Exploring Individual Differences in Decision Strategy

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Abstract

Individuals vary in their decision-making strategies and the types of information they attend to when presented with conflicting information. Our prior research found that people who were more biased toward visual or verbal information had faster response times when sorting stimuli than more neutral attenders. The current study investigates whether experience with picture vs. word stimuli (Relative Skill) or a more general threshold for accumulating evidence when making a decision (General Decision Strategy) drives our former results. 175 participants completed the Card Sorting Task, followed by subsequent trials modified to instruct participants to select the visual or verbal information. This created "correct" and "incorrect" ways to sort the stimuli, allowing the use of Drift Diffusion Modeling to measure evidence accumulated before decision-making. Across participants, word-sorting was consistently faster than picture-sorting, and visual attenders showed a relative advantage on picture-based decisions compared to verbal attenders. However, both groups remained faster with words, suggesting a strong experience-driven benefit for verbal information. Drift diffusion analyses revealed no differences in decision thresholds between biased and neutral attenders, indicating that groups did not differ in the amount of evidence they needed before making a decision.

Keywords: attention, decision making, conflict perception

Exploring Individual Differences in Decision Strategy

People are constantly asked to make decisions while being bombarded with information. In this digital age, individuals are often presented with more information than they can process and are forced to choose which information to attend to and ignore. Individual differences in people's attention are shaped by both past experiences and processing strategies (Alfred, 2017). It is unclear, however, whether experience with a specific kind of information or more general decision strategies drives decisions under competition for attention. This study aims to investigate the driving force behind attention and decision-making, and how individuals navigate conflicting information.

One individual difference in characteristic patterns of attention that has been identified is people's tendency to attend to visual versus verbal information (Childers et al., 1985; Hatakeyama, 1997; Kozhevnikov, 2007; Mayer and Massa, 2003; Paivio, 1979; Riding & Ashmore, 1980; Riding and Watts, 1997; Roebuck and Lupyan, 2020). For instance, when receiving navigation instructions from an app, some people tend to focus on the verbal instructions given, while others focus on the spatial information presented in the map. Visualizers and verbalizers correspond to individuals who consistently attend to either visual information or verbal information. They show key differences in the way that they process information: people associated with visual information processing recruited more of the visual cortex when processing information, while verbal people recruited more phonological parts of the brain, such as the Supramarginal Gyrus (Kraemer, 2009).

Visualizers and verbalizers show processing differences in the real world. A study investigating individual differences in processing during navigation found that more verbal people used more landmark memory and more visual people focused more on relative direction when navigating a simulated city (Kraemer, 2017). Some studies maintain that matching presentation modality in the classroom or at work to an individual's information processing style holds no benefit to processing (Aslaksen & Lorås, 2018; Kollofel, 2011; Pashler, 2008; Thomas & McKay, 2010). There are even arguments that people process information better when the presentation modality *misaligns* with their processing style, as it forces individuals to actively focus on the task (Lyle, 2023). Differences in information processing show up in the classroom as well. Students with higher visuospatial abilities showed more success in STEM fields, especially mathematics, and higher verbal cognitive abilities were correlated with higher academic performance, especially in language and writing areas (Alfred, 2017). The present study aims to add insight into how information processing style affects people's daily lives and how it is connected to strategies used to process information.

Visual and verbal processing differences do not only occur when the modality of the processed stimulus aligns with an individual's information processing style (visual or verbal). When presented with a stimulus that did not align with an individual's processing style, individuals were able to convert it to their preferred modality and used the same brain processing regions that aligned with their processing style, regardless of whether the stimulus was verbal or visual (Kraemer, 2014). A study investigating the impacts of information processing style in an educational context found that information processing style misaligning with the modality of the stimulus showed longer response times, but the same quality of work when compared to matching modality trials (Alfred, 2017). Matching presentation modality to an individual's information processing style did not necessarily show any benefits, but it did show faster response times overall, and that deficits in one information processing style often lead to offloading into the other one, making it more of an automatic process.

