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Understanding Perceptual Illusion in Children with Special Needs: A Comparison

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ABSTRACT

Purposes: *The study aimed to investigate perceptual distortion of visual illusion in children with special needs and mainstream school children.*

Method and Material: *A sample of N=54 (17 Down Syndrome, 10 Slow Learner and 27 Mainstream Children) with the age range of 6-14 years (Mage =10, SD = .49) were participated in the present study. Data was obtained from different special education and mainstream schools of Jhelum and Sara-I-Alamgir. Quasi experimental research design was used, and purposive sampling strategy was implemented. Poggendorff illusion experiment (1) was used for measuring visual illusion.*

Results: *There were significant mean age differences on reaction time 1 but non-significant gender differences. Outcome further revealed that there were significant difference in reaction time 3 in mainstream school children and children with special needs.*

Conclusion: *It was concluded that Down syndrome and slow learner were more perceptually distorted on visual illusion then mainstream children.*

Introduction

Human perception and sensorial system depends on 5 senses which is stimulated by the flow of event. Perhaps, the most important component of human sensual system is vision (2). Human visual system has a mainstream to focus within an extensive area rather than focus on one point, for this reason visual system is known as parallelism volume. When large amounts of stimuli from the environment are perceived by retina, the sensory system converts that information into electric signals. It is the primary processing area that provide the starting characteristic of environmental information about the shape, colour, and distance. Perception is a process of organization, identification and interpretation of information gather by visual system (3). However, loss of withdrawals from perceptual truth and reality caused perceptual illusion (4). Nonetheless, one of the most important perceptual illusions is visual illusion which is false adaptation to visual marvel. Visual illusions may be the unplanned side effects of mechanisms of specie's cognitive and

perceptual abilities and may thus involve psychological top-down estimation of different patterns, knowledge, and assumption of expected reality (5). Moreover, there are three different types of visual illusion cognitive, physical, and physiological. One of the examples of cognitive visual illusion is Poggendorff illusion and is defined as a phenomenon that human brain misperceives a diagonal line as being apparently misaligned once the diagonal line is interrupted by two parallel edges, in addition size of illusion is negatively correlated with the angle of interception of the oblique angle, i.e., the sharper the oblique angle, the larger the illusion. Furthermore, Poggendorff illusion can be produced by both real and illusory contour (6). There are different theories which explain this phenomenon, according to angular displacement theory during information processing human brain minimizes all the obtuse angle and exaggerate acute angles. Moreover, cells in the retina respond differently to different angles because neurons inhibit the brain activity of neighboring neurons during contour perception. Consequently, this inhibition made the two lines appeared to be on different trajectories. Furthermore, according to depth-processing theory a figure is perceived in a three-dimensional pattern rather than two dimensions i.e., a rectangle is perceived as a three-dimensional figure due to its appearance in front of the viewer while the diagonal lines perceived as two-dimensional because it appears far away from the viewer (7). Different studies indicated that children with special needs have problem in processing of information because they are unable to perceived and process gathered information and make use of appropriate way of problem solving (8) One of the most prevalent caused of intellectual disability (ID) is down syndrome (DS) occurring in 1 out of every 1000 live births (9). The main cause of Down syndrome is non-disjunction of chromosome 21 during cell-division (10). Children with Down syndrome are mostly identified by their facial features, they have rounded face, somewhat slanting uphill eyes, small mouth with flat top and bulged tongue (11). There are three categories of Down syndrome (Trisomy, translocation trisomy 21 and Mosaic DS) (12). The IQ level of individual with Down syndrome is range from mild to moderate level. Additionally, IQ level is continuously fall throughout their childhood and intellectual phenotype of is likely to develop during initial stages for visual processing (13). Children and adult with Down syndrome have visual search and consideration challenges and they have relative strength in visual processing (14). Individual with down syndromes have poor verbal processing skills but their visuo- spatial abilities are very strong (15). Furthermore, when children with Down syndrome treated with conventional techniques, they showed contrast sensitivity and limited visual acuity which cause sensory deficits especially optical (16). Besides, Slow learners are individuals with low achievement and comparably low IQ scores with mild, moderate and severe level (17). It is suggested by research that individuals with developmental disorder have more sensory abnormalities then normal individuals. They have poor perception of vision, hearing, and touch and had poor executive functioning and information processing (18). It was hypothesised that Down syndrome and slow learner will be more perceptually distorted on visual illusion then mainstream children.

