Chapter 4: Temporal Integration

It was argued in Section 1.4.2 argued that weak gestalt perception may result from reduced magno input at a cortical level into gestalt perception processes, rather than weak central coherence, as proposed by Frith (1989). The reduced magno input theory generated predictions for the Illusions and Launching experiments and, for the most part, the performances of the Autism group have been consistent with the predictions. An amendment to the theory was required to accommodate the performances of the AS group.

A more direct test of the reduced magno input theory, than the previous experiments, was also required. Hogben and Di Lollo (1974) developed a temporal integration procedure that may be sensitive to a shift in balance from sustained (parvo) to transient (magno) processing. The temporal integration procedure that was chosen is a variation from Walther-Muller (1995). This involves rapid, sequential presentation of two displays (see Figure 4.1) with each display featuring two separate arrays of dots in the right and left visual field respectively.

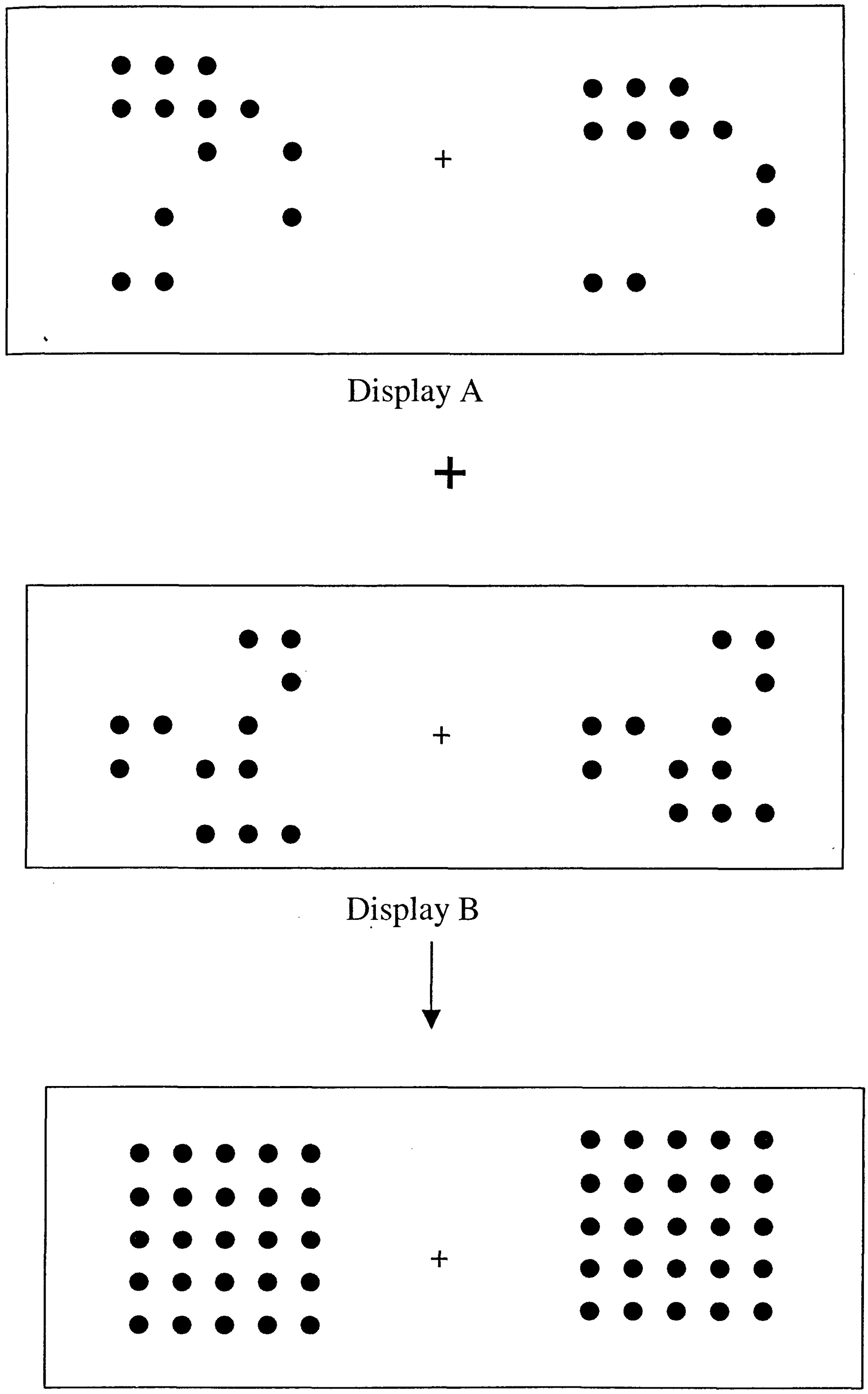

Figure 4.1: Temporal integration. If Display A and Display B are presented sequentially with rapid presentations with only low ISI between the presentations, they fuse together to form two stable matrices in the right and left fields.

