Chapter 6

Discussion
DISCUSSION

The major objective of the study is to measure and prepare a profile of executive function (EF) of the persons with autism (ASD) and intellectually impaired (II) along with the effect of training on that EF for both the group with their respective comparisons. The variables chosen for training of executive functioning includes mental set shifting and working memory. The standardized test used for the measure of executive function is Tower of London (TOL), Trail Making Test; Part B (TMT; Battery, 1944) and Block span test (BST) (from Neuropsychological Battery of children, NIMHANS). TMT (Part B) is used as a measure of set shifting tasks and BST is used as the measure of Working memory while TOL is taken as a composite measure of EF. The TOL task requires the integrated functioning of multiple cognitive operations, including complex reasoning, planning, working memory, flexibility, fluid intelligence and inhibitory control. (Unterrainer et.al., 2004; Miyake et.al., 2000; Bugg et.al., 2006). The individual components of executive function considered in the present study (e.g., working memory, set shifting) do not have much individual explanatory power for evaluation of executive functioning holistically as a construct but considered as major components of EF. So, the training is scheduled on these two major components of EF by a battery of tools. The purpose was to see the transfer effect of these two components on the composite EF as measured by TOL as well as TMT and BST.

This study included 15 individuals with autism and 15 individuals with intellectual impairment. The two groups have been matched by IQ (Color Progressive Matrices) and Age.
Illustration of the empirical results

**TOL profile of the two groups**

The present study reveals that the two groups can successfully complete the task of TOL though, for some components of EF, the scores of both the persons with Autism and Intellectually Impaired are far below the norm. These discrepancies can be attributed to the ‘time’ and ‘rule’ the two major components of test rules by which the scores and the norms of the test is bound to a considerable extent. But it can be accepted without doubt that the successful completion of the tasks itself signifies that both the groups have the ability of problem solving and a number of other executive functions related to TOL such as set shifting, fluid intelligence and working memory (Unterrainer et al., 2004; Miyake et al., 2000; Bugg et al., 2006).

‘Time’ and ‘Rule’ associates with the concept of socialization; here, socialization is supposed to contribute the concept of good /bad score, i.e., the ‘time’ here is score oriented but not the problem solving capacity. Both groups, particularly ASD groups, are subject to impairment in socialization – the ability which leads a person to collect better score. This impaired factor kept them unaware about the time and move concept – the essential rules and regulations of TOL which may, by rule, lowered their scores. But their ability as executive planners cannot be denied as evident from their successful completion of the problems.

Interestingly, in case of ‘Initiation Time’ of EF, scores of 5 persons with autism out of 15 (32, 31, 28, 32, 30) reveal more or less equal to their respective norms (30, 30, 30, 30, 32) whereas the obtained scores of only two persons with intellectual impairment are more or less equal to their respective norms(Graph II). Theoretically, slower initiation times are usually associated
with a more mature and thoughtful preparation to a problem. Performance of the 7 individuals (5 with autism and 2 with intellectual impairment) whose Initiation time is mostly equal to the norm can be interpreted as their mature and controlled response to the problems. Moreover, the average initiation time of more number of persons with ASD (N=5) in comparison to that of their II counterpart (N=2) is the evidence of maturity and thoughtful preparation of persons with ASD in comparison to their II counterpart though no statistical comparison was used. But, overall the obtained score of initiation time of most of the participants in the two groups are much more rapid which indicates a less mature and less thoughtful preparation.

The total problem solving time and execution time in TOL of both the groups exceeded the existing norm which reveals a negative connotation in respect to the available TOL norm (Graph I & III). Increased Problem solving time can be attributed for the low social demand of praise or punishment for the individuals with autism and intellectual impairment. This also justifies the increased time violation scores. Due to rapid initiation time which is considered as immaturity as rapidity hinders thoughtful cognition in general, the time violation scores are also increased. It can be said that in case of both neurodevelopmental disorder, particularly for II thoughtful cognition cannot be expected. Even in case of autism where much cognition is expected, the silent or abstract thinking is not applicable, whereas longer initiation time signifies the silent thinking (Graph IV). Similarly above notion can be attributed to the obtained score of Rule violation far exceeded the existing norm for both the groups (Graph V).

