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Visual strategies in solving Raven's Matrices: Insights from autism

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ABSTRACT

Autism Spectrum Disorder (ASD) has been associated with superior performance on Raven's Progressive Matrices (RPM), yet the mechanisms underlying this advantage remain unclear. In typically developing (TD) individuals, two main solving strategies have been described for RPM: Constructive Matching (CM) and Elimination Response (ER). This study aimed to investigate group differences in the use of these strategies through eye-tracking glasses, allowing an ecological completion. Forty-six adults (19 ASD, 27 TD) completed the standard RPM while wearing the mobile eye-tracking device. A composite score reflecting strategic tendency was calculated based on the percentage of matrix and response areas exploration and the number of transitions between them. Results revealed no significant group differences in accuracy or resolution time. Higher composite scores—indicating greater use of the CM strategy—were strongly associated with better performance across participants, as reported previously. Moreover, for successful items, autistic individuals showed a more pronounced preference for the CM strategy than TD individuals but both groups modulated their strategy according to item difficulty in a similar manner. These findings suggest that autistic individuals tend to engage in more analytical and constructive visual reasoning, possibly supported by cognitive traits associated with autism. As no performance advantage emerges with the moderately difficult RPM used here, we discuss the possibility that task complexity and adaptability to complexity may be key to revealing group differences. Future research using more complex tasks and diverse samples may clarify how autistic cognitive profiles affect reasoning strategies and RPM performance.

Introduction

Autism Spectrum Disorder (ASD) is a neurodevelopmental condition that manifests in early childhood and persists throughout life. According to the DSM-5, autism is characterized by differences in social interaction and communication, as well as restricted interests and stereotyped behaviors; sensory atypia have also been described ([American Psychiatric Association, 2013](#)). In addition to these distinctive characteristics, studies have demonstrated that autistic individuals exhibit particular aptitudes in specific domains such as visuospatial abilities ([Caron et al., 2006](#); [Dawson et al., 2007](#)). For example, autistic people outperform typically developing (TD) individuals at identifying a shape hidden within another in the Embedded Figures task, or at constructing a 2D pattern with cubes in the Block design task (see meta-analysis from [Muth et al., 2014](#)). Early results on this topic ([Shah & Frith, 1983, 1993](#)) contributed to the emergence of the "weak central coherence" theory which hypothesized a tendency to focus on details in the context of a deficit in global

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processing (Happé, 1999; Shah & Frith, 1983). These findings were initially interpreted as indicative of a low-level intelligence, limited to perceptual skills and shape manipulation. However, the performance of autistic people on Raven's Progressive Matrices—one of the most complex tests of general intelligence—has challenged this view, suggesting that they also have high-level analogical reasoning skills (Dawson et al., 2007; Morsanyi & Holyoak, 2010). This is consistent with the "enhanced perceptual functioning" theory proposed by Mottron et al. (2006), which suggests a preference for local processing supported by superior perceptual skills rather than a deficit in global integration.

Raven's Progressive Matrices (RPM) are a non-verbal test designed to assess fluid intelligence, i.e. the ability to reason and solve problems independently of acquired knowledge (Raven et al., 1998; Raven & Raven, 2003). The test consists of 5 series of 12 items, each corresponding to a sequence of incomplete visual patterns that the participant must complete by identifying the underlying rule. There are several versions of the RPM: Standard Progressive Matrices (SPM), designed for the general population; Advanced Progressive Matrices (APM), which are more complex and suitable for individuals with a high cognitive ability; and Color Progressive Matrices (CPM), designed for young children or people with impaired cognitive skills (Raven et al., 1998). Dawson et al. (2007) pointed out that the competences of autistic individuals are not limited to low-level perceptual abilities but also extend to complex analytical skills, thus paving the way for numerous studies on this task in the context of autism. For example, autistic people have been shown to score higher on the RPM than on the Wechsler scales (e.g. Courchesne et al., 2015; Nader et al., 2016; Simard et al., 2015; Soulières et al., 2011). These findings highlight that verbal tests tend to underestimate the intelligence of autistic individuals due to language characteristics in autism, making tools based on visual and non-verbal reasoning more suitable to assess it. At the same time, studies have also reported preserved (Meilleur et al., 2014; Morsanyi & Holyoak, 2010; Yamada et al., 2012) or even superior performances on RSPM in autistic versus non-autistic individuals. While some studies focusing specifically on children diagnosed with Asperger's syndrome have shown higher scores than among TD children (Hayashi et al., 2008), better resolution times without score differences have been observed in the larger autistic population (Simard et al., 2015; Soulières et al., 2009). These differences in performance suggest that several factors could influence the success of autistic people on this task. Among these, one concerns visual exploration strategies, which could play a key role in the way these individuals analyze and solve matrices.