Display A is briefly presented, followed by a variable inter stimulus interval (ISI), containing a blank display, followed by Display B display, also presented briefly. Across Displays A and B, the arrays of dots on the left are complementary in that, if fused together, they make a 5 x 5 dot matrix with all 25 positions filled. The same is true for the display in the right field. However, in each pairing of Displays A and B, in one of the visual fields, the fused matrix contains only 24 dots with the centre dot missing.

The task is to name the side where the centre dot is missing in each trial. This is quite easy when the matrices are perceived as fused but at some ISI between the two displays, the matrices are no longer perceived as fully stable and performance falls to chance. The current research used an up and down step procedure, which involves three trials at each ISI, to identify the ISI at which the participants have a 71% correct threshold in choosing the side of the missing dot (Walther-Muller, 1995).

There are three stages of perception with these displays as ISI is increased. At low ISI, the matrices are seen as if there was no ISI. At a higher ISI, apparent motions from the dots in the first display to the dots in the second display are perceived. At a still higher ISI, the two displays are seen in sequence without a perceived connection. It is assumed that, with low ISI, the local, parvo stream sustains the dots in the first display into the same position across the ISI, therefore allowing the fused matrices to be perceived. As ISI increases, the balance shifts towards the more global, magno stream and perception shifts towards linking; hence, apparent motion is perceived. At still higher ISI, the connection is no longer maintained and the displays are perceived independently. If the strength of the streams reflects integration between the streams at a cortical level, rather than simply the more discrete properties of the streams at a subcortical level, reduced magno processing could delay the shift to apparent motion, with a stable perception of the matrices at relatively high ISI allowing superior performance on the task. Therefore, it was predicted that the Autism/AS group would produce a higher 71% correct threshold than the NT group.

As noted in Section 1.3.2, there is evidence of neuropathology at an early, subcortical, level of the magno stream in a subgroup of people with developmental dyslexia (Galaburda and Livingstone, 1993) and deficits have been found in dyslexia groups on 'flicker' tasks, which are considered to be sensitive to low-level magno functioning (Lovegrove, 1996). However, there has not been a finding of superior performance in dyslexia groups on temporal integration tasks. For example, Walther-Muller (1995) found no difference between dyslexia and NT groups with the task that was used here.

One possible reason for this is that the tasks are sensitive to integration of the streams. This thesis has argued that the perception in autism appears to be consistent with reduced magno input into such integrative processes. Temporal integration may test the relative strength of the streams, rather than just the discrete properties of each stream in isolation, so it might be sensitive to abnormal magno processing at a higher level than what may occur in dyslexia. Also, the stages of perception seem to reflect proximity (a dot is seen in the same position across time) and linking by co-linearity (a dot in one position moving laterally to another dot) that seem to be important in the launching effect. As such, the task was selected to be the 'direct' test of the reduced magno input theory.

4.1 Method

Participants: The displays were presented in a tachistoscope. The viewing apparatus did not allow for glasses and seven of the original AS group wear glasses. Also, five AS participants had secondary conditions, such as epilepsy, which made the experiment unsuitable, while three other participants could not be contacted. As such, there was only one AS participant who was placed in an Autism/AS group. This was deemed appropriate as it was expected that this task may be sensitive to a common abnormality between the disorders.

As such, there was an Autism/AS group and a NT group, with all participants having taken part in the previous experiments. Table 4.1 presents some relevant results from the previous experiments for the participants in this experiment.

Table 4.1: Group details. Poggendorff and control display errors (in mm), pause threshold for launching 10cm/s (in ms) and pause thresholds for continuity (in ms), plus ranges (standard deviations in parentheses).

	Pogg	C-Pogg	Launch 10	Continuity
Autism n=7	2.40	.60	98	113
range	-1.2 – 6.5 (2.35)	-.94 – 1.9 (.94)	55 – 130 (34)	60 - 175
AS n=1	7.58	.82	175	175
NT n=15	5.40	1.19	129	157
range	3.3 – 8.6 (1.59)	-6 – 3.6 (1.34)	75 – 195 (28)	90 – 225 (46)

Apparatus: Displays were presented on a Gerbands tachistoscope, model number G1128 T-3A. This has three separate fields, allowing for the presentation of three sequential visual displays. The participants directed their eyes into the viewer, which occluded light from other sources. A 4W Sylvania tube provided lighting for each display, while the sequencing and timing of the displays were controlled with a Gerbands 300C series timer. The experimenter changed the displays manually and the participants initiated each trial by pressing a button.

