrational to speculate that skills that were first acquired while music and language both

operate specifically on the same auditory system remain intertwined to some degree even after requirement on domain-specific neural circuitry may have increased for either one of the domains.

Possible Effects of Culture on the Discrepancy

Based on music acquisition's capacity to match language acquisition in speed, Brandt et al. (2012) also stresses that discrepancies between musical development and linguistic development after the first year of life can be attributed to cultural effects since infants seem to be equipped with the necessary biological tools to have an equal level of proficiency in both domains. Their implication is that music's universality is both an evolutionary cause and an evolutionary consequence of language's universality as it is crucial for children to acquire and rely on music skills in order to acquire language skills along the same developmental path. It is also important to consider that language education is generally considered to be a top priority in many countries around the world whereas music education is rarely prioritized compared to language education, often optional, and in some cases, unavailable. This factor may also be contributing to the separation of the two domains' developmental courses after the first few years of life.

Conclusion

Whatever the case may be for later development (i.e., after the emergence of speech), with these parallels between the overall developmental patterns, the evidence for both music using language-associated brain areas and language using music-associated areas in early stages of life, along with similar typical skill acquisition ages and the reliance on auditory pattern recognition in both musical and linguistic development, it seems reasonable to suggest that these two domains use common brain structures starting at birth. Furthermore, the validity of the statement that music is a specific form of language to infants seems equal to that of the statement that language is a specific form of music to infants with the definitions of music and language that we've used.Thus, it may be more appropriate to assume that a more generalized system of *auditory development,* relying partially on the same neuro-cognitive mechanisms for both domains, may underlie both linguistic and musical development during the first few years of life before becoming two distinct systems (i.e., displaying emergent modularity) to allow children utilize the more social, pragmatic qualities of language. On this note, treating the two domains similarly with this idea in mind when conducting research concerning the musical and linguistic abilities of infants younger than 12 months may also be fruitful for future developmental research.

References

Bates, E., Thal, D., Trauner, D., Fenson, J., Aram, D., Eisele, J., & Nass, R. (1997). From first words to grammar in children with focal brain injury. *Developmental Neuropsychology,* 13(3), 275-343. doi:10.1080/87565649709540682

Brandt, A., Gebrian, M., & Slevc, L. (2012). Music and early language acquisition. *Frontiers in Psychology*, 3.

Cross, I., and Morley, I. (2008). "The Evolution of Music: Theories, Definitions and The Nature Of The Evidence," in Communicative Musicality, eds S. N. Malloch and C. Trevarthen (Oxford: Oxford University Press), 61–82.

Deutsch, D. (1998). *The Psychology of Music: Cognition and Perception.* Cambridge: Academic Press.

Deutsch, D. (2004). Absolute Pitch, Speech, and Tone Language: Some Experiments and a Proposed Framework. *Music Perception,* 21(3), 339-356.

Gervain, J., Nespor, M., Mazuka, R., Horie, R., & Mehler, J. (2008). Bootstrapping word order in prelexical infants: A Japanese–Italian cross-linguistic study. *Cognitive Psychology*, *5*756-74. doi:10.1016/j.cogpsych.2007.12.001

Hannon, E. E., Trehub, S. E., & Purves, D. (2005). Tuning in to Musical Rhythms: Infants Learn More Readily Than Adults. Proceedings of the National Academy of Sciences of the United States of America, (35). 12639.

Jusczyk, P. W., Hohne, E. A., and Bauman, A. (1999). Infants' Sensitivity to Allophonic Cues to Word Segmentation. *Perceptual Psychophysiology*. 61, 1465–1476.

Lynch, M. P., Eilers, R. E., Kimbrough Oller, D., and Urbano, R. C. (1990). Innateness, experience, and music perception. *Psychological Science.* 1, 272–276.