To interpret the above result for the persons with ASD, it can be said that, it is difficult for individuals with autism to understand and abide by the social or environmental rules and restrictions since impairment in socialization is one of the core symptoms in autism. The time factor in the test is environmentally demanded and the rules pertaining to the test are external for
the individuals with autism. So, ‘The executive planning of the persons with autism is time consuming – this resolution can be justified in this manner that – completion of a given task within time is a social demand which has too little meaning to them to motivate for quick completion of any task which is also indirectly supported by many researchers (e.g., Culbertson & Zillmer 2005 and others).

To comprehend and complete the test within time is very difficult for the group of intellectually challenged. It is also difficult for them to overcome the constraints i.e. the rules in the test and govern executive planning. Overall their slow cognitive processing and cautious approach to problem solving can also be attributed to their poor performance. (Culbertson & Zillmer 2005). Probably this is why their obtained scores of Time and Rule violation exceeded the norm.

The most interesting finding from the TOL measures is that Move score of 7 out of 15 participants with autism mostly equal to the norm and 3 out of 15 individuals with autism took less moves than the norm to complete the test (Graph VII). Total move score in TOL measures the quality of executive planning and supportive cognitive components of attention allocation, response inhibition, working memory and flexibility. (Culbertson & Zillmer 2005). So, those individuals completing the test with minimum moves. 4 out of 15 participants with intellectually challenged also exhibited such quality of executive functions, though not at par with autism. Move scores of some of these persons are also near to their respective age norms.

In case of autism, their obsessive quality may be positively contributed to their quality of EF skills.

Though ‘obsession’ deluges the individuals with autism into the gloomy world but here this obsessive quality of autism along with their cognition may act as very good mediator. The
quality obsession along with good cognitive function helps the person with autism to solve the general problems (visual puzzle, maze etc.) adequately and not let them to give up the problem until completed. So, no matter initiation time is more rapid or less they can qualitatively and minutely solve the problem.

From this result, the present study can recommend the individuals with a autism a proper executive function task for their self advocacy with sufficient cognition but less bounded by the rules.

Focusing on the correct score which signifies the number of test problems solved in the minimum number of moves, it is evident that 1 out of 15 individuals with autism is nearly equal to the norm of total correct score. One of them obtained correct score even better than the norm. 2 out of 15 individuals with intellectual impairment scored mostly equal to the norm of Total correct score (Graph VI).

In comparing the TOL measure of the two groups statistically, difference is found in Execution time, Problem solving time and correct score between the two groups (Table D). To illustrate, the participants with autism took less time both in Execution of the task and Problem solving time of the task in comparison to their intellectual impaired counterpart. The intellectually challenged group took more time in execution and problem solving because of their restricted cognitive ability and less goal-directed problem solving strategies. (Culbertson & Zillmer 2005). The participants in intellectually challenged group obtained low correct score in comparison to their ASD counterpart. This signifies that the autism group solved the test problems in minimum number of moves in comparison to that of their intellectually impaired counterpart. A low correct score suggests compromised working memory (Culbertson & Zillmer 2005). So, it can be
derived that the individuals with intellectual impairment have limited cognitive resources, particularly, ‘Working memory’ for which may one of the causes of low total correct score as supported by Yeo, Hill, Campbell, Vigil & Brooks (2000) and others.

**TMT and Block Span result illustration**

Considering the test of TMT; (Part B) which measures set shifting ability the participants of both the group members was slower to complete the specified task (Letter-Number Switching task) (Table C a; Graph A). In theory, an individual with a relatively steady set shifting skill, should find the task manageable and be able to accomplish within a relatively brief time, whereas, an individual having trouble in such skill will find tracing and shifting between stimulus items more difficult (Lloyd, 2010). However, in the present study the participants of both the groups completed the test within the optimum time allotted for completion of the test though their completion time have exceeded the average time in the norm and showed detained capacity in set shifting task. Statistically there is no difference in the ability of set shifting task in both the groups (Table D). So, it can be said that from TMT result that both the groups of autism and intellectually challenged have deferred capability in set shifting without any difference between them.