Displays: Figure 4.1 provided an example of the spatial arrangement of one set of displays. The combined image of the A and B dot displays was two 5 x 5 matrices, one on each side of the screen, with a centre dot missing on one side. A plain white display was presented during the ISI. The distance between the dots was .25 of a degree, relative to position of the viewer, and the edge of the matrices were each one degree from the cross in the middle. Twenty pairs of dot displays were developed, with the spatial arrangements randomised by a computer program. The arrays in Displays A and B each contained 12 dots, except for the array with the extra centre dot.

Pilot testing with 5 participants suggested that accommodation (i.e. getting used to the rapid presentations) occurred most readily when the light controls for the dot displays were on full and the light control for the ISI display was on half. The presentation duration for the dot displays was 20ms, which is at a relatively long presentation time for the procedure. This was because two participants in the pilot test found it difficult to accommodate to10ms durations, without any ISI.

Procedure: Most sessions were conducted in the participant's home. The experimenter adjusted the lighting in the room to a semi-luminant state, which minimised interference of light from sources other than the tachistoscope. The first stage of the training procedure was to accommodate the participants to the rapid presentations. This started with the displays being presented together over long presentations (about 1s); therefore, the 'fused' matrices were perceived. The experimenter asked the participants what they were seeing and they all indicated that they saw the two matrices with the centre dot missing on one side. The presentation rate was gradually reduced without any ISI between the displays. This reduction was paced to individual needs with the experimenter asking if the matrices were perceived at the given presentation rate. This continued until the participant confidently saw the matrices at the experimental rate of 20ms per dot display. The training then switched to sequential presentation, without an ISI and no participant had any difficulty making that step. The accommodation procedure varied from approximately 10 minutes to 20 minutes.

The up and down step procedure requires the experiment to start at near threshold for perceiving the fused displays (Walther-Muller, 1995). Therefore, the next stage was to establish the near threshold point. An ISI of 10ms was introduced been the two dot displays and adjusted upwards by 10ms per trial until the participant reported that they no longer saw stable matrices. The near threshold point was the last ISI at which the participant reported seeing stable matrices.

The experimenter then explained that the task was to name the side where the centre dot was missing in each trial and the experiment proper began. There was a set of three trials at each ISI, starting at the near threshold. If the participant gave correct answers in all three trials, the ISI was adjusted up 10ms for the next set of three trials. As soon as the participant gave an incorrect answer, the set was terminated and the ISI was adjusted down 10ms for the next set. Each change in direction from upwards to downwards or the reverse ended a run and the ISI at the end was the score for the run.

The experiment was completed with the end of the fourth run. The average ISI for the four runs was the 71% correct threshold, which was considered the threshold for perceiving the stable matrices. The order of presentation of the given displays was randomised before the experiment by a computer program.

4.2 Results

This experiment measured ISI thresholds for identifying the side (left or right) where the centre dot was missing in the temporal integration task. An up and down step procedure was used to obtain 71% correct thresholds, averaged over four runs. Table 4.2 presents the thresholds for the Autism/AS group and the NT group.

Table 4.2: Results of the temporal integration experiment. Mean thresholds of ISI (in ms) for temporal integration, plus ranges (standard deviations in parentheses).

	Autism/AS n=8	NT n=15
threshold	53	44
range	37-73	23-85
	(12)	(15)

The mean difference between the Autism/AS group was in the expected direction but was not significant, with t(21)=1.38, p=.18 (two-tailed test). The participant in the Autism/AS group with

Asperger syndrome was among the high scorers in that group, so that person's presence did not prevent a significant difference being found. There were no significant correlations to report with the measures in the previous experiments.

The power of the above analysis was quite low (.26) and one NT participant had a threshold of 85ms, which was over 2 standard deviations above the mean. This was the only person in either group whose threshold fell outside of the 95% confidence interval for the group. If that person is removed from the analysis, the independent group analysis was significant, with $t(20)=2.29$, $p=.03$.

