Chapter 5

DISCUSSION
5 DISCUSSION

5.1 EXPERIMENT 1

This study is one of the first to assess both RT and RF among children with and without disabilities and hence provides us baseline values and understanding of their response abilities. Overall, the results of the experiment enable us to understand the baseline difference that exists in the RT and RF abilities of children with IDD, DS, and TDC when they perform a simple task.

Across groups, there was no statistically significant difference in the RT and RF when measured from the right or left upper extremity. With respect to the extremity under evaluation, RT findings were in favor of previous studies which reported no difference in RT between extremities. However, the influence of extremities on RF is novel and can be further elucidated in future studies.

Slowness in responding among DS group as compared to typically developing peers is in line with the previous literature. The study did not find the mean RT significantly lower in DS group when compared to IDD group as was previously stated. With regard to RF, TDC had significantly higher RF compared to IDD and DS. There was no statistically significant difference in RF between IDD and DS.

The RF findings of our study echo those of Heffernan et al., wherein the force output of DS was lower than the comparison group; but not with Masumoto et al. where the DS group had higher force output. Masumoto et al. studied the force control and timing ability for a tapping task in adolescents with DS. Their
observations were in part similar to this study’s finding wherein the DS group performed slower compared to TDC group. They, however, identified a greater force component, which was contrary to the findings of this study. Even though Heffernan et al. studied the isometric handgrip task the findings of this study are similar i.e. the force output of DS being lower than the comparison group. In this study, the RF was higher among TDC as compared to both IDD and DS. Moreover, the IDD and DS group had comparable response force abilities. The lower ability to generate force among DS as compared to TDC has frequently been attributed to the inherent muscle dysfunction seen in DS. However, the similarity in performance between the IDD and DS group reflects that the response force abilities has more than a structural or anatomical influence and could be attributed to the altered perceptual motor abilities of individuals with IDD and DS. Further, there appears to be an inverse relation between the time and force with which individual’s respond, which supports literature that individuals with faster RT respond with greater force. However, more studies are needed for us to better understand the ability of individuals across various eitiologies to modulate the force with which they respond.

The first experiment provided an understanding of the baseline difference in performance of RT and RF across TDC, IDD, and DS when they performed a simple task. The TDC group could perform the task faster and with greater force than the IDD and DS group whose performance was comparable.
5.2 EXPERIMENT 2

The experiments assessed the response abilities (i.e., RT and RF) of participants with IDD, DS, and TDC to respond while performing a simultaneous passive and active dual-task. The inability of most children in the IDD and DS groups to participate in the study itself suggests the difficulties that persist among children with IDD and DS when it comes to learning and performing dual-tasks. However, it was interesting to observe that the proportion of children with IDD and DS who could learn to perform the dual-task and participate in the experiment were similar (table 1).

The finding of no significant difference between extremities from which RT and RF were measured while performing both dual-tasks, are consistent with the findings of the first experiment and expands our understanding that extremity may not influence dual-task performance.

The participant’s response abilities in the passive and active dual-task were compared to their abilities in simple response task to understand whether the change in task conditions influenced their response abilities. The RT measured during the active dual-task had a statistically significant difference from the simple response task with a medium effect size. However, the RT measured during the passive dual-task and simple response task did not vary significantly. This finding implies that the amount of interference produced by the performance of simultaneous task was not adequately achieved by the listening task, but was significant enough to influence the RT when the motor task was performed.

On the other hand, RF varied significantly from simple response task with a medium effect size when the passive dual-task was performed, but not when the
active dual-task was performed. The converse is true here, wherein the amount of interference produced by a dual-task was significant enough to produce a change in RF when the passive dual-task was performed but not when the active dual-task was performed. This association can be explained by the fact that auditory stimulus is known to produce a greater force output as it causes increased arousal. The music provided could have increased their arousal and thereby influenced RF when a simultaneous motor task was being performed.