Nuñez, S. C., Dapretto, M., Katzir, T., Starr, A., Bramen, J., Kan, E., Bookheimer, S., and Sowell, E. R. (2011). Fmri Of Syntactic Processing In Typically Developing Children: Structural Correlates In The Inferior Frontal Gyrus. *Developmental Cognitive Neuroscience*. 1, 313–323.

Patel, A. D. (2003). Language, music, syntax and the brain. *Nature Neuroscience*, 6(7), 674.

Patel, A. D. (2008). Science and music: talk of the tone. *Nature.* 453, 726–727. doi: 10.1038/453726a

Polka, L., & Werker, J. F. (1994). Developmental changes in perception of nonnative vowel contrasts. *Journal of Experimental Psychology: Human Perception and Performance*, 20(2), 421-435. doi:10.1037/0096-1523.20.2.421

Rivera-Gaxiola, M., Klarman, L., Garcia-Sierra, A., and Kuhl, P. K. (2005). Neural patterns to speech and vocabulary growth in American infants. *Neuroreport* 16, 495–498.

Sallat, S., & Jentschke, S. (2015). Music Perception Influences Language Acquisition: Melodic and Rhythmic-Melodic Perception in Children with Specific Language Impairment. Behavioural Neurology, 20151-10. doi:10.1155/2015/606470

Tarnopolsky, A., Fletcher, N., Hollenberg, L., Lange, B., Smith, J., and Wolfe, J. (2005). Acoustics: The Vocal Tract and The Sound of a Didgeridoo. *Nature* 436, 39.

Trainor, L. J., and Corrigall, K. A. (2010). Music acquisition and effects of musical experience. *Music Perception*, Vol. 36, eds M. Riess Jones, R. R. Fay, and A. N. Popper (New York, NY: Springer), 89–127.

Trainor, L. J., and Trehub, S. E. (1994). Key membership and implied harmony in Western tonal music: developmental perspectives. *Perceptual Psychophysiology.* 56, 125–132.

Werker, J. F., and Tees, R. (1984). Cross-Language Speech Perception: Evidence for Perceptual Reorganization During the First Year of Life. *Infant Behavior. Dev.* 7, 49–63.

Investigating Genetic Basis of Reading and Language Abilities

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It is known that language abilities are highly heritable and with the advance of genetics studies, causal relationships between genes and phenotype started to be established. However, after the identification of FOXP2, acceleration in the discovery of genetic basis of reading and language abilities slowed down. These traits have been investigated in terms of changes in gene structure, gene number and nervous system structure. Most studies failed to identify significant causal relationships between genes and reading and language traits. Two main reasons of this can be technical problems related to genomic analysis and utilization of psychometric measures that test rather broadly defined traits. Since reading and language abilities rely on multiple cognitive and sensorimotor functions, I propose that previous studies should be revised by using psychometric tests that measure these cognitive and sensorimotor functions so that there is an increased probability of identifying significant causal relationships between genes and behavior. If these relationships are established, we will discover candidate "language" genes. Determining molecular functions of these genes will reveal etiology of language disorders.

Keywords: language, reading, FOXP2, GWAS, CNV

Discovering Genetic Basis of Reading and Language Abilities

Thanks to the acceleration in discovering new molecular techniques, we are now able to investigate the molecular basis of cognitive functions. The scope of these techniques varies from detecting single letter changes in DNA, to observing structural changes of the nervous system. Language research is one of the fields that have benefited from the development of these techniques the most.