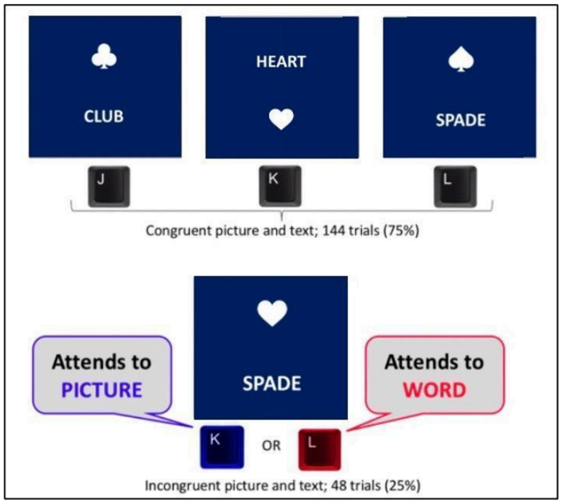

Fig. 1 Example congruent (top) and incongruent (bottom) trials from the Card Sorting Task. In congruent trials, the picture and word depict the same suit; in incongruent trials, they conflict. Adapted from Alfred (2020).

The Card Sorting Task is a cognitive test designed to measure the degree to which an individual attends to visual or verbal information (Alfred, 2020). People are shown a card with a visual and verbal representation of a card suit, and asked to sort the card based on which suit it is (Fig. 1). Congruent trials show the same suit in word and picture form; however, incongruent trials show two different suits, measuring people's propensity for visual or verbal information by which suit they attend to. Fig. 2 shows the distribution of how people attend to incongruent trials- there are people who very strictly attend to only one modality, as well as people who are more neutral in their attention and select both modalities more equally.

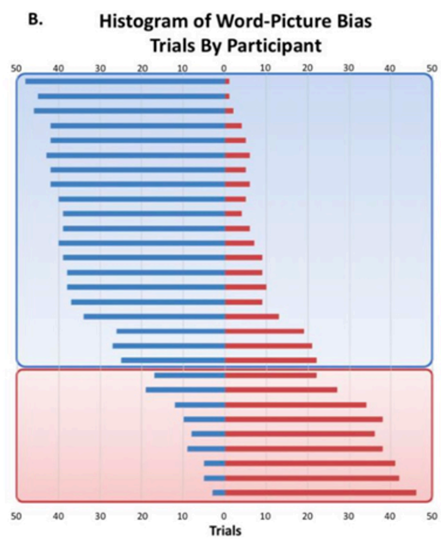

Fig. 2 Distribution of individual bias scores in the Card Sorting Task, illustrating the continuum from strong visual bias (blue) to strong verbal bias (red). Adapted from Alfred (2020).

Previous Research on Visual vs. Verbal Decision Making

Not only do people vary in the degree of their bias toward visual or verbal information, but they also vary in the strength of these biases. Our previous research investigated whether biased attenders (very verbally or visually biased people) and neutral attenders (people more evenly split in what modality they attend to) showed significant differences in how they experienced conflict during congruent and incongruent trials in the Card Sorting Task. We found that biased attenders had less of a response time difference between congruent and incongruent trials than neutral attenders and had faster response times than neutral attenders overall. See Fig. 3.

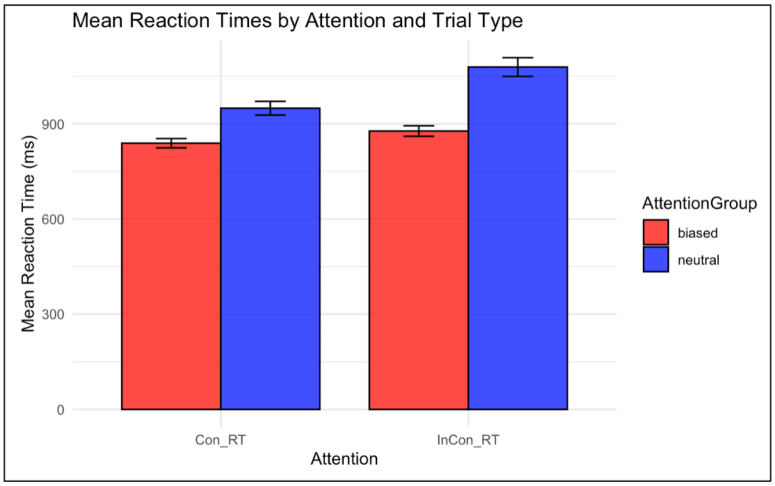

Fig. 3 Response time differences across congruent and incongruent trials for biased and neutral attenders, based on a 2 × 2 ANOVA examining congruency and bias group.