Overall this experiment demonstrated, that there was an increase in the mean time needed to perform tasks and reduction in mean force needed to perform the task as one progressed from simple task to dual-task. The findings confirm literature which suggests that performing two tasks at a time increases the RT for the task. From the study, it was seen that across all groups the time required to perform the dual-task was more than that required to perform the simple task, with the active task taking longer than the passive task. Of interest was the decreased force required to perform the task as the difficulty in performing the task progressively increased, i.e. the force was lesser while performing the active task than the passive dual-task and simple task. An inverse relation between time and force observed in this study supports previous literature. Studies have shown that individuals have the ability to modulate the force with which they respond based on the external influences. Hence, as the complexity of the task increased, the RF across all participant groups changed. As mentioned in experiment 1, the findings of our study were similar to Masumoto et al. in terms of the slower RT in DS. However, the lower force output among DS as compared to TDC is contradictory to what was found before. The addition of IDD group whose performance was similar to the DS group when compared
to TDC, further adds to the evidence on our understanding of RF. It can be inferred that the response abilities of IDD and DS group for both the active and passive dual-task were comparable.

The difference in ability to dual-task among children with IDD and DS as compared to TDC could be attributed to a number of reasons. Apart from good coordination for performing multiple tasks, dual-task requires a good ability to switch attention between two tasks; both of which require an intact working memory.\textsuperscript{161} The cognitive dysfunctions especially impaired executive functions existing in individuals with IDD and DS may be attributed to the poor performance on the dual-task as compared to age-matched healthy controls.\textsuperscript{6} Children with IDD have lower executive function especially working memory abilities when compared to chronological age matched controls.\textsuperscript{4,162} Impaired working memory in both IDD and DS could be the cause of difficulty in performing dual-task.\textsuperscript{7,30} The selective impairment especially the working memory part of the executive function as seen in individuals with IDD may alter their ability to perform dual-task when compared to controls.

In addition, the experiment demonstrates how the performance of a simultaneous active or passive dual-task influences the participation and the response abilities of children with IDD, DS, and TDC. The RT findings of the study add evidence to previous literature and the RF findings give us scope to further explore this novel finding. There are very few dual-task studies in children with IDD and DS and therefore this study throws light towards the need to study and understand their dual-task abilities. Moreover, dual-tasks studies predominantly focus on the change in the time required to perform a task, rather than the dimension of the impact that it had on
force and time. Studying both force and time together widens our understanding of the parameters that can be influenced by dual-task. The study helps us understand the RT and RF abilities, their changes with the increase in complexity of tasks and the need to consider RT and RF for assessment and rehabilitation of individuals with IDD and DS. The dual-task had a similar influence with regard to the performance of RT and RF among children with IDD and DS.

5.3 EXPERIMENT 3

The lesser number of participants in the force modulation task demonstrates the difficulties faced by participants to understand and perform the task based on the demands of the experiment. However, the proportion of participants across IDD and DS group who could perform the experiment were similar indicating similar learning abilities across the groups (table 1). For the force modulation task, there was a difference between the extremities with a small effect size when RF was measured, but not for RT.

The experiment found that there was a difference among participant groups in their response abilities while performing a force modulation task. Among groups, the response abilities of the TDC group were significantly from IDD and DS, while the IDD and DS group had comparable performance levels during the force modulation task. Moreover, all groups could modulate the force with which they responded and this finding was consistent across all groups. Interestingly, the response of participants was appropriate for the red stimulus (i.e. press the switch with less force), but not the green stimulus (i.e. press the switch with more force). Although the direction of force modulation was contrary to what was expected for the green light, it can be said that
the participants could modulate the force with which they responded. Further studies with a larger sample size and a different experimental framework would probably yield directionally appropriate results.

When the time and the force needed to perform the force modulation task were compared to simple response task, it was observed that there was a statistically significant difference with large and small effect sizes for RT and RF of participants across the two tasks. The force modulation task may have required a greater processing time and thereby had a large difference in the time taken by the participants to respond. The change in RF can be attributed to the demands of the experimental setting which expected the participants to modulate the force with which they respond.

From this experiment, it can be inferred that the participants across groups could modulate the force with which they responded when different colored light stimulus was provided. Participants across groups took a greater amount of time to perform the force modulation task as compared to the time with which they performed the simple response task. The IDD and DS group had similar force modulation abilities which differed significantly from the abilities of TDC group.

5.3.1 EXPERIMENT 4

Although participation in the choice response task dropped across all groups, it was interesting to see that the participation of the DS group was higher as compared to the IDD group (table 1). The greater ability of the DS group to perform the task as compared to the IDD group in the present study suggests the ability to participate and perform the choice response task is less impaired in DS as compared to IDD group. In
addition, noteworthy was that extremity did not influence the RT and RF during this task.