In Block Span test, the most of the participants of both the groups scored below the cut off score in the norm as they performed poor in tapping task (tapping in correct sequence on the blocks) (Table C b; Graph B). Here also, statistically there is no difference (Table D) in the ability of visuospatial working memory in both the groups i.e. both the groups have deficits in working memory skill.
Training and transfer of EF

The next step of the present research work is the training of EF to the persons with Autism and Intellectual Impairment. There are series of training sessions of the two components of executive functions i.e. set shifting and working memory. The intervention of set shifting ability includes training by mazes and color shape sorter. The intervention of working memory includes training by object span and picture span. After rigorous training sessions, the ASD group showed significant improvement, i.e., transfer effect in the TOL measures viz in Move score, Initiation time, Execution time, Problem solving time and Rule violation(Table E a). But no difference is found between pre and post measures of set shifting task in TMT (Part B) and working memory in Block Span test itself in autism group(Table E a). So, it can be said that, there is no remarkable improvement for person with ASD in mental flexibility and working memory even after intervention. Impairment in switching from one learned rule to a new rule in response to changing behavioral contingencies is a very common feature of autism (Corbett et. al., 2009; Geurts et. al., 2009; Kaland et. al., 2008; Ozonoff 1995; Ozonoff et. al., 2004; Pellicano 2010; South et. al., 2007; Yerys et. al., 2009) which can be attributed for this failure. So, even after 15 (approx.) training sessions, probably the shifting tasks from one learned way of response to the unknown and new alternative response is difficult for them. So, it can be said that more rigorous and intensive training should be suggested to address this skill.

The intervening sessions of set shifting and working memory also showed a transfer effect (significant difference) on executive functioning of the intellectually impaired group. This group showed a remarkable improvement (pre-post measures) in all the measures of TOL (Table E b).The set shifting tasks (TMT; Part B) is also improved (pre-post measure) in intellectually impaired group after the training sessions (Table E b). So training can improve the set shifting
ability of intellectually impaired individuals. No improvement is found in working memory task in Block Span test.

The two groups have improved executive measures after the training sessions. The most important finding in the study is that the two groups’ obtainment or procurement from the training has no significant difference (Table F); this is evident from the Ipsative values of two groups. That means the progress of their executive functioning after the intervention in autism group does not differ with the progress in intellectual impaired group after the same intervention (no statistical significance in U test of Ipsative values).

**Executive Functioning Profile in autism and intellectual impairment**

The above illustration of the TOL,TMT and block span test performance of both the groups in comparison with each other, pre-post measurements and improvement in EF followed by training, suggests a well-established profile of EF in autism and intellectual impairment.