It was known that language abilities were highly heritable and with the advance of genetics studies, many attempts to establish the causal relationships between genes and phenotypes were made. The most popular example of this is the identification and characterization of the FOXP2 gene (Lai, 2001). Mutant forms of this gene were shown to cause speech apraxia. Identification of FOXP2 was relatively easy because it exhibits Mendelian inheritance; similar to the way a pea plant produces round shaped peas if it has the dominant version of the "round shape" gene, if a person has a mutant FOXP2 gene, she has a pathological phenotype. Yet, only a few human genes exhibit a Mendelian inheritance pattern. Establishing causal relationships between language disorders and abnormal forms of single genes is hard because the majority of pathological phenotypes are caused by interactions of various abnormal gene products. Fisher (2016) emphasizes three implications of this occurrence: 1) a single gene does not specify phenotype and it indirectly affects cognitive

functions, 2) a single gene interacts with multiple other genes, contributing to multiple processes in the cell or interactions between neurons, 3) genes relay their effects on the phenotype by forming complex interaction networks. Psycholinguistics research aims to discover and understand these complex interactions on multiple levels such as inter-neuronal interactions and behavior.

To investigate the genetic machinery underlying reading and language abilities, various techniques are used. These techniques include genome-wide association scan (GWAS) (Carrion-Castillo, 2016; Gialluisi, 2014), copy number variation (CNV) (Gialluisi, 2016a) and neuroimaging (Gialluisi, 2016b). DNA consists of four nucleotide bases: adenine (A), thymine (T), guanine (G) and cytosine (C). Patterns of these nucleotides recipes of proteins and changes in the patterns can change the final protein. GWAS studies that aim to detect whether single letter changes in DNA, e.g. a change from A to G, referred to as single nucleotide polymorphisms (SNPs), are associated with abnormal reading and/or language ability traits. CNV studies aim to detect whether changes in numbers of a gene(s) correlate with abnormal reading and/or language abilities. In addition to molecular tools, more global approaches, e.g. neuroimaging, are also used. Brain structures, connectivity, activation levels of affected individuals are compared with those of healthy individuals.

Gialluisi (2014) did a meta-analysis based on previous research that identified probable gene variations that are associated with reading and language ability. Participants were recruited from three datasets, UK Reading Disability (UK-RD), SLI Consortium (SLIC) and Colorado Learning Disabilities Research Centre (CLDRC). These were children with reading or language problems and their healthy siblings. The CLDRC dataset included participants with reading disability (RD) and attention deficit hyperactivity disorder (ADHD) as these children scored similarly in reading and language tasks. Variance in performance on reading and language abilities were considered as continuous traits. All of the datasets were tested for SNPs using DNA extracted from whole blood or buccal swab samples of the participants. The first Principal Component (PC) was derived from reading and language related quantitative traits. PC analysis is carried out to transform variables that are likely to be correlated with one another into a set of values, so it allows identification of correlations between variables. In this paper, PC analysis was done to identify shared neurobiological machinery underlying reading and language traits. The SNPs were tested for association with the PC. Then GWAS results from previous studies were meta-analyzed and compared to their results. This was done to identify candidate genetic effects on shared variance within reading and language traits. No SNP exceeded the genome-wide significance threshold (Please refer to Box 1 for some more detailed information on this).

To investigate the effects of the two SNPs on the central nervous system level rather than the molecular level, the same authors did a follow up study (Gialluisi, 2016b). The dataset was obtained from Brain Imaging Genetics (BIG) resource. Participants were composed of 1275 healthy adults. Data on reading and language measures of these adults were absent. The participants had undergone anatomical MRI scans and their SNP data was already present. They focused on variation in cortical regions that have been previously shown to be affected in individuals

Box 1.

Additionally, the two SNPs that had significance values approaching threshold level (rs59197085 and rs5995177) were tested against individual measures by univariate analysis and multivariate modeling. The aim of this was investigating pleiotropy (the effects of a single gene on multiple traits). These two SNPs displayed broad association profiles across the measures used for constructing PC, suggesting these SNPs have pleiotropic effects on the traits measured. Functional analysis of these SNPs showed that their expressions are specific to neural tissue. rs5995177 is localized to an intron (a region within a protein-coding DNA segment that is not translated into protein, introns can be involved in gene expression regulation) of the RBFOX2 gene, which codes for a protein that is expressed in neurons and regulates alternative splicing (a process that generates multiple proteins from a single gene). This protein was shown to have significant roles in CNS development (Gehman, 2012). There is a FOXP2 binding site ~5kb from rs5995177 (The ENCODE Project Consortium, 2012), indicating a link between rs5995177 and reading and language traits. rs59197085 is located in CCDC136. Functions of CCDC136 are poorly characterized but it is highly expressed in the occipital lobe and cerebellum.