Based on both behavioral observations and eye-tracking data, two primary strategies have been identified for solving Raven's Progressive Matrices (Bethell-Fox et al., 1984; Snow, 1978, 1980). The first, known as "constructive matching" (CM), involves a detailed analysis of the matrix to mentally construct a hypothetical response before comparing it to the available response options. In this approach, individuals extract the underlying rule, generate a mental representation of the correct answer, and then scan the response options to find the matching one. The second strategy, referred to as "elimination of response" (ER), takes a more trial-and-error approach in which participants repeatedly compare each response option against the matrix until they identify the correct answer. These different strategies have been further validated using advanced eye-tracking techniques (Carter & Luke, 2020), which allow for the precise measurement of gaze indices. Specifically, the CM strategy is associated with prolonged focus on the matrix and fewer gaze shifts between the matrix and response options, whereas the ER strategy is characterized by more frequent shifts between the matrix and response options (Bethell-Fox et al., 1984; Vigneau et al., 2006). These strategies have been shown to influence performance, with higher scores and shorter response times associated with gaze indices linked to the CM strategy (Hayes et al., 2011; Liu et al., 2023; Vigneau et al., 2006). Previous research has also shown that the strategy is adapted in order to maintain performance throughout the SPM test as the difficulty increases, switching from the ER to the CM strategy (Gonthier et al., 2024). Furthermore, the CM strategy has been observed to be associated with higher working memory capacity and intelligence and these individual cognitive factors seem to shape the strategy switch during the course of the test as individuals with superior working memory capacity and intelligence are more likely than others to rely on the CM strategy on the most difficult items (Gonthier & Roulin, 2020; Gonthier & Thomassin, 2015; Liu et al., 2023). These findings highlight the importance of considering both internal test factors and individual factors in understanding the determinants of problem-solving strategies.

In the ASD context, eye-tracking studies have highlighted specificities in visual exploration (e.g. Bast et al., 2021; Tan et al., 2018). As few studies have used this technique in visuospatial tasks, our current understanding of the visual strategies used by the ASD population is limited and does not allow us to relate them to existing cognitive theories. Thus, differences reported in the literature regarding RPM performance between autistic and non-autistic individuals may be driven by different strategic preferences induced by an atypical visual behavior. The aim of the present eye-tracking study was therefore to explore strategic differences, as defined in the literature, between autistic and non-autistic individuals. To investigate this further, a composite score based on gaze indices (exploration time of the matrix, exploration time of response options and gaze transitions between matrix and responses) was used. This score, which provides a quantitative measure of strategy use for each item and participant, was designed to reflect a tendency towards the ER strategy when low, and a tendency towards the CM strategy when high. Based on the existing literature, we hypothesize that performance differences could emerge between autistic and non-autistic individuals on the RPM. Higher composite scores are expected to correlate with better performance, indicating greater reliance on the CM strategy. We also expect autistic individuals to achieve higher composite scores than non-autistic ones, suggesting a distinct strategic preference in this population. Considering only successful items, this study examined the influence of group and item difficulty on strategy use, as well as the strategic consistency of individuals in each group to deepen our understanding of group differences. Analyses were carried out at both item and individual level, as recommended by Bors and Vigneau (2003), to provide a global understanding of strategic variability.

Method

Participants

Participants were recruited either from the local university or through social media. Inclusion criteria required good verbal comprehension skills as well as normal or corrected-to-normal vision. Visual acuity was assessed using the Monoyer scale (3 m), a standard optometric test, ensuring that visual impairments did not introduce biases into the data. To minimize bias related to intellectual functioning, participants' IQ was taken into account during the selection process, and only individuals with an IQ superior to 70 were included in the study. Individuals in the TD group were excluded if they had a history of neurological or psychiatric disorders or if they scored above the cutoff (32) of the Autistic Quotient (Baron-Cohen et al., 2001). All participants in the ASD group had received a formal diagnosis (DSM-IV or DSM 5) using the Autism Diagnostic Observation Schedule (ADOS 2; Lord et al., 2012) and/or the revised version of the Autism Diagnostic Interview (ADI-R; Rutter et al., 2003) or other standardized tools; the diagnosis was confirmed by a medical doctor. This study was part of a larger experimental protocol that also involved other cognitive tasks. Five participants were excluded from the analysis due to insufficient eye-tracking signal quality (i.e. more than half of their data could not be extracted due to a recorded signal below 60 %), including two TD and three ASD individuals.