Literature showed that children with special need are more susceptible to visual illusion then normal children. A study reported that performance of Down syndrome children is poor on visual illusion and on ambiguous figures tasks then performance of non-specific intellectual disabled children (19). Moreover, researcher used visual illusion such as Poggendorff illusion, Ponzo illusion, Herring and Muller lyre illusion to understand visual inconsistency in developmental dyslexia and autism spectrum disorders. It was revealed that risk of visual illusion high in neurodevelopment disorders (20). However, researcher further studied this phenomenon in children with developmental disorder and found that children with severe intellectual disability have discrepancy in visual perception (21). Perceptual distortion and visual dysfunction was studied by researcher in children with Autism spectrum results reveal that children show perceptual disabilities and visual hypersensitivity (22).

Environmental conditions are complicated and modifies over time. However, perceptual phenomenon helps human being to adjust to these changing environments, sometimes there are some errors in our perception. Brain processes visual information gathered by outer environment, but sometimes brain systematized information in different manner then it's true sense which triggered illusion (23). Moreover, hormonal imbalance especially deficiency of thyroxin and tri-iodothyronine inhibit brain functioning and caused visual illusion in children with special need (24). Present study is crucial because few research in the past have looked this concept on individual with intellectual disabilities (25) This study was intended to examine whether children with down syndrome and slow learner are susceptible to visual illusions and to compare their performance with mainstream school children with similar age and gender. This study provides profile of development among specific etiological groups of children with intellectual disabilities (ID) and is essential for all aspects of research and educational intervention in the field of children with special needs. Moreover, this study was intended to focus on perceptions of ambiguous figures and visual illusions in children with special needs and to find how children with intellectual disabilities (ID) face difficulties in understanding of cases in which they have to keep track of multiple representations, and perceptual rigidity than typically developing (TD) children (24). Furthermore, the area of visual illusion and perceptual distortion is not well documented in developing countries like Pakistan therefore, there is necessity to rule out this concept. In addition, finding of current study will help clinician and psychologist to make future research on visual illusion and perceptual distortion.

Materials and Method

Study Population

Cross sectional research design was implied, and purposive sampling was used in the present study. A sample of N=54 (17 Down syndrome, 10 slow learners and 27 mainstream) school children from special education and mainstreams schools of Jhelum and Sari-e- Alamgir. The age of the sample ranged 6-14 years (M_{age} =10, SD = .49). Down syndrome and slow learners were already assessed and diagnosis according to DSM 5 in the respective institutions. 27 comparison participants recruited from the local community were assigned to the control group. These children were age matched (6-14 years) counterpart of Down syndrome and slow learners.

Measures

Demographic sheet

Demographic characteristics of sample.

Variables	**Category**	***M***	***SD***	***F***	***%***
Gender					
	Boys			31	57%
	Girls			23	43%
Category					
	DS			17	31%
	SL			10	19%
	MS			27	50%
Age					
	6-10			31	57%
	11-14			23	43%
SES					

	Lower			5	9%
	Middle			48	89%
	Upper			1	2%
Age		10	0.49		

Note: SES =Socio Economic status, *M*= mean, *F*= frequency. DS=Down syndrome, SL=slow learner, and MS=mainstream school

Poggendorff Illusion

Data was collected from online Poggendorff illusion experiment (1). The experiment was discovered by Johann Poggendorff. Discovery of Poggendorff illusion was embedded with another type of illusion as Johann was editing a paper presenting about Zollner illusion when he discovers Poggendorff illusion. In Poggendorff illusion central line image i.e., line parallelism or length is appeared to be distorted by background lines or intersecting shapes. The main independent variable in this experiment is angle and position. We can set several angles and can see its effect on illusion. The experiment was presented on laptop screen. There are three different Bar width (Narrow, Medium and Broad width). Numbers of trail range from 1 to 100 set according to study. Fixation duration of experiment is 50- 1000 ms.