with reading disability and language impairment. These regions were Broca's and Wernicke's areas, middle temporal gyrus (MTG) and postcentral parietal gyrus (PPG). Broca's area corresponds to parts in the left inferior frontal gyrus (IFG-PO and IFG-PT, respectively). Wernicke's area corresponds to the posterior part of the left superior temporal gyrus (STG). These regions are structurally (i.e. anatomically) and functionally connected. Functional connectivity is defined in terms of statistical correlations between activations of certain regions in neuropsychological events. The authors analyzed genetic associations with grey matter volumes in these areas. The surface area and thickness measures of these regions were obtained for left and right hemispheres and multivariate association analysis was done with these correlated measures. Multivariate analysis with cortical surface area and thickness of selected regions showed that rs5995177 was significantly associated with thickness. This SNP was associated with reduced grey matter thickness in left PPG, right MTG, right IFG-PO and IFG-PT and right and left STG. The authors speculate that poor reading/language performance could be affected by reduced thickness these regions. Due to the fact that RFBOX2 being an alternative-splicing regulator with important roles in CNS development, it might affect brain morphology, resulting in variation in reading and language abilities. However, as reading and language measures are missing in this dataset, this hypothesis needs further testing.

Changes in the genome are not limited to SNPs. CNVs are structural changes in the genome that have a size greater than 1kb that result in a non-diploid copy number. Gialluisi (2016a) aimed to investigate the influence of CNVs on reading and language performance. The dataset Colorado Learning Disabilities Research Centre (CLDRC), composed of children with school history of RD or ADHD their siblings, was used. The first Principal Component (PC) was derived from reading and language related quantitative traits. An additional phenotypic trait, a composite measure of word recognition, spelling and reading comprehension, referred to as IBG discriminant score (IBGdiscr) was used. This score was used to diagnose RD in the CLDRC dataset. The participants in the first and tenth decile of IBGdiscr score represented poor (RD case) and good (control) reading

performance respectively. RD cases and controls were used when dichotomous case control classification was necessary. A significant correlation between PC and CNV burden, both in terms of number and length of CNVs, was not found (Please refer to Box 2 for some more detailed information on this).

Similar to Gialluisi, Castillo (2016) aimed to detect associations between SNPs and reading and language abilities. The top SNPs obtained in six GWAS studies were tested for supportive evidence in The Familial Influences On Literacy Abilities (FIOLA) dataset. This dataset comprises a general family-based Dutch population in which there are a number of quantitative reading and language traits available. The top SNPs identified in each of the six GWAS studies did not overlap with each other. The traits measured in this study were word and nonword reading fluency, phonological awareness (PA), and serial rapid automatized naming (RAN). Word reading fluency was assessed using the One-Minute-Test in which participants were made to read as many words as possible in one minute. To measure non-word reading fluency the Klepel test was used. Participants were asked to correctly read as many non-words as possible in two minutes. PA was measured using a phoneme deletion task. A phoneme (always a consonant) had to be deleted from a non-word for every test item, generating another non-word. A fluency measure was constructed by combining accuracy and speed. RAN was measured by naming a 50-digit matrix as fast as possible. The time needed to finish the task was used to yield the number of digits read per second. Three SNP associations almost reached significance threshold in the multivariate analysis of the children, but no significant association was detected.

Box 2.