The final sample consisted of 46 participants, aged between 18 and 40 years ($M = 25.3$ years; $SD = 5.28$) including 27 TD and 19 ASD participants. Descriptive characteristics of each group are presented in Table 1. Groups did not differ significantly in terms of age ($U = 244$, $p = .788$, $r = .05$), sex distribution ($\chi^2 = 0.164$, $df = 1$, $p = .685$, Cramer's $V = 0.060$), educational level ($U = 233$, $p = .591$, $r = -0.09$) or verbal abilities, as assessed by the Similarities ($t(44) = -0.32$, $p = .752$, $d = -0.10$) and Vocabulary ($t(44) = -0.12$, $p = .909$, $d = -0.03$) subtests of the Wechsler Adult Intelligence Scale (WAIS-IV; Wechsler, 2008).

Procedure

Experiments took place in a quiet and isolated room to avoid external distractions. After providing informed consent, participants completed a visual acuity assessment and performed the Standard Raven Progressive Matrices (SPM) task while wearing an eye-tracking device. They were seated approximately 45 cm from the stimulus book which was placed on a stand tilted at approximately 60° to ensure optimal eye-tracking recording. For each participant, a calibration was conducted before the task, allowing free head movement during the session. Instructions were given using the first item as a training trial. Neurotypical participants completed the Autistic Quotient questionnaire (Baron-Cohen et al., 2001) via the online platform LimeSurvey to screen for potential ASD. All participants received a gift voucher as compensation. The study was part of a larger research project that has received the approval of the University of Toulouse's ethics committee (#2021-446) and that follows the General Data Protection Regulation (GDPR).

Raven's Progressive Matrices

Raven's Standard Progressive Matrices (SPM; Raven & Raven, 2003) consist of five series (A to E), each containing 12 items. Difficulty increases progressively within and across series, ensuring that the last items in a series are more difficult than the first items in the next one. For each item, participants were presented with a matrix of visual patterns (3 × 3) following a logical rule and containing a missing element. They were asked to select (by saying aloud) the correct figure from different possible responses to complete the matrix and could correct themselves if necessary. As there were 60 items and each correct answer was worth one point, the total score ranged from 0 to 60. There was no time limit on this version of the test.

Data Acquisition and Pre-processing

Data were collected using SMI ETG 2w (version 2.6) mobile eye-tracking glasses to acquire data under ecological conditions.

Table 1
Descriptive Characteristics of Participants in the ASD and TD Groups.

Characteristics	ASD Group (n = 19)	TD Group (n = 27)
Age (years)	25.68 (5.42)	25.11 (5.27)
Sex (female %)	42 %	48 %
Educational level (% per level)	[1] 5.3 % [2] 42.1 % [3] 10.5 % [4] 26.3 % [5] 15.8 %	[1] 3.7 % [2] 37.0 % [3] 11.1 % [4] 25.9 % [5] 22.2 %
Similarities (WAIS-IV)	14.6 (2.41)	14.4 (2.31)
Vocabulary (WAIS-IV)	13.5 (4.17)	13.4 (2.87)

Note. Values are presented as means with standard deviations in parentheses, or in percentages for categorical variables. Educational levels correspond to French national degree classifications: [1] = trade/technical qualification (*CAP/BEP*), [2] = high school diploma (*Baccalauréat*), [3] = two-year post-secondary diploma (*BTS/DUT*), [4] = bachelor's degree (*Licence*), [5] = master's degree (*Master*).

Combined with iView ETG software, this setup recorded the visual scene while tracking gaze position through infrared cameras (binocular tracking) with a sampling frequency of one image every 16 ms. The device was compatible with participants wearing contact lenses or corrective lenses up to a certain prescription level (± 4 diopters). Prior to the test, a three-point calibration was conducted for each participant to ensure optimal tracking accuracy. Raw eye-tracking data were processed using BeGaze 3.7 software (SensoMotoric Instruments). The software's Semantic Gaze Mapping tool was used to align fixation data with reference images of each test item. When necessary after acquisition, an offset correction was applied to correct for minor shifts in gaze alignment (see Holmqvist et al., 2012). Two Areas of Interest (AOIs) were defined on the reference images as the model -or matrix- area and the response options area (see Fig. 1). They were sized slightly larger than their target elements to account for potential slippage of the eye-tracking glasses. Their size and position remained consistent across all items.

