Chapter 8

DISCUSSION
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The study aimed to compare the effect of training with object control skills or video game based training interventions on response abilities in terms of response time and response force among children with IDD. The main findings of the study was that training participants with IDD with object control skills helped improve their RT. Studies have shown that training helps to improve RT among individuals with DS and IDD.\textsuperscript{39,53,54} Interventions which address object control skills are said to be important as these skills are said to help improve specific cognitive abilities among individuals with intellectual disability.\textsuperscript{4,39}

The object control skills performed in this study brought about a statistically significant change of 290ms in the RT of object control skills training group (Table 7 and 8). The change, however, did not sustain until the follow-up period where it increased by 22ms. Nevertheless, the change in RT although not statistically significant did not come back to the pre-test levels. Children with IDD have shown to have poorer object control skills than those who are typically developing which was attributed to the complexity of object control skills and the manner in which the individuals master performance of these skills. These skills are usually mastered during regular play and other exposures that children who are typically developing have more access. Children with some form of disabilities have limitations in their ability to participate either due to lack of opportunities or due to their behavioral or communicative disorders. Most individuals with disabilities have poorer access to enriching environments which can enable them to develop life skills. This factor is amplified in children with disabilities in low-middle income countries where the access to facilities and amenities is further
reduced. Moreover, what an individual learns in one setting needs to be adapted and replicated in another setting based on the changing environment constraints, for which executive functions play an important role. Impaired executive functions may be another reason why the change in RT persisted during the post-test period but not during the follow-up period.

In the video game training group, there was a change of 260ms in RT (Table 7). This change although was 30ms lesser than improvement in RT, it was not adequate to produce a statistically significant difference with training. Although the training did bring about a change in the RT of the video game training group, the training was not sufficient to produce a statistically significant change. The amount of training required for video game training to have an influence on RT may have been much higher than that provided by this study. Inspite of sufficient training period the expert gamers differed from non-gamers in a variety of cognitive skills, indicating that a basic background with gaming experience yields to better performance on cognitive tasks. Most participants in this study had no prior exposure to video games. A longer period of training and acquaintance with the games may probably yield improvement in cognitive performance among children with IDD. Söderqvist et al. trained children with ID using computerized cognitive training interventions for approximately 20 minutes, five days a week for five weeks. The training resulted in improvement in working memory and non-verbal reasoning, which however did not sustain at one year follow up. The exact frequency and intensity of cognitive training to bring about a significant effect among children with IDD is not clear; however, it is suggested that extended periods (i.e. 10 weeks) or repeated training (i.e. 5 weeks every 3 months) can potentially result in the effects of training to be maintained. Future studies can help
understand the intensity and duration of intervention required for training to have an influence on RT among children with IDD.

A study done by Wuang et al. shown that 24 weeks of training with virtual reality using Wii games showed greater improvement in motor proficiency, sensory integration functions and visual-integrative abilities of children with DS, than standard occupational therapy interventions.\textsuperscript{149} Wii games are more active and have a better level of user interface and thereby could have resulted in greater benefit. Training cognitive functions using game-based training has gained recent emphasis. The current study employed a video game training approach using games freely available online. Studies which compared the effects of a single bout of video game-based training to aerobic training, found a reduction in RT with aerobic training alone and not with video game-based training, implying that these interventions do not have an influence on parameters of cognition like the traditional exercises have.\textsuperscript{153} The findings of O’Leary’s study is similar to the present study where the changes were present in the object control skills training group but not the video game training group. Although the participants in that study were healthy college-aged adults and performed a single bout of intervention, it can be said that the influence of video game training intervention was similar across healthy adults and children with IDD. Therefore, no statistically significant change in RT in the video game training group, cannot be attributed to motivation or other parameters like poor ability to understand, as although the duration and type of training differed, similar effects were present in healthy participants.
RT of the no training group in the post-test period did not reduce but instead, it increased by 32ms (Table 7). From the post-test to the follow-up phase the RT reduced in the no training group by 145ms. The large change in RT in the no training group could attribute the findings to the learning effect and familiarization with the testing. This can also be due to a large amount of intra-individual variability in RT which is observed among individuals with IDD which is primarily attributed to the EF deficits seen among individuals with IDD. The slowness in information processing among individuals with ID can be attributed to the lower amount of cerebral white matter integrity or a strategic choice to prefer stability over speed while performing a task.