4.3 Discussion

This experiment compared a combined Autism/AS group against a NT group on a variation of the temporal integration task (Walther-Muller, 1995) that was devised by Hogben and Di Lollo (1974). This task is arguably sensitive to the relationship between magno and parvo processes because of the two stages of perception with increasing ISI before the two displays are perceived as sequential. In the first stage, the displays are perceived as stable matrices despite the ISI. It is assumed that this shows the influence of parvo processes sustaining the position of the dots in the first display across the temporal gap into the overall perception. As the ISI increases, the dots in the first display appear to move towards the nearest dot in the second display. It is assumed that this reflects increasing dominance of the magno system, with its global superiority. As above chance performance on the task should depend on seeing stable matrices, it was assumed that reduced magno input would allow higher ISI thresholds for the task.

The temporal integration task was chosen for three reasons. Firstly, among the tasks that were considered to be sensitive to the properties of perceptual streaming, it seemed the most likely to be tapping relatively high level (cortical), integration between the streams, which this thesis argues is abnormal in autism. Secondly, the task seemed to isolate processes that could underlie proximity and continuation that Michotte (1946) claimed are the key to the launching effect. Thirdly, the task is not sensitive to abnormal processing of early, pre-cortical, magno input that has been proposed to occur in a subgroup of people with dyslexia (Lovegrove, 1996).

It was predicted that the Autism/AS group would show significantly higher thresholds than the NT group on the temporal integration task, which was not found when all participants were included in the analysis. The lack of a difference was not due to the presence of one participant from the earlier AS group in the Autism/AS group. However, the NT group included one participant whose threshold was more than two standard deviations above the group mean and well above the next highest threshold for the NT group. When that participant's score was removed from the analysis, the difference between the groups was significant.

Is the removal of the participant justified? The argument for removing an outlier due to unexpectedly good performance is usually that the person might have used a strategy that was beyond what the task was used to measure. A strategy that could be used with the temporal integration task is to focus on the centre area on one side of the screen. If the centre dot was apparent in the area of focus, then the missing dot was on the other side; if it was not apparent in the area of focus, it was the side of the missing dot. Given that possibility, it is arguable that the removal is justified.

It should be noted that the same argument could be used to account for the significant difference that emerged with that the removal of that participant. The strategy suggested was that the participant may have taken an unusually 'local' perspective. As noted in Section 1.3.3, Plaisted et al (1999) found that an autism group used a local style with the Navon task when they were not primed to take a global perspective. The same argument for removing the NT participant could be used to suggest that the resultant difference between the groups reflects distinct styles, not distinct perceptions.

The time that it took for participants to accommodate to the rapid presentations was not recorded in the current experiment, as this is not standard procedure. However, there were large differences in the amount of time that individual participants did take to accommodate and the high scorers in both groups were among those who took the least training duration. Tiredness from the training procedure may have hindered the performance of other participants. Alternatively, rapid accommodation may reflect an inherent ability, such as high acuity, that the experiment simply confirmed. This difference may not have effected results but, in hindsight, it would have been better if accurate data regarding the training procedure was recorded.

It was suggested in Chapter 2 that the Autism and AS groups may be representative of a single population with normal distribution of pre-cortical magno and parvo input retinal acuity, with the Autism group at the high end of parvo input. Whether slightly higher acuity was a confounder in this experiment is not clear, due to the lack of separate AS group. This was not a problem that was anticipated when the temporal integration task was selected. Some attrition was expected on medical grounds, as dual diagnosis is not uncommon with Asperger syndrome. It was clear at the first session for the Illusions experiment that it would be inappropriate for some of the AS group to undertake the temporal integration task. However, unexpected attrition was due to the surprisingly high ratio of people who wear glasses in the AS group. A literature search found no reference that suggests that the need for glasses is unusually common with Asperger syndrome, so it appears that it was a random effect.

There are three ways that the results of this study could be interpreted. Firstly, there was no difference between the groups on the direct test of the current thesis. Secondly, there was a difference between the groups, which supports the theory of the current thesis that there is reduced magno input at a cortical level. Finally, there was a difference but it reflected the high acuity of the Autism/AS group, not reduced magno input at a cortical level.

Whether or not the results are interpreted in the first way is a judgement that is left to the reader. The difference between the second and third possibilities is not as significant as it might seem.

No task could test the integration of the streams without confounding effects of sub-cortical processing. The important question was whether the participants in the Autism group would demonstrate a pattern that was commensurate with that which was found in the Illusions and the Launching experiments and they did. This thesis argues that this type of abnormal processing makes people with autism vulnerable to a weakness in perceiving the launching effect.

Chapter 5: General Discussion

Leslie (1987) and Frith (1989) provided two very important theories of autism. They inspired informative strands of research and created unprecedented interest in autism that led to major inroads in understanding what had previously seemed to be incomprehensible. Their work also contains insights into the nature of autism that have stood the test of time. The question that this thesis addressed was whether there is a link between these insights.