A CNV that co-segregated with RD status in a family with two affected siblings (including the most severed subject in the dataset) and one unaffected sibling was detected. This CNV is rather large compared to the others and overlaps with a region that includes many olfactory receptor genes. Proteins coded by these genes function in responding to odors. Two other CNVs were detected in two affected siblings but not in any unaffected participant. One of these CNVs overlapped with a region of UTRN gene and the other overlaps with DNAH14. UTRN gene codes a protein is expressed in the CNS and has functions in postsynaptic membrane maintenance and of acetylcholine receptor clustering in neuromuscular synapses. One of its possible roles is connecting the cytoskeleton to the plasma membrane. Yet, due to the region of CNV overlap with UTRN, the protein product of the gene may not be affected by the CNV. DNAH14 codes for a protein that has functions in cell motility. Independent studies have reported that such proteins are also involved in RD. This suggests a hypothesis that RD can be a form of deficient cell motility (Massinen, 2011). Even though there were no genome-wide significant associations, the top CNVs have essential functions in the brain tissue.

I presume that the main reason for finding insignificant results is the utilization of psychometric measures that test rather broad traits and biochemical reasons that cause gene expression to differ amongst individuals. Due to these biochemical reasons, individuals may have abnormal phenotype even though they have non-mutant versions of genes.

Some of the measures that are used to identify reading and language performance are word reading, word spelling, phonological decoding and phoneme awareness. Although these measures are indeed indicative of

reading/language abilities, current findings from neurobiology and cognitive neuroscience indicate that language skills are heavily dependent on activities of several sets of cortical and subcortical circuits. This means that they are emergent functions of other cognitive or sensorimotor functions. French (2014) illustrates this phenomenon based on research about FOXP2. The traits associated with FOXP2 disruption in humans include inconsistent and imprecise control of the coordinated movement sequences of movements necessary for fluent speech. This indicates that FOXP2 aberrations cause disruptions in the brain's capacity to plan motor sequences required for speech production. Also, structural abnormalities in speech-related circuitry, corresponding to regions of high FOXP2 expression, are observed. The same regions also overlap with circuits related to motor control, pointing to a framework in which speech-related circuitry overlaps with processes necessary for motor control. Additionally, it was shown that mice with one abnormal copy of FOXP2 display motor learning deficits displayed in accelerating rotarods and running wheels (Groszer, 2008).

Marchand-Krynski's 2017 study investigated motor skill impairments in children with RD and/or ADHD. Findings of the study indicate that RD, ADHD and comorbid cases display atypical motor skill development compared to matched controls. Measures used in this study vary from simple motor movements to difficult complex bimanual coordination. As this study investigates the relationship between motor skill impairment in a sample that overlaps with the GWAS studies, the psychometric tests are used to investigate the association of motor function variance with SNPs, CNVs and structural and functional connectivity.

Another reason why the genome-wide association studies failed to detect significant associations can be biochemical reasons. Having the normal copy of a gene does not directly yield a healthy phenotype. Healthy versions of genes may not be reflected in the phenotype due to modifications in the genome, independent of DNA sequence, that alter expression of a gene in certain cell types. Thus, even though a person does not have a mutant copy of FOXP2, the gene they have can be regulated in a manner that results in a similar functioning pattern with that of mutant FOXP2. This is impossible to identify through genome sequencing. For the purposes of this paper, this issue will not be discussed further.

As demonstrated above, previous studies failed to discover significant associations between genomic variance and reading and language traits. Current research suggests that reading and language deficiencies observed in RD, specific language impairment (SLI) and ADHD cases have simpler cognitive and/or sensorimotor functions as their basis. The current proposal was designed as a response to this issue. An investigation of the association between motor skills that are impaired in reading and language disorder cases and genomic variance is proposed. It is hypothesized that this will yield significant associations because previous research investigated rather broad traits that are composed of various simple motor functions and the shared aspects of broad reading/language cannot be attributed to a PC measure. This statistical tool is not likely to encompass every motor component shared by broadly-defined traits such as phoneme awareness and word spelling.