Response force forms an important aspect for proper and precise execution of motor response. This is one of the first studies to assess the influence of training on RF. In the object control skills training group, the RF increased by 0.04N in the post-test period and by 0.2N in the follow-up period (Table 7). In the video game training group, the RF increased by 0.3N in post-test and by 1.51 N in follow-up period. In the no training group, the RF increase by 0.17N in post-test and by 0.97 N in follow-up period. RF changed across all three groups in the post-test period and the follow-up period. The participants of the object control skills training group could sustain their ability to modulate the force with which they responded. The object control skill training resulted in very less change in RF i.e. of 0.04N in the post-test. Similar effect was not observed in the other two groups where there was a greater change in the RF i.e. increased by 0.3N in video game training and 0.15N in the no training group during the post-test measurement. The change from pre-test to post-test although not statistically significant (Table 8) suggests that the participants of the object control skills training group were better able to control the force with they responded. At the
follow-up period, there was a change of 0.2N in RF of the object control skills training group. The video group changed by 1.51N and the no treatment group by 0.97N. The change in the object control skills training group was lesser indicating that the training did help them modulate their ability to control and sustain the force with which they responded. The other two groups had a greater increase in the RF. The change from post-test to follow-up showed a statistically significant difference when compared to the control group (table 8). This can be attributed to the fact that the RF in control group changed to a greater extent as compared to the object control skills training group, thereby resulting in a statistically significant change. The underlying message is that the ability to modulate and control the force with which one responds was found to be improved among those participants in the object control skills training group. This control was persistent inspite of the influence of confounding factors like variability in RF assessment at different time points or learning over time points of assessment. It can be said that training with object control skills helped regulate and control the RF abilities of participants, which was not observed in the other two groups.

Both RT and RF form important components of response dynamics and hence we aimed at addressing both these factors. In the first phase of the experiment, it was observed that as the task complexity increase the RT increased and RF decreased across participant groups. Since RT and RF are found to have an inverse relation, we hypothesized that the same should be applicable for training. Studies have shown that RT reduces with training. The same was found in the present study wherein RT reduced with training. With this relation in mind if RT reduced with training, then RF
would increase with training. This was observed in our study wherein with training the mean RT was found to decrease and the mean RF was found to increase.

The amount with which the RF increased was much lesser in the object control skills training group. These participants were, therefore, able to perform consistently across three time points of measurement inspite of confounders like variability in RF measurements or learning effect or different time points of measurement. This shows that the training helped alter and modulate the inverse correlation between RT and RF. Inspite of reduction in RT with training, RF abilities stayed consistent. Therefore, inspite of faster responses, participants in the object control skill training group were able to sustain the force with which they responded.

The secondary outcome measures did not show statistically significant change over time points of assessment with either form of intervention (table 11). There was a change in mean values which was present across groups, which could be suggestive of variability in assessment over time points, learning effect or familiarity with the tests which could have influenced the ability of participants to perform the tests over time. All participants could perform most components of the upper-limb speed and dexterity subtest (figure 21). However, the number of participants who could perform the RST and RDT tests were lesser in number. Lesser number of participants who could perform the secondary outcome measures may have been another factor which could have influenced the result. The change in the ability of the participants was observed across groups, which did not lead to a statistically significant difference in performance between groups. The participants found it difficult to learn to perform the RST task. There were two prime complaints, one of pain while holding the arm up
and pressing against the wall and the other of difficulty adducting the finger and holding the stick with their thumb. Another factor which could possibly have contributed is the extremity from which the assessments were performed. Apart from RDT, the other secondary outcome measures were assessed only from the preferred hand and not both hand. This prevented the average of the extremities as the output to be assessed.

When the RT measurements obtained from the response analyzer were correlated with those obtained from the ruler drop test, a very weak correlation was observed. The ruler drop test is a commonly used test in field settings and has the advantages of being easily available and replicable. However, RT measured by ruler drop tests cannot be used as an alternative for RT measured by a response time analyzer. The measurement of RT using a response time analyser (in the present study a response analyser) can be considered as a more appropriate measure to get an accurate estimate of RT among individuals.