Leslie (1987) recognised that pretend play and the understanding that beliefs can be false present similar processing demands, which he suggested could be solved by M-representation. He proposed that people with autism are unable to generate M-representations and the current thesis has not contested this. This proposal remains the best explanation for the severity of the disorder at the cognitive level.

Leslie (1987) also proposed that the central cause of autism is a domain-specific impairment to theory of mind, which seems to fit the picture of autism. People with autism do have extreme difficulty in relating to the intentions of others, while even people who are considered to be low functioning can be highly proficient in using and manipulating the particular objects that interest them. Even those who challenged Leslie's (1987) proposal that the social impairment results from the lack of a theory of mind module, such as Hobson (1990), generally presented alternate accounts of a physical/social distinction. Moreover, it was shown in Section

1.2.4 that much of the research that followed from Leslie (1987) appears to endorse the basic concept of a domain-specific, theory of mind impairment.

Frith (1989) noted that the superior performances of autism groups on the Embedded Figures and Block Design tasks (Shah and Frith, 1983, 1993) could result from weak gestalt perception. More direct evidence that gestalt perception is weak came when Happe (1996) found that an autism group had reduced susceptibility to a number of well-known visual illusions. Frith (1989) also suggested that the abnormality that underlies weak gestalt perception could account for the isolated abilities that may be universal in autism. These abilities may extend to the savant level, and studies suggesting that enhanced pitch detection is widespread in autism (e.g., Heaton et al, 1998) support that proposal.

5.1 Weak Launching and Autism

Leslie (1987) argued that the ability to metarepresent is expressed through M-representations and does not arise at the point that false belief tasks are passed, which is normally between four to five years of age. Instead, he suggested that the ability is present very early in life and helps to shape the rapid and reliable path to acquiring a functional theory of mind. Given this pattern of development, and that the social impairment seemed to be central to autism, Leslie (1987) suggested that a theory of mind module generates M-representation and that this module is lacking in autism.

It was argued in Section 1.2.4 that the ability to metarepresent depends on the idea of force and that the rapid development of theory of mind suggests that there is an innate basis for this idea. This thesis proposed that the type of abnormal perception that is found in autism suggests that the launching effect, a perception of physical causality that was discovered by Michotte (1946), is weak in autism. It also suggested that the launching effect is potentially an innate basis for the idea of force. As such, it was claimed that the inability to metarepresent might result from weak launching, rather than the lack of a theory of mind module. The theory of mind research was reassessed in sections 1.2.5 and 1.2.6, where it was argued that the pattern of results is as likely to follow from weak launching as it is from the lack of a theory of mind module.

One reason for this is the similarity between Leslie (1987, 1994) and the current thesis. Both propose that the launching effect is the basis for the idea of force and agree that an inability to generate M-representation defines the psychological profile that is specific to autism. The main difference between the two theories, in fact, comes down to a fine distinction about whether or not the extension of good continuation across the spatial discontinuity within the launching event structures is amplified into a gestalt perception. It might be asked, if that is the only real difference, what is the point of this thesis?

Firstly, a connection between Leslie (1987) and Frith (1989) would mean that a complete understanding of the nature of autism would really be at hand. As it stands, it is unclear why inability to generate M-representation would cause weak gestalt perception or why weak perception of illusions and figure/ground would lead to a problem in acquiring a theory of mind. If it can be shown that the launching effect is the basis of the idea of force and that it is weak in autism, then it would be clear that there is a connection between the abnormal perception and cognition in autism.

There would still be issues to resolve, such as the distinction between autism and Asperger syndrome and the relationship between abnormal perception and the social deficits highlighted by Hobson (1990) and Baron-Cohen (1995). However, those issues should be much easier to resolve, if the key connection is made. Also, more attention could be given to devising the best possible interventions.

The second point is that if weak launching is the connection between the Leslie (1987) and Frith (1989) models, then failure to realise this will inevitably lead to confusion. The study of early development in autism with regards to theory of mind has decreased in recent years, which suggests that most researchers feel that it has gone as far as it can for the moment. The main focus of attention has moved to theory of mind in adolescents and adults with autism and Asperger syndrome (e.g. Baron-Cohen et al, 1997) and also to the isolated abilities (e.g. Heaton et al, 1998). Even though this thesis argues that autism results from abnormal perception, it should not be simply assumed that all isolated abilities result directly from abnormal perception.