TOL being a very complicated test can be fully administered to them and they are performers in the given complex and composite task (in spite of going beyond the norms provided) leading to the notion that EF is not fully impaired in autism and intellectual impairment rather the EF constraint that came to the surface in the present study is actually delayed not really in the form of deficit. This is probably because as mentioned earlier that they cannot readily respond to external environmental demands and adhere to time and rule in the given test. The intensive research study with TOL suggests, that problem solving ability, when measured by one’s performance on the TOL, may be directly influenced by several factors such as planning time or
Initiation time (Kaller et al., 2008; Luciana et al., 2009; Asato et al., 2006; Unterrainer et al., 2004), processing speed (Asato et al., 2006), working memory (Miyake et al., 2000), mental set shifting (Bugg et al., 2006) fluid intelligence, (Unterrainer et al., 2004) and various combinations of these variables. In the present study, planning time or the initiation time yielded mixed result where autism group are near norm and intellectual impaired group took a rapid planning time. Though researches suggest that initiation time has a strong relation with problem solving time (Unterrainer et al., 2004; Asato et al., 2006) Philips et al., (1999) found no differences in performance between participants who were directed to plan their moves versus those who were not given directions to plan ahead. This suggests that planning time doesn’t necessarily predict TOL problem solving performance. Rather the Initiation time in TOL indicates the quality of performance. So it can be derived that the quality of problem solving strategy in BII and autism is mostly important rather than abiding by the test bound quantity of completion time. The quality of problem solving strategy is also evident in the TOL performance of both the groups yielding minimum move score. In other words, better performance on the shifting task was related to fewer excess moves on the TOL task (which demonstrates better performance) (Bugg et al., 2006). In evaluating the set shifting ability of the two groups by TMT there the capacity of set shifting task is deferred. The inability in mental set shifting task or the cognitive inflexibility in autism underlies the core autism symptomatology of restricted and repetitive behavior (Lopez, Lincoln, Ozonoff & Lai 2005; Miller et al., 2015; Guasch et al., 2013; Corbett et al., 2009; Geurts et al., 2009; Kaland et al., 2008; Ozonoff 1995; Ozonoff et al., 2004; Pellicano 2010; South et al., 2007; Yerys et al., 2009).

Research on the effect size of working memory on problem solving performance showed evidences ranging anywhere from no effect to moderate effect (Asato et al., 2006; Koppenol-
Gonzalez et al., 2010) to large effect (Luciana et al., 2009; Unterrainer et al., 2004; Welsh et al., 1999). The TOL being itself a visuo-spatial task requires the constant update of working memory in order to sustain necessary elements of the plan while leaving information behind that is no longer relevant in order to solve further. In the present study along with TOL, block span test is administered to both the groups to evaluate visuospatial working memory where working memory skills of both the groups were in shortfall. And also training cannot improve the working capacity in both the groups. So the shortfall in block span test especially in BII indicates that they have reduced working memory capacity. Reduced working memory capacity is also evident in their performance of TOL yielding low correct score (low correct score indicative of restricted working memory capacity as mentioned earlier). Thus, it can be derived that, the inability to use complex problem solving strategies is because of restricted working memory capacity and deficient inhibitory control in intellectual disability (Numminen, Lehto & Ruoppila, 2001).

Thus, the EF profile of autism and intellectual impairment goes this way:

- All the components of executive functions skills are not impaired in persons with ASD; it is tedious and delayed as they cannot promptly respond to the social demand and motivate themselves accordingly.
- The cognitive flexibility is directly related to the autism core symptomatology.
- The quality of their problem solving ability is more appreciable than the quantity of the task.
- The executive challenges for the intellectually impaired group is difficult since their cognitive process is detained but they can overcome the restrain.
✓ Restricted working memory capacity hinders the effective problem solving strategies in borderline intellectual functioning group.

✓ Executive function is trainable to some extent in regards to autism and intellectually tender individuals and further the transfer of training is also evident from the present study.

✓ The ability of the persons with intellectually impaired in set shifting and some components of executive functioning is appreciable.

✓ If the shortfalls are properly manipulated or treated and the EF abilities of two groups can be trained and used properly, it may contribute in their life as well as to the society a great deal instead of pushing them to a negative world.

Case study illustration in the light of manifestation of executive function skills

In dealing with autism population and low intellectual functioning group, generalizability of the findings are difficult because every participant is unique and case specific. Their upbringing, other intervention procedure, parental guidance, environmental exposure and many other factors cannot be overruled. Autism mind is a difficult purview to explore. Though we try to generalize the facts empirically found, the spectacularity and individuality of their mind and mental processes are really difficult to chalk out in a single string. Mere shuffling the data obtained in formal setting and interpreting those quantitatively restricts the research in unique exploration unless the quantitative findings are supplemented by the qualitative findings.