Procedure

Research was started after getting permission from advanced studies and research board. Permission letters to use research tasks were taken from respected author and organizations. Different special educational institutes were visited according to study. A letter of consent describing the research project was provided to the concerned authorities participants were approach after taking permission from school authorities. Informed consent was taken from parents and guardians of the children. Already diagnosed cases of down syndrome and slow learner from special education institutes were included in the study. The researcher established rapport with the children. Prior to experimental trial a practice trial was conducted so that participants could familiarized themselves to task. Participants were tested individually in a quiet room.

Results

The primary analysis of research suggested that mean age of research participants was 10 years. Sample characteristics were determined by calculating means, standard deviations, frequencies and percentages, and one-way ANOVA was calculated to check the mean difference of Reaction time 1 and Reaction time 3. Correlation design was used to measure the relationship between variables (Reaction time 1, Reaction time 3 and position1, position 3 and category). Independent sample t - test was used to measure mean difference between Reaction time 1 and Reaction time 3. Neural networks analysis assessed the prediction of the illusion and the demographic variables.

Table illustrates that Position 1 and 2 were significantly negatively correlated with Category (r=-.51, -.56, p=.01) and Position 1 is significantly positively correlated with Position 2 and Position 3 (r=.40, .35, p<.01) Moreover, Reaction time 2 and Reaction time 3 is significantly negatively correlated with Category (r=-.30, -.33, p<.05). Furthermore, there is significant negative relationship between Reaction time 1 and age (r=-.22, P<0.05).

Table 1: Correlation between position 1 and 3 reaction time 1 and 3 and Category (N=54)

Sr. no.	Variables	1	2	3	4	5	6	7	8	9
1	category	-	-.02	-.10	-.51**	-.56**	-.15	-.05	-.30*	-.33*
2	Gender		-	-.21	-.02	-.05	.09	-.03	-.05	.22*
3	Age			-	.02	.07	-.12	-.22*	-.05	-.06
4	P1				-	.40**	.35**	-.06	.28*	.13
5	P2					-	.24*	.08	.14	.00
6	P3						-	.07	.07	.09
7	RT1							-	.10	.13
8	RT2								-	.66**
9	RT3									-

Note. P1= Position 1, P2 = Position 2, P3 = Position 3, RT 1 = Reaction time 1, RT 2 = Reaction time 2, RT 3 = Reaction time 3.
**p<.01, *p<.05