Across groups, there was a significant difference in the response abilities of the TDC group when compared to the IDD and DS when they performed the choice response task. However, both the IDD and DS groups were comparable thereby suggesting similar response abilities for a choice response task.

With respect to errors performed during the choice response task, neither the extremity nor the color of stimulus had any influence on the choice response task or the errors performed across groups (Table 3). The lack of difference in performance between groups could be attributed to the lesser participation levels in the IDD and DS group which limits our understanding of the difference in performance between the groups.

When the RT and RF values of participants measured during their choice response task were compared with their simple response task, there was a significant difference with large effect size and moderate effect sizes for RT and RF respectively.

RT is known to be faster in simple than choice response task due to the complex nature of the later.\textsuperscript{163} Similar findings were observed in the present study wherein the RT of participants across groups was faster in a simple task as compared to the subsequent tasks. As compared to simple response task, the choice response task involved the process of discriminating stimuli and selecting the desired response. The additional component of RF thereby helps to understand how a choice response task will influence both the time and the force with which a response is produced. Choice response task requires more time as to divide attention between different
stimuli, differentiate between the stimuli and generate the desired correct response for the presented stimuli. Simple response task has only one stimulus and one response; no time is required for differentiating between the stimuli and selecting the response, thereby not allowing the response to be preplanned, resulting in lesser time requirement and faster RT.

The experiment gives us insight into the choice response abilities of participants. The choice response abilities in terms of RT and RF was similar and comparable across IDD and DS groups. The experiment found no difference in errors performed between groups. Choice response is usually measured just with respect to the time. The novelty of this study is that the influence of choice response task was assessed on both time and force.

5.4 SUBGROUP ANALYSIS

The analysis showed that there was an influence of the participant group and the task performed on the response abilities of participants which were significant for both the RT and RF. Pairwise comparison between the groups showed a significant difference in RT and RF when the TDC group was compared to IDD or DS but not when IDD and DS were compared with each other. For RT, the mean values of TDC group was the least, and that of the DS group was the longest, implying that the DS group was slowest to perform the RT task. It can also be observed that the mean RF of the TDC group was greatest and that of the DS group was least, implying that the DS group used the least amount of force to perform tasks. The findings of the slower RT and lesser RF among DS as compared to other groups supplements previous literature.21,29,13
For the tasks, there was a significant difference in the RT and RF abilities only between the simple response task and force modulation task and between the passive dual-task and force modulation task. There was no statistically significant difference between any other task conditions either for RT or RF. The difference in response abilities of force modulation task from both simple response task and passive dual-task implies that the passive dual-task and the simple response task did not differ much from each other. It can further be inferred that the element of dual-task interference was not sufficient to produce a difference in response among groups of participants for the passive dual-task.

The analysis of a random sample of participants across groups who could perform all tasks adds a new dimension and understanding about the response abilities of participants. Across all groups, RT increased and RF reduced as the tasks progressed from simple to complex tasks (figure 14). Across tasks, the RT and RF of the TDC group varied significantly from the DS and IDD group. The DS and IDD group, however, performed consistently across tasks with their response abilities being comparable. The comparable ability of the IDD and DS groups across task settings adds insight to our understanding of response abilities of these participants across task conditions.

5.5 GENERAL DISCUSSION

Previous research has assessed RT and RF individually and across one or two experimental settings. Studies have shown variation in RT and RF in individuals with DS as compared to their typically developing peers. However, how these parameters varied when assessed by clubbing RT and RF together, across more
than one group of participants and studied across multiple experimental and task settings, provides us a better understanding of their response abilities. The study gives us insight towards the perceptual motor competencies across multiple task settings among children with IDD, DS, and TDC.

Overall the findings of the present study confirm the RT deficits and provide insight towards the RF deficits in DS and IDD as compared to TDC. It was seen that as the complexity of the task was increased across experiments, the information processing became more complex, thereby leading to increase in time required to perform the tasks (figure 13). As the time taken to perform the task increased, the force with which the task was performed decreased (figure 13). It was also seen that as the complexity of the task was increased, the participation across the groups reduced (table 1). This factor elucidates how the cognitive motor deficits in individuals with DS and IDD influences their participation. Although the response abilities of DS and IDD varied significantly from TDC across task settings, they were comparable with each other and did not vary significantly from each other across all tasks. The task constructs thereby had a similar change in response abilities for both these groups. The similarities in response abilities of IDD and DS supplements the influence of their perceptual motor abilities during task performance and not solely their inherent muscle dysfunctions as has been commonly implicated. The extremity used did not influence the RT or RF measures irrespective of the task or experiment under concern.