Also, EF is not separable from daily life activities and gradually develops with the developmental years, as mentioned earlier. In daily life activities, executive functions underlie a
large number of life skills and behaviors. Starting from as simple abilities as, following one step instruction, following rules, remembering simple rules, seeking alternative method to retrieve an object, till as complex abilities as, following multiple instructions, abiding to situational appropriate rules, remembering strategies and ability to construct a plan, is the range of executive functions. Children uses executive function skills to complete tasks that involve following two or more rules showing that they can alter their attention to make deliberate choices (cognitive flexibility), hold rules mentally as they figure things out (working memory) the strategy to complete the task (planning). The interrelated executive function skill examples by Best & Miller (2010); Diamond (1991a, 1991b, 2002, 2006) and developmental tasks requiring executive skills listed by Dawson, Peg and Guare (2010) shows how children develops and experiences executive function skills in the progressive developmental years. They develops ability: to remember that unseen objects are still there, to seek alternate methods to retrieve objects beyond directly reaching for what’s in view, to execute simple means-to-ends tasks and two-step plans, to seek alternate methods to retrieve objects, to hold in mind two rules and act on the basis of the rules, to shift actions according to changing rules, to run simple errands, to tidy a room, to perform self-help tasks with reminders, to inhibit behaviors. These are the knits and bits of behaviors that display executive functioning skills which cannot be measured in formal or clinical setting. Behavioral observation, parental report and case study analysis can provide anecdotal records supporting the presence of EF skills in them.

For this purpose, this section portrays a few relevant and ineluctable behaviors of some of the participants. Mostly the behavioral observation of the researcher during sessions, in some cases informal setting also when the session is not conducted and parental or special educators’ reports are the chief source of such anecdotal records in the present study.
**CASE STUDY ANALYSIS**