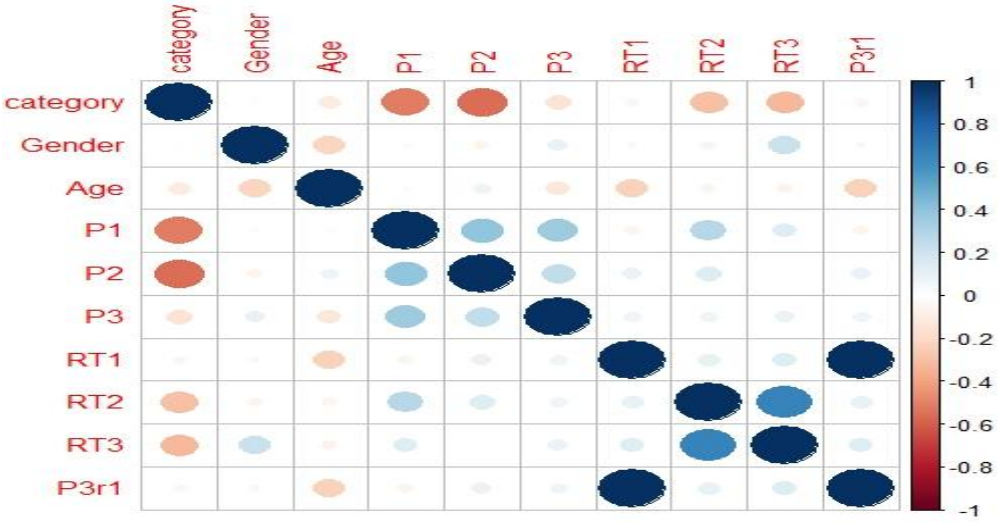

Figure 1: Correlation plot among different variables

Table 2: Mean difference of Down Syndrome and Slow Learners on Reaction Time 2 and Reaction time 3 on experiment (N=108)

	down syndrome		slow learners		Mainstream			
Variables	***M***	***SD***	***M***	***SD***	***M***	***SD***	***F***	***P***
RT 2	18717.04	9531.1	17885.43	8987.3	8678.78	28628.6	5.85	0.003
RT 3	11911.17	5468. 2	12857.41	7882.49	8306.85	2204	9.17	0.000

Note: **p< .05,* RT 2= REACTION TIME 2, RT 3= REACTION TIME 3, *M*= mean, *F*= frequency

Table of ANOVA illustrates mean difference on Reaction time 2 and Reaction time 3. There were significant mean differences in reaction time 2 F (2, 105) =5.851, P =0.003. and reaction time 3, F (2, 105) =9.178, P =0.000.

Table 3: Post hoc analysis of Down Syndrome and Slow learners on Reaction time 3.

					95% CI	
Variable	***i***	***j***	***S. E***	***P***	***LL***	***UL***
REACTION TIME 2	1	2	-831.57	.97	-10652.29	8989.15
		3	-9206.65	0.006	-17673.13	-2403.31
	2	3	-10038.22	0.05	-18472.08	-58.76
REACTION TIME 3	1	2	946.31	.76	-2264.831	4157.45
		3	-4550.56	0.002	-6100.684	-1107.81
	2	3	-3604.24	0.001	-7580.13	-1520.98

Note: CI =Confidence Interval, LL=Lower Limit, UL=Upper Limit

Table showed significant mean difference in performance of slow learners and normal children in Reaction time 2 and Reaction time 3