Series A and B were considered as practice and thus excluded from the analysis, which focused on 18 items selected from series C, D, and E of the SPM test. Within each series, we defined three levels of complexity respecting the test structure: level 1 for the first four items, level 2 for the middle four, and level 3 for the last four. Two items from each level were selected based on TD participants' success rates to approximate a 50 % success rate and to allow for a comparison between successful and failed items. The final selection included C1, C3, C6, C8, C10, C12, D1, D2, D7, D8, D11, D12, E3, E4, E7, E8, E9, and E10. Some items were excluded due to insufficient eye-tracking signal quality (<60 % signal coverage per item); this concerned 3 items from two TD participants and 13 items from seven ASD participants. Consequently, the final dataset included 812 items (329 from ASD and 483 from TD participants).

In addition to the success level of each item, extracted variables included an *item resolution time* (i.e. duration between the first gaze on the item and the answer), an *exploration percentage* within each AOI (i.e. time percentage spent on each defined area relative to item resolution time) and a *number of gaze transitions* (frequency of gaze transitions between matrix and response options areas). A *composite score* was calculated for each item as: Matrix area exploration time [%] / Response options area exploration time [%] * (Item resolution time [s] / number of gaze transitions). It was designed to quantify participants' visual strategies and reflect a tendency toward an ER strategy when low and a CM strategy when high (see Fig. 1). In addition, the mean composite score was calculated for each participant to reflect their overall strategic tendency throughout the test. In order to evaluate intra-individual variability of visual exploration through the test, the *median absolute deviation* (MAD) of the composite score was also calculated for each participant (see a similar analysis by Kovarski et al., 2019). General performance variables such as entire test resolution time and score for each participant were also considered.

Statistical analyses

To better investigate both cognitive processes and individual differences, analyses were conducted at two levels: the item level, which captures the influence of task-internal factors, and the participant level, which reflects interindividual variability in strategy use (Bors & Vigneau, 2003). General performance differences between groups were assessed using Mann-Whitney tests for independent data. The effect of strategy on performance was examined at the item level by comparing the composite scores of successful and failed items using Mann-Whitney tests. At the participant level, Spearman correlations were conducted to assess the relationship between mean composite scores and overall test performance. To analyze group differences in strategy use, Mann-Whitney tests were used to compare composite scores between groups at the item level, as well as the mean composite scores of individuals at the participant level.

To further explore the effects of group and difficulty factors on the composite score in successful items, we used a Generalized Linear Mixed Model (GLMM) with a Gamma distribution and a log link function. This approach was chosen based on the recommendations of Ng and Cribbie (2017), given the strictly positive and right-skewed nature of the variable. Predictor significance was assessed with a significance threshold of $\alpha = .05$. The model included Group (ASD, TD), Series (C, D, E), and Complexity (1, 2, 3) as fixed effects, along with their interactions. A random intercept for participants (id) was included to account for individual variability. Estimated marginal means are provided in the [supplementary materials](#).

Lastly, participants' strategic consistency was investigated by comparing MAD between group using a Mann-Whitney test, and by Spearman correlations to examine its relationship with the overall performance of participants.

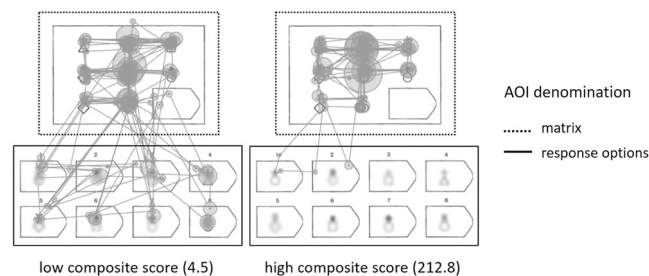


Fig. 1. Illustration of Areas of Interest (AOIs) and Strategic Scan Path Patterns for an RPM Item. **Note.** The figure displays two scan path patterns for item E7 of the RPM task, in which circles represent gaze fixations (size is proportional to duration) and lines indicate eye movements. The scan path on the left corresponds to a low composite score associated with the ER strategy and the one on the right corresponds to a high composite score associated with the CM strategy. AOIs are shown for model and response areas, as described in the legend. Visual stimuli on the item have been blurred for copyright compliance.