The superior abilities that are likely to be directly reflecting abnormal perception include enhanced perfect pitch and performances on the Block Design and Embedded Figure tasks. Baron-Cohen et al (2001) also found superior performance in an Asperger syndrome group on a 'folk physics' tasks. It was argued in Section 1.2.5 that this performance could result from weak launching, in that it might lead to a system of causal attribution that is less force-based than is normal. This system may have allowed the Asperger syndrome group to readily adopt a mathematical stance that is successful at solving physics problems. If that is the case, the superior performance should be understood in terms of causal attribution that results from abnormal perception. This is not the same as the superior performances on Block Design, which may result from perception of the stimuli in the task.

As Leslie (1994) suggested, the idea of cause and effect is likely to be the 'central organising principle' in object mechanics and theory of mind. We experience the world through our perception but it may be through the idea of force that our species actively connects to the world, in both thoughts and actions.

5.2 Summary of the Research Program

5.2.1 Illusions

This thesis proposed that abnormal perception in autism results from reduced magno input at a cortical level, rather than weak central coherence, as proposed by Frith (1989). It was suggested that this reduction particularly limits magno influence in integrations with parvo input. A result of reduced magno influence would be that parvo influence is increased. For example, it was suggested in Section 1.3 that reduced mango input could underlie enhanced pitch detection that is found in autism, due to increase influence of frequency input (Heaton et al, 1998). It was also suggested that reduced magno input weakens the phenomenal experience of some gestalt perceptions, most notably, the launching effect.

The research included Autism, Asperger syndrome (AS), Mild Intellectual Disability (MID) and Neuro-typical (NT) groups. The first experiment (Chapter 2) measured illusion effects with the Poggendorff, Muller-Lyer and Brentano displays. Happe (1996) found that an autism group showed reduced susceptibility to Poggendorff but not Muller-Lyer. Muller-Lyer and Brentano result from 'wings effects', while Greist-Bousquet and Schiffman (1985) claimed that wings are embedded within the Poggendorff display. Given the possibility that there is a similar factor in all three illusions, it was hoped that the structure of the experiment would isolate the reason for any differences between the groups in the magnitude of illusion effects.

Happe (1996) suggested that weak central coherence in autism causes weak integration when there is not a physical connection between inducing and induced parts. If that were the case, the Autism group should have shown reduced susceptibility to both Brentano and Poggendorff, as the shaft is implicit in both illusions.

However, the Autism group showed an equivalent Brentano illusion effect to the other groups.

Zucker (1980) claimed that wings effects reflect local processing, while Day et al (1987) argued that misalignment is a factor in the Poggendorff illusion that is independent of wings effects. Misalignment is a global process acting over local functions, the position of the ends of the diagonals. Therefore, this thesis predicted that the Autism group would show a reduced illusion effect with the Poggendorff display only, which was found in the experiment.

This thesis also predicted that the reduced Poggendorff illusion effect would be due to reduced misalignment. Whereas the other three groups showed a bias on the control display error for the Poggendorff (i.e., without the wings) in the same direction as the illusion display, the Autism group did not show a bias. Therefore, the results of this experiment supported the predictions about the performance of the Autism group that were generated by the reduced magno input theory.

However, there is evidence that gestalt perception is also weak in Asperger syndrome (Jolliffe and Baron-Cohen, 1997). Unless there are two distinct abnormalities, the AS group should also have reduced magno input. However, if the Poggendorff control display was the marker of misalignment, which reflects magno input, and the AS group had the highest error on the display, then it would appear that they showed increased magno input. It was suggested that reduced magno input occurs at a cortical level, which would make retinal and subcortical processes potential confounders. Therefore, it was suggested that the Autism group and AS group may have been representative of a single population with a normal distribution of subcortical input but that the Autism group had low subcortical magno input and the AS group had high subcortical magno input.

An alternate possibility is that there are distinct abnormalities in autism and Asperger syndrome. The abnormality in Asperger syndrome might be effecting the ability to direct attention, rather than perception. For some reason, this impairment still allows quick detachment from gestalt perceptions and, as such, Asperger syndrome groups show superiority on the Block Design and Embedded Figures tasks (eg Jolliffe and Baron-Cohen, 1997) but do not show reduced susceptibility to illusions (Chapter 2, Ropar and Mitchell, 2000). When global processes were not significant, for example, in the Brentano and Muller-Lyer conditions, the performance of the Autism group was commensurate with the NT group. As such, there was no difference in acuity between the Autism group and the NT group. The Autism group differed from the NT group only when global processes were significant for linking by co-linearity, in misalignment, as expected from the reduced magno theory. Therefore, from the position that the performances of the Autism and AS groups in the Illusions experiment reflected distinct abnormalities, the performance of the Autism group was consistent with the reduced magno theory, as originally posited.