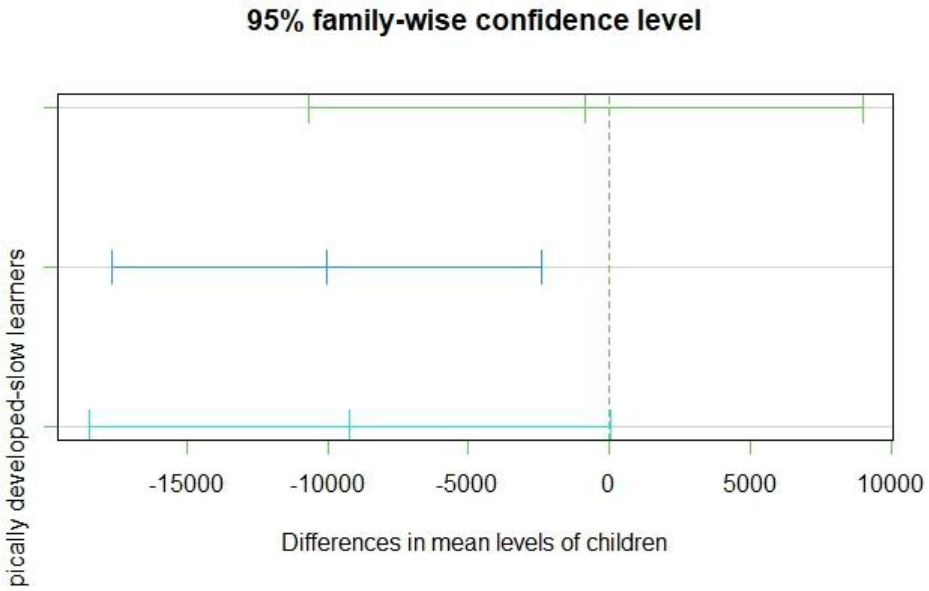

Figure 2: Post hoc analysis among Down syndrome, slow learners and typically developed children and Reaction time 2

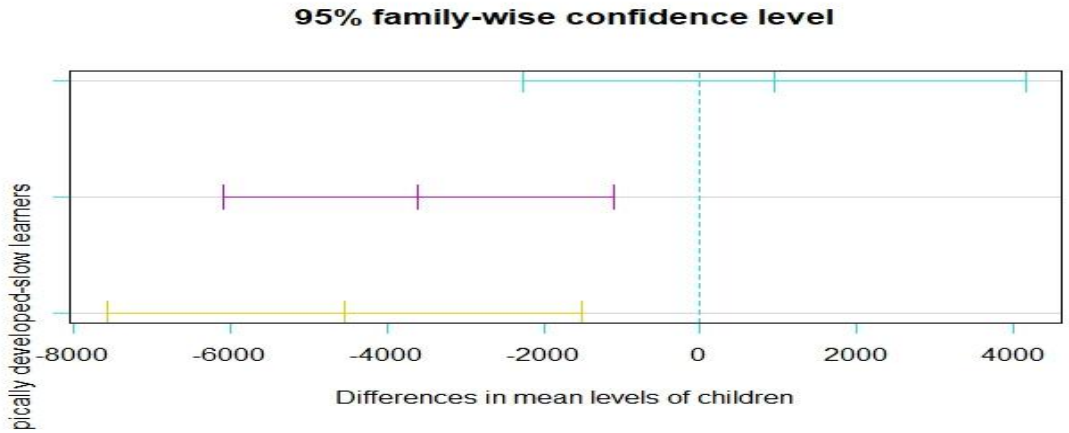

Figure 3: Post hoc analysis among Down syndrome, slow learners and typically developed children and Reaction time 3

Table 4: Mean age difference on reaction time 1 and reaction time 3 (N=54).

	Age								
	6-10 years		11-14 years				95% CI		
Variables	***M***	***SD***	***M***	***SD***	***t(52)***	***p***	***LL***	***UL***	***Cohen's d***
RT 1	1.83	27133.55	8.85	3617.2	0.10	0.04	-20061.00	20904.10	0.04
RT 3	1.06	5605.64	9.97	4759.9	0.65	0.97	-2258.20	3556.20	0.02

Note: RT 1=Reaction Time 1, RT 3= Reaction Time 3, CI= confidence interval

Table Indicates that there is significant mean age difference in reaction time 1 (t = 0.10, P= 0.04), but there was no mean difference on reaction time 3 (t=0.65, P=0.97).

Table 5:

	Sum of Squares Error		3.192
Training	Sum of Squares Error		3.192
	Average Overall Relative Error		0.089
relative error for scale dependent		RT 1	0.082
		RT 3	0.095
Training			00:00:00.047
Testing	Sum of Squares Error		0.611
Testing	Sum of Squares Error		0.611
	Average Overall Relative Error		1.529
Relative Error for Scale Dependents		RT1	4.473
		RT 3	0.285

The neural network has found a suitable pattern in the data for the training set. The model fit consistently with the relative error of the scale dependents RT1 error equal to 0.082 in training and 0.082 for testing for RT3 the error for training is 0.095 and for testing error is 0.285.