<table>
<thead>
<tr>
<th>CASE REFERENCE (Sl. No. of participants)</th>
<th>DEMOGRAPHIC DETAILS AND AREA OF INTEREST</th>
<th>BEHAVIOURS AND ACCOMPLISHMENTS</th>
<th>RELATED EXECUTIVE FUNCTION SKILLS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participant 3</td>
<td>Age: 8 years</td>
<td>Performs simple chores like</td>
<td>Working memory and Planning</td>
</tr>
<tr>
<td></td>
<td>Gender : Female</td>
<td>fetching a bottle of water and</td>
<td></td>
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<tr>
<td></td>
<td>Diagnosed: Autism</td>
<td>self-help tasks with reminders</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IQ: 80</td>
<td>like, fixing trouser, combing</td>
<td></td>
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<tr>
<td></td>
<td>Receives intervention in special school</td>
<td>hair (though messily) etc.</td>
<td></td>
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<tr>
<td></td>
<td>loves colors</td>
<td></td>
<td></td>
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<tr>
<td>Participant 5</td>
<td>Age : 7 years</td>
<td>Remembers where something</td>
<td>Working memory</td>
</tr>
<tr>
<td></td>
<td>Gender: Male</td>
<td>was hidden, then again</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Diagnosed: BII</td>
<td>exploring it.(e.g., a game of</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Receives intervention in special school</td>
<td>hiding an object under one of</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>three cups),</td>
<td></td>
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<tr>
<td>Participant 14</td>
<td>Age : 14years</td>
<td>Can adhere to changing rules</td>
<td>Cognitive flexibility</td>
</tr>
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<td></td>
<td>Gender: Female</td>
<td>e.g., can takeoff shoes at home</td>
<td></td>
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<tr>
<td></td>
<td>Diagnosed: BII</td>
<td>after returning from outside,</td>
<td></td>
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<tr>
<td></td>
<td>Receives intervention in special school</td>
<td>keeping the bag in different</td>
<td></td>
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<td></td>
<td></td>
<td>shifted place etc.</td>
<td></td>
</tr>
<tr>
<td>Participant 7</td>
<td>Age : 9years</td>
<td>Can comprehends the similarity</td>
<td>Working memory</td>
</tr>
<tr>
<td></td>
<td>Gender: Male</td>
<td>between objects e.g. apple and</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Diagnosed: Autism</td>
<td>banana are the fruits and to be</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Receives intervention in special school</td>
<td>kept together separated from</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>vegetables</td>
<td></td>
</tr>
</tbody>
</table>
| Participant 9 | Age : 11 years  
Gender: Male  
Diagnosed: Autism  
Receives intervention in special school | Can hold in mind two rules like the clothes goes in wardrobe and the book goes in self and act on the basis of the rules. | Set shifting |
| --- | --- | --- | --- |
| Participant 4 | Age : 8 years  
Gender: male  
Diagnosed: Autism  
Receives intervention in special school | Can seek alternate way to retrieve objects like reaches for the ball when the direct way to the ball is obstructed  
• Can execute simple means-to-ends tasks and two-step plans like assembling the different parts of broken toy.  
• learns to put two actions together in a sequence (removing the dumped cloth and grasping remote control of the TV) | Planning, Working memory and Sequencing |
| Participant 13 | Age : 11 years  
Gender: Male  
Diagnosed: BII  
Receives intervention in special school | Successfully adapts to changing rules, even when multiple dimensional activities are there like to stop working when break bell is run, to shift from one room to other for vocational therapy in school etc. | Cognitive flexibility |
| Participant 26 | Age: 16 years  
Gender: Female  
Diagnosed: Autism  
Receives intervention in special school | • Takes food order in canteen of special school, remembers the food items and expresses those accurately.  
• Inhibits range of behaviors like wait for turns, keeps hands to self-etc. | Working memory and Response inhibition |
| Participant 27 | Age: 19 years  
Gender: Male  
Diagnosed: Autism  
Receives intervention in special school | Can exhibit situationally appropriate responses like resists from grabbing food from other’s plate. | Response inhibition |
| Participant 30 | Age: 20 years  
Gender: Male  
Diagnosed: Autism  
Receives intervention in special school | Capable of making action plan in accordance to changing environment. | Set shifting and planning |
| Participant 26 | Age: 18 years  
Gender: Male  
Diagnosed: BII  
Receives intervention in special school | Can remember more than one task and rules at a time. | Working memory |
| Participant 15 | Age: 14 years  
Gender: Male  
Diagnosed: Autism  
Receives intervention in special school | • Can differentiate, like can keep aside the different biscuits in different jars.  
• Unwrapping the | Sorting and shifting, Planning and Working memory |
| Participant 12 | Age: 12 years  
Gender: Male  
Diagnosed: Autism  
Received intervention in special school | chocolate and throwing away the wrap in the bin  
- keeping the book in the bookshelf and the toy in the toy table | Planning, Attention and set shifting |
|----------------|-------------------------------------------------|--------------------------------------------------------------------------------|----------------------------------|
| Participant 16 | Age: 15 years  
Gender: Female  
Diagnosed: BII  
Received intervention in special school |  
- Can execute means to ends tasks like building the ring from smaller to bigger in pegs.  
- Prompt in closing the pop ups by moving the laptop cursor while watching video in youtube.  
- Fetching the shoe from the shoe rack to reach grandmother for her assistance to wear it. | Working memory |
|----------------|-------------------------------------------------|--------------------------------------------------------------------------------|----------------------------------|
From the above case studies it is evident that the daily activities they exhibited required executive function skills and in many cases the skills are more or less age appropriate when the skills they displayed are compared with the normal age appropriate skills (Shonkoff et.al.,2011). This is an important finding that ascertains that EF develops gradually and continues till adolescents. (Best & Miller 2010 Diamond 1991a, 1991b, 2002, 2006). Also the fact that the executive behavior they accomplished mostly requires synchronization of cognitive abilities and multiple executive function skills with the working memory capacity being the prime function in most of the cases. So, though in the present study working memory capacity cannot be improved in both autism and BII it cannot be affirmed that they have an impaired working memory; rather there might be some other factors that can be attributed to the failure of working memory training.

Thus the most important resolution of the present research breaks the myth that ‘Executive Functioning cannot be measured or cannot exist at all in the persons with autism and Intellectual Impairment’.