Method

Participants

Participants of this study will be

composed of the CLDRC, as this dataset includes children with RD and ADHD and their healthy siblings. The number of participants is 749 in total, having a mean age of 11.7 years, ages ranging between 8-19, from 343 unrelated sibships/twinships. 266 of the twinships/sibships (585 participants) have a history of RD and have been originally recruited via a proband .77 of the twinships/sibships (164 participants) have a history of ADHD and have been originally recruited via a proband.

Procedure

First, handedness questionnaire will be given to the participants to determine their dominant hands. A modified version of the Edinburgh Handedness Inventory will be used. This inventory includes eighteen questions about hand preference for eighteen actions. The possible answers to the questions are “right hand always”, “right hand most of the time”, “both hands equally often”, “left hand most of the time” or “left hand always”. The

total possible score is 90. A score between 18-29 is considered right-handed, 29-54 ambidextrous, and 55-90 left-handed. Then, these results will be used to refer to participants’ hands as Dominant Hand (DH) and Non-Dominant Hand (NDH).

Grooved Pegboard (GPB) is a dexterity test that will be used to assess fine motor skills.

Leonard Tapping Task (LTT) is used to rapidly assess simple (unimanual rapid tapping) and complex motor (bimanual out of phase movements) coordination and motor sequencing. It consists of two symmetrical round metal plates divided to 4 equally sized quadrants that are numbered from 1 to 4. The participants must tap with a stylus with either one hand at a time or both hands together, following a sequential order. Four conditions are administered. Conditions 1-3 are repeated twice after completion of the first three trials, without any time interval in between. Condition 4 is performed after completion of both trials of conditions 1-3. Details of GPB and conditions of LTT are specified in Marchand-Krynski, 2017. After these tasks, DNA will be collected from participants for genetic studies.

Discussion

The short-term goal of this study is identifying significant associations between motor skill variation linked to reading and language disorders and genomic variation. If candidate genes are identified, I propose the usage of organoid models for functional testing of the genes in the long-term.

Organoids are mini organs that can be cultured in a dish. Organoids can be generated from skin cells of an individual. First, skin cells are converted into stem cells via treatment of multiple chemicals. Then, stem cells are treated with another group of chemicals that cause them to give rise to the cells of the nervous system. If this structure is kept in a spinning bioreactor, cerebral organoids can be generated (Lancaster, 2013). This technology has been used to model molecular basis of microcephaly and autism spectrum disorder (Mariani, 2015). I presume this approach is going to be the most beneficial for this study because the participants are composed of affected individuals and their unaffected twins/siblings. Cerebral organoid systems can be established from the cells of both siblings. Comparison of the developmental differences between organoids from the unaffected sibling and the affected sibling will yield answers regarding what went wrong during

the development of the abnormal CNS tissue in terms of molecular, cellular and circuit levels. This model is advantageous for investigation of differences between healthy and affected individuals at a cellular level. Thus, it is not possible to comment on how environmental factors effect generation of abnormal phenotypes. This will allow us to detect functions of genes in multiple levels. This can be a significant step in defining etiology of reading and language disorders because it can yield genes that code for proteins that specify the "language circuitry".

References

Carrion-Castillo, A., van Bergen, E., Vino, A., van Zuijen, T., de Jong, P. F., Francks, C., & Fisher, S. E. (2016). Evaluation of results from genome-wide studies of language and reading in a novel independent dataset. *Genes Brain Behav, 15*(6), 531-541. doi: 10.1111/gbb.12299

French, C. A., & Fisher, S. E. (2014). What can mice tell us about Foxp2 function? *Curr Opin Neurobiol, 28*, 72-79. doi: 10.1016/j.conb.2014.07.003

Fisher, S. E. (2017). Evolution of language: Lessons from the genome. *Psychon Bull Rev, 24*(1), 34-40. doi: 10.3758/s13423-016-1112-8