5.2.2 Launching

Michotte (1946) suggested that when object A pushes object B, there is an anomaly between proximity (A before impact is A after impact) and good continuation (the movement of A extends into the movement of B) that is resolved as a gestalt perception where the movement of A ampliates into B. Following the suggestion made in Wilson (1991), Michotte's (1946) theory was converted to a perceptual streaming model, in which the parvo stream favours proximity and the magno stream favours good continuation and the anomaly is resolved through cortical integration, a strong gestalt perception of ampliation arises that facilitates the development of the idea of force.

The strength of the launching effect cannot be isolated as easily as illusion effects. As such, Michotte's (1946) theory, that the effect arises from an anomaly between proximity and good continuation, was used as a basis to infer launching strength. It was proposed that reduced magno input at a cortical level would lead to a lower threshold in the Autism group, and perhaps the AS group, than the other groups for the pause between the movements of object A and object B for the change in reports between *pushing* and *not pushing*. The Autism group did show low thresholds but the AS group showed unexpectedly high thresholds (Section 3.1). From the position that the Autism and AS groups reflect distinct populations, and given the finding in the Illusion experiment that the Autism group showed weak gestalt perception as predicted by the reduced magno input theory, it could be inferred that the Autism group had weak ampliation of movement. However, given the possibility that the Autism group had low subcortical magno input and the AS group had high subcortical magno input, the pause thresholds may have simply been reflecting dominant subcortical processes, rather than weak ampliation. Therefore, further investigation was necessary.

Pause thresholds were measured for the change in reports from *flipping* and *not flipping* for the continuity event (Section 3.2). The Autism group showed the lowest pause threshold for the continuity event, while there was no difference between the NT and AS groups. This result, by itself does not distinguish whether the Autism group had low ampliation (cortical function) or low subcortical magno input. It was argued that, if Michotte's (1946) theory is correct, group launching thresholds should reflect the perception of delayed launching, show a reduction in pause threshold from the continuity event to the launching event because of added proximity information in the latter and show correlations between launching and measures of continuity (the continuity event) and proximity (a wings illusion). The NT group met all four criteria, while the Autism and AS group each only met one criterion, which was one correlation between the launching threshold and their proposed dominant subcortical process. Therefore, it was suggested that both the Autism and AS groups had weak ampliation of movement.

One difference between an illusion like Poggendorff and the perception of the launching effect is that the launching effect can be weakened both by increasing proximity (towards two independent movements) and by increasing continuity (towards one single movement). As such, it was suggested that the Autism group may have a perception of launching events that is more like two independent movements than neuro-typical perception, while the AS group may have a perception that is more like tunnelling.

The extended pause thresholds of launching shown by the AS group also suggested that they may have an unusually broad spatial threshold for the tool effect, which may be perceived when there is an intermediate object (I) between A and B (Michotte, 1951). The significance of the tool effect is that it could provide a perception of an agent's force acting across space and time and through objects, which could be an important step towards the ability to metarepresent. It would appear that children with Asperger syndrome groups do not experience the same difficulty in acquiring a theory of mind as children with autism (Ziatas et al, 1998). Children with Asperger syndrome would have to have a compensation for weak ampliation.

An unusually broad threshold for perceiving agency across gaps in space and time is a possible compensation. Therefore, it was predicted that the Autism group would show the shortest spatial threshold for the tool effect, while AS group would show the broadest spatial threshold, due to differences in sub-cortical input. While the research that was reported in Section 3.3 found no difference between the spatial thresholds of the Autism group and the NT group, the AS group did show a significantly broader threshold than those groups.

5.2.3 Temporal Integration

With the exception of the tool effect experiment, the performances of the Autism group had been consistent with predictions of the theory that there is reduced magno input at the integration of the streams. The temporal integration task (Hogben and Di Lollo, 1974) was selected as a test that might be sensitive to the balance between the streams at a cortical level (Chapter 4). The task used was a variation from Walther-Muller (1995), which involved rapid, sequential presentation of two displays that were separated by a variable inter-stimulus interval (ISI). The two displays, fused together, made two 5 x 5 dot matrices on either side of a screen but with the centre dot missing on one side. The task was to pick the side of the screen with the missing centre dot. This is easy when the stable, or 'fused', matrices are perceived. However, as ISI is increased, the perception becomes unstable with apparent motions between the dots being seen, instead of the dots in the first display sustaining their position during the presentation of the second display. Finally, at some ISI, there is no integration between the displays and the displays are simply perceived in sequence.