It was interesting to observe that, a few participants who could not learn to perform the outcome measures at the pre-test period could do so after the training period. Although the intervention did not reflect a change in the performed outcome measure, there was a change in the ability of the participants to learn and perform these outcome measures, that they initially found difficult to perform. In all, there were 18 participants who could not perform an outcome measure at pre-test but could do so at subsequent time points. It can be said that the ability of participants to perform the test was not solely due to the intervention provided as there were participants from all three groups who could not initially perform the tests but could
do so later. It can be said that this ability to perform could be due to learning of the task, familiarity with the task and the assessor. The severity of intellectual disability did not influence this aspect either as these participants were spread across the spectrum of IDD.

The nature of video games need be simpler in form for those with IDD. They need to be easy to understand and adopt following simple instructions and movements. This component was achieved by the choice of video games used in the present study. Participants in the present study could learn to play the video games, as seen in previous studies with IDD. Most participants of the video game training group participants could progress through the levels of intervention, except three participants, all belonging to the video game group. One could not progress beyond the first level, another beyond the second level and the third took longer time or more number of sessions before he could progress from level two to three. The object control skills training group had one participant who could not progress beyond the third level. The inability or longer time taken by the participants to progress from one level to the next could be suggestive of the difficulties in motor learning among children with IDD. There were two participants in the video game training group who were not interested in playing video games, but would perform all the assessments. Similar concerns were not seen in the object control skills training group where all the participants were interested in performing the activities. The degree of active participation in the intervention in the object control skills training group could have led to the above-mentioned findings.
In the present study, participants attended an average of 69% of total scheduled sessions with a higher attendance in the object control skills training group as compared to the video game training group (figure 20). The video game training group had a higher percentage of hostel students and this could be the reason for a better attendance rate. A study performed by Söderqvist et al demonstrated that more than 85% of their participants attended more than 80% sessions. The participants in that study were either trained in school with the teacher’s supervision or at home under parent’s supervision. This could possibly be due to double-blinded nature of their study and to aid greater participation. The present study was performed under a Physiotherapist’s supervision who was kept constant across all the participants. This ensured consistency and reduced variability in the practice of intervention. Performing the present study with parental supervision at home and teachers’ supervision at school may yield better participation and attendance rates.

The difference between the results of Söderqvist et al and our study could be attributed to numerous factors. They assessed the influence of training on visuo-spatial working memory and non-verbal. They excluded participants with autism who were included in our study. Their study allowed participants to do the training from home which could have yielded to better response rate. Participants who performed less than 80% of sessions were considered excluded from the study, which invariably led to a good attendance rate. The study suggested that a specific level of cognitive capacity or training ability seemed essential for the training to provide beneficial effects. The present study assessed response abilities of participants, included those with autism, allowed for control in training setting and analyzed all participants who were randomized. Their study revealed a large variability in training performance.
with some participants showing larger improvement compared to others. They emphasized the need to understand how inter-individual differences in how the cognitive training was received. This was eliminated in the present study by keeping the trainer and the training set-up constant thereby eliminating the confounder of multiple trainers and multiple training set ups.

The gaming industry is a multi-billion-dollar industry which advertises the potential benefits of cognitive training, which in turn can result from overt advertisement. A study done by Foroughi et al that improvements in a number of cognitive training interventions may result from placebo effects from overt and suggestive recruitment strategies. The possibility of placebo effects from overt strategies are negligible among the participants of the present study. Most studies use commercial forms of game-based training are most commonly used than video games. Most of these commercial forms are not specific to the patient population, while some are modified to suit their patient specific demands. Therefore, use of video games that are freely available is a novel pursuit. It is said that the level of engagement or immersion in a game based task is not solely dependent on the gaming system but the task at hand. There are times when an individual can be more engrossed in the games he plays on his phone than a gaming console. Therefore, use of video games as a method of training children with IDD is a novel pursuit.