Across all the experiments, the TDC group consistently increased the time with which they responded to each experimental condition (figure 13). A similar trend was not observed among children with IDD or DS, which could essentially be due to lesser
number of participants in IDD and DS groups across experiments. The increase in time required to perform tasks reflects the increase in processing time with the increasing cognitive demands of the tasks. The lesser participation as the task complexity increased despite familiarity with the apparatus and the experimental settings, suggests difficulty in learning new strategies thereby reflecting the difficulties in motor learning and poor adaptability to different task conditions among children with both IDD and DS. The greater time taken to perform tasks based on the increasing demands of the task given brings to light the difficulties that individuals with both DS and IDD face as they perform their daily skills and therefore has implications towards performance of their daily activities.

5.6 STRENGTHS OF THE STUDY

The study is one of the first attempts at understanding the response abilities of children across groups and various experimental conditions. For the results to have greater external validity, the study was carried out in the free-living environment in suburban school-based settings thereby emphasizing the feasibility of performing similar studies. The apparatus used served as a simple and inexpensive tool for measuring RT and RF in community settings. Since the instrument helped us assess both the RT and RF with the same apparatus, it eliminated the need to have multiple tools or devices that would assess RT and RF separately. None of the experiments reported any adverse events. The study elucidates how RF can be incorporated with other assessments and is acceptable and feasible to be measured in community settings, as opposed to being restricted to measurements in controlled environments. Since the study provides first data with regard to the RT and RF across multiple groups
of children with and without disabilities, the cross-sectional nature of the study is warranted and will help form a basis for future large-scale studies. Future longitudinal studies would help us understand the causal effect of RT and RF on a multitude of parameters.

5.7 LIMITATIONS OF THE STUDY

The study participants were not matched for age or any other variables as all participants with ID and DS across numerous schools within the region where the study was conducted, who met the inclusion criteria were included in the study. As the number of participants were limited, matching for variables was beyond the scope and the objective of the present study. However, as far as possible the TDC group was recruited in such a way that there was more than one child of either gender for every age distributed across the specified age range. The cross-sectional nature of the present study limited our ability to assess and understand how RT and RF change across time. Similar studies in future can analyze the data using the developmental trajectories approach, which will help assess the change in RT and RF over time.\(^{164}\)

Various factors could have contributed as confounders to these experiments. One being the use of the same stimulus and expecting the same response across experimental settings. There is a possibility that learning may have occurred in the earlier experiments which could result in an overlap of response from one experiment to the other. The color of the stimulus, i.e. red and green lights, could have been a possible confounder for experiments 3 and 4. Despite measures taken (i.e., each experiment performed on a separate day, demonstrations, practice sessions) to minimize potential confounders, there is a possibility that the stimulus and the
modifications of the protocol may have influenced the participant’s response and the subsequent results.

5.8 **IMPLICATIONS**

This study lays the foundation from which further experimental work can be carried forward to understand the response abilities of children with perceptual-motor deficits. In addition to understanding the complexities of RT and RF, the study allows us to explore prospects of developing strategies to train these aspects in children with IDD and DS. Training of RT may have significance in the light of literature suggesting increased risk for all-cause mortality among young and healthy older adults.\(^{47,48}\) Studies among children with IDD and DS have shown that RT improves with training.\(^{52-54}\) However, it is unclear if RF can be trained and if so, what further benefit will this provide to children with IDD and DS. Strategies which can help improve the execution of motor tasks among children who have motor control deficits can aid in the efficiency of performing movements. The influence of these strategies on RT and RF can help us understand whether these aspects respond to training, whether these training effects can be sustained and whether these benefits translate into the everyday life of children with IDD and DS.

To conclude, the findings of the present study suggests that RT and RF abilities of children vary across the groups and with the complexity of tasks performed. Even though differences in RT and RF in various task conditions among children with IDD and DS when compared to TDC exist, not much difference was seen between the response abilities of children with IDD and DS.