Table 5: Independent variable importance (n=54)

	Importance	**Normalized Importance**
Position 1	0.278	100.0%
Position 3	0.251	90.2%
Category	0.081	29.3%
Gender	0.031	11.3%
Age	0.061	21.8%
Birth Order	0.055	19.7%
Sibling	0.147	52.9%
Socio Economic Status	0.095	34.3%

Table shows how much the network's model predicted value changes for different values of the independent variable. Position 1 is predicted as the most suited variable in relation to RT1 and RT 3 equal to o.278 importance rate. Position 3 is the second main variable equal to 0.251importance

with 90.2%. Socioeconomic status is the 3rd key variable equal to 0.095 with 34.3%. Furthermore, Bonferroni correction was carried out to study significant differences in detail. Gender is listed with lower importance value .031 with 11.3% normalized importance.

Discussion

The study investigated perceptual distortion of visual illusion in children with special needs. Outcome showed consistency with previous researches. Results of prior studies indicated that intellectually disable children face difficulties when presented with different task and chances of perceptual distortion increases as compared to typically develop children when performed same tasks (26). Moreover, results showed inconsistency with previous studies as there is non-significant gender differences on RT1 and RT3. As mentioned in a study small size of sample develop large effect size. Due to large size effect, there is no gender difference show in vision experiments (27). Moreover, position (acute angles) displayed significant negative relationship with category (r=-.52, p<.001). Results revealed that acute angle poses more visual distortion. One of the most important reason for more distorted visual illusion and increased RT is that children were unable to perceive two-dimensional object in three dimensional ways (28). Moreover, result was inline with result of earlier study according to which Individuals with the special needs have deficit in Attention and perception. Furthermore, they have difficulty to initiate, direct, tolerate and shift their attention according to the specific situation which is the main cause of visual illusion (29). Individuals with special need have poor ability to recognize stimuli, perceived through vision, hearing and touch they have perceptual disorder. (30). Further, table of ANOVA described mean difference of Down syndrome and Slow Learners on Reaction Time 1 and Reaction time 3. Table further shows that there is significant mean difference between slow learners, Down syndrome and mainstream school children. Results of the study illustrated that performances of children with Down syndrome and slow learner were poor than the normal children (r=0.92, p<.001) and (r= 0.04> .05). One determination for the poor performance is inferior acute sight. It is supposed by professionals that children with special need would not respond to task when they feel that task was difficult (31). Moreover, slow learners have problem in gaining attention, their span of attention was very short which was the main cause of increased reaction time. Furthermore, hypotonia, joint hyper flexibility, and visual deficit were common in children with special need (24). Delays are often seen by individual, they responded slowly due to interruption in volume of myelinated white matter and due to reduction in the density of synopsis (32). Moreover, Results were consistent with previous study as it was suggested that that visual illusion increase with age. They propose that children at early age are lass influenced by visual process. They also identified that after 11 years' old's the extent of optical illusion is high and is consistent throughout their age (33).

Present study had some limitations. First it was an experimental study, but one important characteristic of the study was missing which was random assignment of the experiments. Time and resources are limited for data collection. Second, data was collected only from Jhelum and Sarai e Alamgir city so, results cannot be generalized. However, the selection of special educational institutions was good but the absence of a professional psychologist in the special canters created difficulty in selection of slow learners. Moreover, there was lack in the performance of slow learners and Down syndrome children due to lack of their exposure to laptop. Sometime the room given by the administration was not completely separated so children are distracted by noise, and it affect their result. There are several strengths of present study. The study was conducted on Down syndrome and slow learner, further studies should also be done on the autistic children and on other children with developmental disorder**.** The current study will be beneficial for the psychologist in understanding of visual illusion and perceptual distortion in

children with special needs in future. The finding of the study will help psychologist in the future to understand the psychological and neurological factor that caused illusion.

Disclosure statement

No potential conflict of interest.

Data availability statements

The data that support the findings of this study are available from the corresponding author, [chaman, A & Mufti, s], upon reasonable request.

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None

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