This study is one of the first to see the influence of object control skills training, computer based training and no training on response abilities and upper limb speed and dexterity among children with IDD. The use of hand function skills to improve the upper limb functions have been assessed across a wide range of studies. The present
study employed the use of video games using affordable systems. Both these forms of training are interesting, engaging, motivating and enjoyable. The object control skills training has more active participation i.e. in the form of actively responding, whereas the video game training requires the individuals to respond by clicking a switch. As the study addresses the response abilities, the response produced in the form of video game training was much lesser than during the object control skills training. This probably could be the reason why the participants in the object control skills training had a change in their RT abilities and not the video game training group. The degree of immersion, engagement, and enjoyability provided by other forms of training such as Microsoft Xbox® Kinect, Nintendo® Wii™ or Sony PlayStation3 Move, was not met with computer based video games training.

The study is not devoid of factors which could possibly act as confounders to the outcomes of the study. The first is the possible learning effect that may have occurred due to familiarity with the apparatus and the tests. The second is the participant’s interest level in playing video games which were not assessed. There are individuals who preferred playing video games and others who preferred actively involving in tasks like exercising or playing a sport. Video games although are interesting can be considered less immersive than systems like Kinect games, and further less interactive than participating in an object control skills training program. This highlights the importance of some of our traditional interventions in which the amount of active participation from the participant’s side is higher. Assigning the participants to groups based on their interest level of participant in video games or object control skills training program would be a possible way to overcome this confounder. Future studies can consider a pragmatic study design which assigns
participants to groups based on their level of interest in video games or object control skills training program may yield different results. A longer period of training and acquaintance with the games may influence the results of the study. The study thereby highlights that degree of active involvement in a task are important considerations while planning intervention programs.

From the present study, it can be said that the object control skills training interventions were more beneficial to improve the RT among children with IDD than video game training intervention or the no training program. It can also be said that the object control skills training enabled participants with IDD to modulate and control the force with which they responded, as compared to the video game training group or no training group.

8.1 STRENGTHS

This study was one of the first attempts at training to improve RT and RF among children with IDD using novel techniques in school-based settings. The inclusion of a no training group helped compare, interpret and provide greater validity to the results. Analyzing all participants who were randomized provides results which are more reflective of the true world settings. The interventions were chosen to be simple and replicable to allow participants and their families to perform the training program at their homes. The feasibility of the program creates potential for family members, teachers, volunteers and community health workers to replicate the program with adequate training and support. Performing the training programs in home-based settings can improve the compliance and adherence rates as the primary reason for the lower compliance and adherence was absence from school.
8.2 CLINICAL IMPLICATIONS

The study provides insight into the scope for training RF along with RT among individuals with motor control deficits. Training with object control skills among children with IDD helps reduce RT and enables them to modulate the force with which they respond. Response time and response force can, therefore, be trained among children with IDD using object control skills. This form of training can be performed in the form of home-based or school based training with adequate supervision from parents or teachers. Although the present intervention did not detect any change in the outcome measures in the video game based training group, video games based training have resulted in positive health-related outcomes in Physical Therapy practice.\(^\text{168}\)

8.3 LIMITATIONS

The major limitation of the study was that it was not blinded to assessor or participants. The participants were not matched for mental age. However, a recent study showed that inspite of matching for mental age, the participants performed poorly in both gross and fine motor tasks. This implies that the differences in performance are not solely attributable to the cognitive profile of the participants.\(^\text{169}\)

The drop-out rates and the absenteeism from school formed another major limitation of the study. Performing similar studies in home-based settings or rehabilitation centres instead of school-based setup may eliminate these concerns.

The study had several participants who could not learn to perform the task and therefore were not able to perform the test. There were also participants who could
not perform certain tests during the pre-test but could do so during the post-test and follow-up period. As the missing data was primarily because of inability to perform the task, intention to treat analysis was not performed.

Visual problems i.e. acuity as well as color discrimination, were not controlled for in the study. Problems with vision, especially seen among children with DS among others, could have influenced the results of the study.

8.4 FUTURE RECOMMENDATIONS

Future research may be required to understand the duration or intensity of training that would be required if video game based exercise were to bring about a reduction in RT and better ability to modulate their RF. Rigorous designs such as blinded randomized controlled trials may provide a better understanding of the training effects. The amount of training needed to allow the effects of the training to sustain beyond the training period is needed to be explored. Replication of similar studies in rehabilitation set ups or health care centres with adequate supervision and training can be considered. Studies can look at sustainability and delivery of care if these interventions were to be provided by family members and care givers. Use of affordable systems in the form of freely available online video games for improving cognitive and motor skills can be explored further.