Statistical analyses were performed using Jamovi (2.6.17) and JASP (version 0.19.3) software, with the critical α -value set to 0.05.

Results

General performance

Regarding the overall performance on Raven's Matrices, our findings indicate no significant discrepancy in scores between ASD ($M = 51.9$, $SD = 3.89$) and TD ($M = 50.0$, $SD = 5.21$) groups, $U = 195$, $p = .172$. Concurrently, scores on the 18 items selected for eye-tracking analysis did not differ between the ASD ($M = 13.5$, $SD = 2.48$) and TD ($M = 12.8$, $SD = 2.90$) groups, $U = 214$, $p = .339$. Comparative analyses of resolution time revealed no differences between groups, neither for the entire test, $U = 188$, $p = .126$, nor for the 18 items preselected for eye-tracking analysis, $U = 207$, $p = .277$.

Effect of strategy on success

In order to assess the influence of participants' visual exploration behavior on success, comparative analyses were carried out for composite scores between failed ($M = 10.0$, $SD = 14.9$; $N = 226$) and successful ($M = 25.8$, $SD = 50.8$; $N = 586$) items. These showed that successful items were associated with higher composite scores than failed items, $U = 49249$, $p < .001$, reflecting that a strategic tendency towards constructive matching appears to be more effective than a strategy of response elimination. This finding aligns with the results observed at the individual level since individuals with the highest average composite scores tended to exhibit the highest scores (and inversely) on the 18 selected items, $\rho = 0.628$, $p < .001$, and on the entire test, $\rho = 0.668$, $p < .001$ (see Fig. 2).

Group effect on strategy throughout items

Comparative analyses on solving strategy between groups revealed that the mean composite scores of individuals with ASD ($M = 27.585$, $SD = 18.245$) were higher than those of TD participants ($M = 17.157$, $SD = 10.698$), $U = 168$, $p = .049$. Despite the lack of significant results, the same trend was observed at item level, as results indicated that ASD individuals ($M = 27.564$; $SD = 56.312$) tended to have higher composite scores than TD individuals ($M = 17.201$; $SD = 33.519$), $U = 73251$, $p = .059$. Thus, it appears that visual exploration in ASD generally tends towards a more constructive matching strategy than in TD.

Concerning the group effects on the composite score for successful items, a main effect was found for the Group, $\chi^2(1) = 6.017$, $p = .014$ (as illustrated in Fig. 3), confirming that the composite score differed between groups, with more extreme constructive matching behavior in ASD individuals. Composite scores were also found to be affected by the two factors of item difficulty, series, $\chi^2(2) = 127.731$, $p < .001$, and complexity, $\chi^2(2) = 54.576$, $p < .001$, reflecting a strategic modulation during the test, regardless of the group. An interaction effect between these two factors was observed as expected, $\chi^2(4) = 21.120$, $p < .001$, indicating that the item complexity effect on composite score differed across series. However, no interaction effects were found for either Group*Series, $\chi^2(2) = 1.296$, $p = .523$, or Group*Complexity, $\chi^2(2) = 1.273$, $p = .529$ (group data illustrated in Fig. 4).

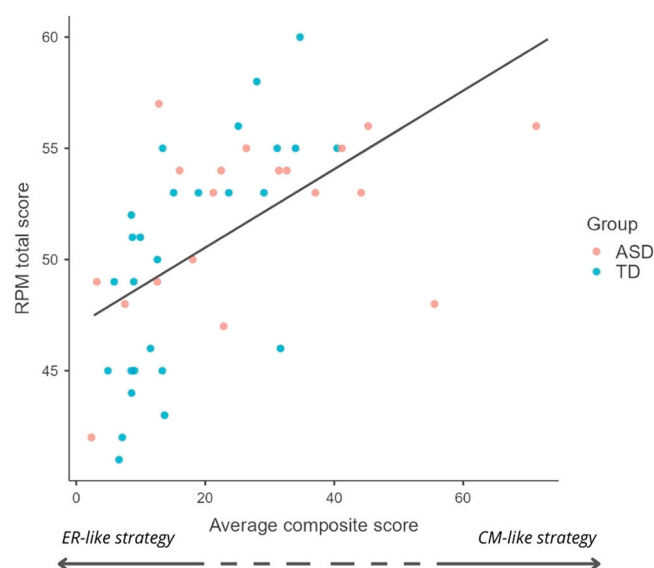


Fig. 2. Correlation Plot between the Average Composite Score and the RPM Total Score of Participants. **Note.** The regression line illustrating the Spearman correlation is shown. Participants from each group are color-coded according to the legend. $\rho = 0.668$, $p < .001$.