Gehman, L. T., Meera, P., Stoilov, P., Shiue, L., O'Brien, J. E., Meisler, M. H., . . . Black, D. L. (2012). The splicing regulator Rbfox2 is required for both cerebellar development and mature motor function. *Genes Dev, 26*(5), 445-460. doi: 10.1101/gad.182477.111

Gialluisi, A., Newbury, D. F., Wilcutt, E. G., Olson, R. K., DeFries, J. C., Brandler, W. M., . . . Fisher, S. E. (2014). Genome-wide screening for DNA variants associated with reading and language traits. *Genes Brain Behav, 13*(7), 686-701. doi: 10.1111/gbb.12158

Gialluisi, A., Visconti, A., Willcutt, E. G., Smith, S. D., Pennington, B. F., Falchi, M., . . . Fisher, S. E. (2016). Investigating the effects of copy number variants on reading and language performance. *J Neurodev Disord, 8*, 17. doi: 10.1186/s11689-016-9147-8

Gialluisi, A., Guadalupe, T., Francks, C., & Fisher, S. E. (2016). Neuroimaging genetic analyses of novel candidate genes associated with reading and language. *Brain Lang*. doi: 10.1016/j.bandl.2016.07.002

Groszer, M., Keays, D. A., Deacon, R. M., de Bono, J. P., Prasad-Mulcare, S., Gaub, S., . . . Fisher, S. E. (2008). Impaired synaptic plasticity and motor learning in mice with a point mutation implicated in human speech deficits. *Curr Biol, 18*(5), 354-362. doi: 10.1016/j.cub.2008.01.060

Marchand-Krynski, M. E., Morin-Moncet, O., Belanger, A. M., Beauchamp, M. H., & Leonard, G. (2017). Shared and differentiated motor skill impairments in children with dyslexia and/or attention deficit disorder: From simple to complex sequential coordination. *PLoS One, 12*(5), e0177490. doi: 10.1371/journal.pone.0177490

Lai, C. S., Fisher, S. E., Hurst, J. A., Vargha-

Khadem, F., & Monaco, A. P. (2001). A forkhead-domain gene is mutated in a severe speech and language disorder. *Nature, 413*(6855), 519-523. doi: 10.1038/35097076

Lancaster, M. A., Renner, M., Martin, C. A., Wenzel, D., Bicknell, L. S., Hurles, M. E., . . . Knoblich, J. A. (2013). Cerebral organoids model human brain development and microcephaly. *Nature, 501*(7467), 373-379. doi: 10.1038/nature12517

Massinen, S., Hokkanen, M. E., Matsson, H., Tammimies, K., Tapia-Paez, I., Dahlstrom-Heuser, V., . . . Kere, J. (2011). Increased expression of the dyslexia candidate gene DCDC2 affects length and signaling of primary cilia in neurons. *PLoS One, 6*(6), e20580. doi: 10.1371/journal.pone.0020580

Marchand-Krynski, M. E., Morin-Moncet, O., Belanger, A. M., Beauchamp, M. H., & Leonard, G. (2017). Shared and differentiated motor skill impairments in children with dyslexia and/or attention deficit disorder: From simple to complex sequential coordination. *PLoS One, 12*(5), e0177490. doi: 10.1371/journal.pone.0177490

Mariani, J., Coppola, G., Zhang, P., Abyzov, A., Provini, L., Tomasini, L., . . . Vaccarino, F. M. (2015). FOXG1-Dependent Dysregulation of GABA/Glutamate Neuron Differentiation in Autism Spectrum Disorders. *Cell, 162*(2), 375-390. doi: 10.1016/j.cell.2015.06.034

Schreiweis, C., Bornschein, U., Burguiere, E., Kerimoglu, C., Schreiter, S., Dannemann, M., . . . Graybiel, A. M. (2014). Humanized Foxp2 accelerates learning by enhancing transitions from declarative to procedural performance. *Proc Natl Acad Sci U S A, 111*(39), 14253-14258. doi: 10.1073/pnas.1414542111