It was assumed that the perception of the matrices at low ISI reflects the parvo stream sustaining the dots in the first display in their position into the perception. As the ISI increases, the more 'global' magno stream becomes dominant, which creates apparent motion rather than stable positions. It was predicted that reduced magno input into the integration between the streams could allow the parvo stream to still be dominant at longer ISI and therefore allow superior performance on the task.

In the first analysis, there was no significant difference between the Autism/AS group and the NT group in their thresholds for the temporal integration task. However, the threshold of one NT participant was over two standard deviations above the mean of the group, which suggested that this participant may have used a strategy that was outside what the task was aiming to measure. When the data from that participant was removed from the analysis, the Autism/AS group showed a significantly higher threshold than the NT group.

In the absence of an AS group, it is difficult to be confident about whether this result reflected reduced cortical magno input (an abnormality) or reduced subcortical magno input (not an abnormality). However, in either case, the result was consistent with the Illusions experiment and the first two parts of the Launching experiment that suggested that reduced magno input was a factor in the perception of the Autism group.

Therefore, the Autism group showed a pattern of perception that was consistent with the reduced magno input theory in most instances. Most importantly, it was argued that reduced magno input would weaken the launching effect. While it is not claimed that the evidence that launching is weak is definitive, there is sufficient grounds to pursue this important issue.

5.3 Suggestions for Further Research

One unresolved issue is whether gestalt perception is weak in Asperger syndrome. As noted in Chapter 2, it is likely that the Poggendorff illusion involves both misalignment and wings effects and the Autism and AS groups showed normal susceptibility to wings effects in the Muller-Lyer and Brentano conditions. Therefore, a sufficient level of misalignment would induce the Poggendorff illusion. Among the 6 illusions that were used in Happe (1996), the autism group had least susceptibility to Kanizsa. It is possible that Kanizsa would be more sensitive to any weakness in gestalt perception that may occur in Asperger syndrome than Poggendorff. However, unlike the illusions used in the current research, Kanizsa is not really amenable to a performance method.

A solution might be to start with a presentation of the Kanizsa display with unsaturated red parts and a white background; that is, ideal conditions for the illusory contour to be perceived. The background could be changed to green gradually over trials, starting from a highly saturated green and progressing towards an unsaturated green. If the Asperger syndrome group reported that the contour disappeared with a more saturated green background than control groups, it would suggest not only that their gestalt perception is weak but that the weakness resulted from reduced influence of magno input in gestalt processes.

Another issue is the direction that further launching effect research might take. As noted, the reports of the Autism and AS groups before the continuity experiment suggested that their perception of flipping may be weak, which may be worth investigating systematically. While the difference between the Autism and AS group in the tool effect experiment was an interesting finding, nonetheless, the lack of a difference between the Autism and NT groups was surprising (Section 3.3.). It was suggested that this might have been because the instructions encouraged the NT group to change from reports of *A pushed B* to *I pushed B* as soon as the latter perception was possible. A method that could be sensitive to differences between the Autism and NT groups might be to focus on the change from tunnelling and one ampliation (the tool effect perception) to two distinct ampliations.

As noted in Section 1.2.6, Hobson (1990) claimed that the perception of emotion expression is impaired in autism. This thesis was introducing the launching effect to research into autism and, as such, affective perception was given little attention. Campos and Stenberg (1981) claimed that gestalt processes are important for detecting invariant structures of expressions in faces. Therefore, a streaming approach might help to understand the relationship between abnormal perception and the early 'social deficits' (e.g. Hobson, 1993, Baron-Cohen et al, 1997) that are not obviously explained by an inability to generate M-representations.

5.4 Final Comment

It was noted in Section 1.4 that Michotte's (1946) research raises two questions. Is the launching effect the basis for idea of force?

Given the problem that forces cannot be detected, how can we see one object push another object? This thesis did not address these questions but it suggested that the pattern of cognition in autism is as would be expected from a system of causal attribution that is not built on the idea of force. It was then suggested that the abnormal perception has been found in autism suggests that the launching effect is weak and the research tested this hypothesis. Theory of mind development normally follows a rapid and reliable path, which suggests that there are innate processes guiding this development, as Leslie (1987) claimed. It was argued in Section 1.2.4 that these processes depend on an idea of force. At this point in time, the launching effect is the leading candidate to be the solution to the problem of force that was identified by Hume (1739). This thesis has only provided only evidence of a coincidence between weak launching and theory of mind deficits. However, the possible connection may be the final key to solving the psychology of autism and should be pursued with vigour.