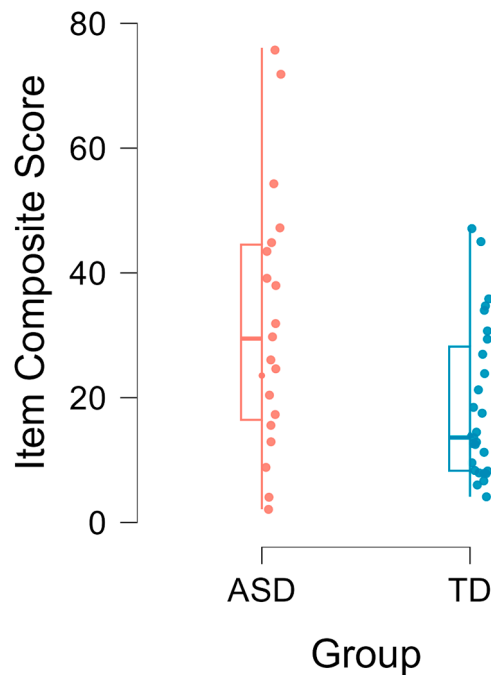


Fig. 3. Composite Scores of Successful Items Aggregated by Participants for ASD and TD Groups. **Note.** Only successful items were analyzed. As a random intercept for individual variability was considered in the GLMM analysis, each dot aggregates the composite scores and represents a participant.

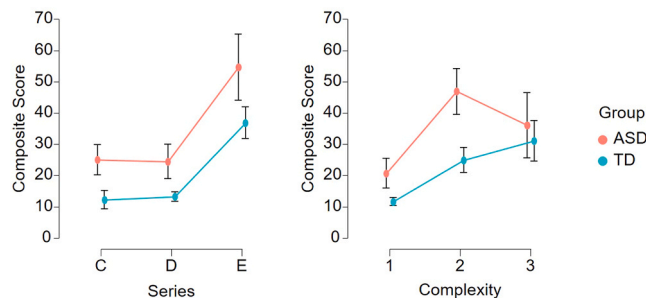


Fig. 4. Average Composite Score by Difficulty Factors (Series and Complexity) and Group. **Note.** The graphs illustrate the average composite scores in each group (ASD, TD) according to series (left) and complexity (right) of items. Error bars represent standard errors.

Strategy Adaptation Throughout Items

Lastly, we investigated the strategy variability using the composite score MAD of individuals, to see whether adaptability led to better results. Although our results did not reveal any significant difference in strategic variability between groups, $U = 200, p = .214$, they showed that individuals who modulated their visual exploration behavior the most during the test were those who obtained the highest scores, both for the 18 items, $\rho = 0.605, p < .001$, and for the entire test, $\rho = 0.657, p < .001$ (see Fig. 5).

Discussion

Superior performances on the RPM task have sometimes been described in autism (Hayashi et al., 2008; Simard et al., 2015; Soulières et al., 2009). While it has been suggested that autistic individuals may use different problem-solving strategies, the nature of these strategies remains unclear. In typical development, eye-tracking research has helped to described two main strategies to solving the RPM, namely the CM and ER strategies (Bethell-Fox et al., 1984; Vigneau et al., 2006). Thus, the aim of this study was to compare the visual behavior of autistic and neurotypical individuals through a composite score designed to reflect the tendency toward the strategies previously identified.

The present study revealed no significant difference in scores or resolution times between groups, suggesting that the general problem-solving abilities of autistic individuals are comparable to those of neurotypical individuals when assessed through the RPM

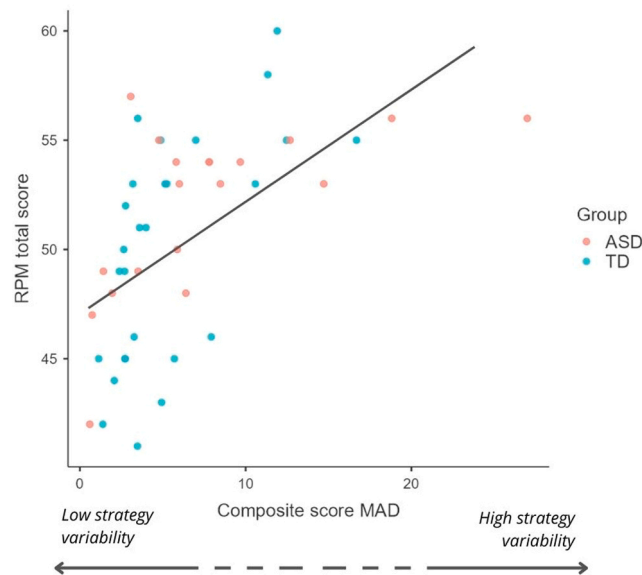


Fig. 5. Correlation Plot between the Median Average Deviation (MAD) of the Composite Score and the RPM Total Score of Participants. **Note.** The regression line illustrating the Spearman correlation is shown. Participants from each group are color-coded according to the legend. $\rho = 0.657$, $p < .001$.

test. This aligns with the observations reported in some previous studies, which did not observe significant differences in performance between autistic and non-autistic individuals either (Meilleur et al., 2014; Morsanyi & Holyoak, 2010; Yamada et al., 2012) but contrasts with research that has shown differences (Hayashi et al., 2008; Simard et al., 2015; Soulières et al., 2009). Although this cannot be confirmed, the differences in results may be due to variations in the sampling of autistic groups across studies, serving as a potential explanation for the lack of significant results in this study. Regarding visual exploration strategies through the composite score, our results showed that a CM-like strategy is generally more effective for solving the RPM compared to an ER-like one. This result, observed at both the item and participant levels, was expected and aligns with previous studies showing that the CM strategy is linked to better performance (e.g. Vigneau et al., 2006). It further validates our methodological approach by demonstrating that the composite score designed reliably reflects the strategy used by participants. Furthermore, when comparing strategy used between the ASD and TD groups, autistic individuals tended to rely more on the CM strategy throughout the test. This tendency was clearly observed at the participant level, while only a trend was found at the item level. This discrepancy may reflect a greater inter-individual variability or a stronger influence of internal difficulty test factors on strategic choice in one of the two experimental groups. Also, the ASD group exhibited higher variability in composite scores overall (standard deviation), which could indicate a broader diversity in cognitive profiles or problem-solving strategies within this population. However, when focusing on successful items, strategies were found to vary in a similar way across both groups as task difficulty increased, suggesting similar strategic adaptation mechanisms. Finally, autistic individuals showed a more pronounced CM-like exploration behavior, indicating that this strategy was not only more frequent but also more salient. Across both groups, individuals who demonstrated greater variation in their visual exploration strategies throughout the test finally tended to perform better, with no significant differences in the degree of variation between groups. These results underscore the value of strategy adaptability in task performance.

Thus, the preference for the CM strategy observed in autistic people suggests a tendency toward a more analytical approach to problem-solving. It could be explained by several factors, as specific cognitive traits associated with autism could facilitate the use of this strategy. For example, their increased perceptual processing abilities (Mottron et al., 2006; Mukerji et al., 2021) could help them process information within the matrix more efficiently and extract underlying rules more easily. Additionally, a cognitive style characterized by visual thinking (Bled et al., 2021; Grandin, 2009) and a superior ability to maintain mental images (Bled et al., 2024) is likely to further support the CM strategy. Strong mental imagery skills may help them construct and retain a clear representation of the response before matching it to the given options. Furthermore, the increased systemizing abilities observed in autism (Baron-Cohen, 2009), which involve the tendency to analyze, categorize, and build systems based on logical rules and patterns, could make the CM strategy more intuitive. Since CM involves generating a response before systematically comparing it to the response options, autistic individuals might naturally favor this strategy due to their cognitive style. These previous interpretations offer possible cognitive explanations for the greater use of the CM strategy in autism, but this finding also raises questions in light of the existing literature. While working memory abilities has been shown to be positively correlated with the use of the CM strategy on the RPM task in the general population (Gonthier & Thomassin, 2015), several studies have reported impairments in working memory among autistic individuals, particularly in visuospatial working memory (see the meta-analysis of Habib et al., 2019). From this perspective, the preferential use of the CM strategy in autism is somewhat unexpected, given that it engages working memory to a greater extent than the ER strategy. As other findings suggest that visuo-spatial working memory may be relatively preserved in some

autistic individuals (Jiang et al., 2015; Lynn et al., 2022; Semino et al., 2021), and that mental imagery abilities, especially image maintenance, may play a compensatory role (Bled et al., 2024), these results call for a more nuanced investigation into the cognitive mechanisms that support analytical problem-solving strategies in autism.

Despite a more frequent use of the CM strategy shown in autism and in other studies, we did not report performance differences between groups. This outcome may reflect the relatively moderate cognitive effort required by the standard version of the test (SPM), which might not be sufficient to reveal the advantage conferred by this strategic preference. The advanced version (APM), which is generally more difficult, could better highlight these differences in strategy and their influence on performance. Some studies in the neurotypical population have shown that as task difficulty increases, individuals with higher cognitive abilities (i.e. intelligence and working memory) tend to use the CM strategy more, while those with lower cognitive abilities are more likely to rely on the ER strategy (Gonthier & Roulin, 2020; Liu et al., 2023). It would therefore be interesting to investigate whether this relationship is similarly observed in autistic individuals. Interestingly, in our sample, the CM strategy was more frequently used by autistic participants, regardless of their performance level. This suggests that, in autism, the tendency to use CM may reflect a cognitive style or strength that is less closely tied to general cognitive ability than it is in neurotypical individuals. Given that the CM strategy is generally associated with higher cognitive performance and greater efficiency in solving complex items, its spontaneous use by autistic participants indicates that the RPM may engage reasoning processes that are particularly aligned with their cognitive profile—especially visuo-spatial strengths and detail-oriented processing. In this regard, and in line with previous studies (e.g. Courchesne et al., 2015; Nader et al., 2016; Simard et al., 2015; Soulières et al., 2011), RPM may be more suitable than other intelligence tests—particularly those relying more heavily on verbal resources—for revealing the reasoning abilities of autistic individuals.

Beyond performance scores, our results suggest that tasks such as the RPM can provide meaningful insights into cognitive strategies, particularly in how individuals approach, structure, and process complex visual information. These strategies may extend to real-world domains including learning, reasoning flexibility, and environmental exploration. Identifying individual differences in such patterns could inform more personalized clinical assessments and interventions, by helping individuals understand and leverage their cognitive styles across various contexts. If validated by future research, the composite score developed in this study could be implemented through computerized assessment systems, including eye-tracking devices, to capture the visual exploration elements needed for its computation. This approach could offer clinicians a more nuanced interpretation of non-verbal reasoning, complementing traditional assessments and providing insights that may support tailored interventions.

A limitation of this study and of many others in the field is the issue of representativity within the autism spectrum, as the type of tasks employed in it are not adapted to the full autism spectrum. More specifically, our sample consisted of autistic adults without intellectual disability and with relatively high verbal skills, which may further limit the generalizability of our findings to the broader spectrum. These sample characteristics differ from those reported in other studies—such as Meilleur et al. (2014) and Simard et al. (2015)—in which autistic participants had, for example, lower verbal abilities compared to controls, yet still showed comparable RPM scores. Developing methodologies that can accommodate the full diversity within the spectrum is crucial for a more comprehensive understanding of autism. As Tan et al. (2018) suggest, future research should include participants with different cognitive levels and investigate how reasoning abilities and eye movements patterns relate to the severity of ASD. Such approaches would not only provide more accurate insights into how different individuals address problem-solving tasks such as the RPM but also help clarify whether specific visual exploration patterns are intrinsic to autism or more closely linked to cognitive profiles frequently observed in this population. This would ultimately lead to a more precise understanding of the factors that shape cognitive strategies in autism.

In conclusion, this study offers valuable insights into the strategies employed by individuals with autism during problem-solving tasks under ecological conditions. Although no performance differences were observed between autistic and non-autistic participants, our findings highlights specific problem-solving strategies that may help explain the superior performance sometimes reported in previous studies using Raven's Progressive Matrices. These strategic differences might be underpinned by cognitive characteristics already identified in the literature, and testing these hypotheses in future studies could help to better understand the cognitive mechanisms that drive strategy use and performance in individuals with autism. To provide more reliable conclusions about fluid intelligence and cognitive profile in autism, it is essential to develop methods that better account for the full diversity within the spectrum.

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CRedit authorship contribution statement

Lucie Bouvet: Writing – review & editing, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Formal analysis, Conceptualization. **Magali Batty:** Writing – review & editing, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Formal analysis, Conceptualization. **Alizée Diu:** Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to

influence the work reported in this paper.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at [doi:10.1016/j.reia.2025.202694](https://doi.org/10.1016/j.reia.2025.202694).

Data availability

Data can be found online on OSF.

[DataSet](#) (OSF)

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