It is unclear why biased attenders have faster overall response times than neutral attenders and show a smaller difference between congruent and incongruent trials. One possibility is the **Relative Skill Hypothesis**, which proposes that individuals with greater expertise in one modality (visual or verbal) process that modality more efficiently. Under this view, both modalities are processed in parallel, but the preferred modality is processed more quickly and therefore dominates the decision, reducing the impact of conflict from the non-preferred modality.

An alternative explanation under the same hypothesis is that biased attenders may not be processing both modalities to the same extent. Instead, they may selectively attend to the modality aligned with their processing preference and devote minimal resources to the non-preferred modality. In this case, faster response times would arise not because one process "wins" a race, but because biased attenders are processing less information than neutral attenders, who distribute attention across both modalities.

These two explanations—parallel processing with differential speed and selective attention to a single modality—are theoretically distinct but not mutually exclusive. Attention research and eye-movement studies suggest that individuals can rapidly orient toward preferred types of information, sometimes with a single rapid eye movement, and may ignore competing inputs entirely (Mahon, Clarke & Hunt (2018), Souto & Kerzel (2021)). Without a fixation point or eye-tracking measures, the current design cannot determine whether biased attenders are (a) processing both modalities but relying on the faster one, or (b) selectively attending to only one modality from the outset. Integrating attention-based models, therefore, provides an important complementary framework for interpreting the observed response time patterns.

To further clarify how these mechanisms might operate in the Card Sorting Task, it is useful to consider how people resolve conflict in other well-studied paradigms, such as the Stroop task, where selective attention, automaticity, and suppression strategies have been extensively documented.

When presented with congruent information, individuals tend to respond quickly as the information shown aligns with people's expectations, while incongruent trials show longer response times because people have to override their intuition to select a response. For example, in the Stroop task, participants are shown a color word (e.g., the word blue) presented in some color of ink, and people are asked to name the color of the ink, not the color that the word says (Stroop, 1935). During incongruent trials where the word doesn't match its ink color (e.g., the word blue printed in red ink), people show longer response times. As reading is a function that individuals practice daily, it is a more automatic process than naming the color of something, driving the difference in response times.

The Card Sorting Task contains this conflict component. Long and Prat (2002) found that if the Stroop task had many conflict trials, people with higher working memory capacity employ a suppression strategy that allows them to selectively pay attention to just the color of the word presented and not the word itself. This leads to faster response times as these people are able to ignore one stimulus and respond more automatically. It is possible that individuals who display a more biased information processing style on the Card Sorting Task are using a strategy similar to suppression, where they selectively attend to the stimulus that is presented in their information processing style modality and ignore the other simultaneously presented information.

This selective attention may reflect not only processing style, but also differences in how people make decisions. Decision-making is shaped and mediated by perceptual preferences and experiences (Prezenski, 2017). Decision-making is shaped by feedback, which participants do not get on incongruent trials in the Card Sorting Task. This ensures that people select an answer based on what they think they should do, reflecting past experiences and habits. Not everyone is perceptive of the conflict in the Card Sorting Task. It is possible that, based on our previous Card Sorting Task data, people who are slowly making decisions may experience more conflict during the task than people who are deciding quickly. This is supported by the **General Decision Strategy Hypothesis**, which maintains that individuals employ different mechanisms to deal with conflicting information. This may be due to a general decision strategy and evidence accumulation, rather than familiarity with a certain type of information, like in the Relative Skill Hypothesis.

A Drift Diffusion Model (DDM) can clarify the strategies used in the Card Sorting Task by separating some of the information processing components that make up simple decision making. Instead of treating a response time as one number, the DDM separates the process into (1) how long it takes to take in the stimulus, (2) how quickly a person accumulates information toward a choice, and (3) how long it takes to execute the motor response. Over many trials, the model estimates these components and provides a measure called drift rate, which reflects how efficiently someone extracts and uses information to make a decision (Myers, 2022). Higher drift means the person is pulling useful information from the stimulus quickly and consistently, while lower drift means the person is gathering information more slowly or noisily.

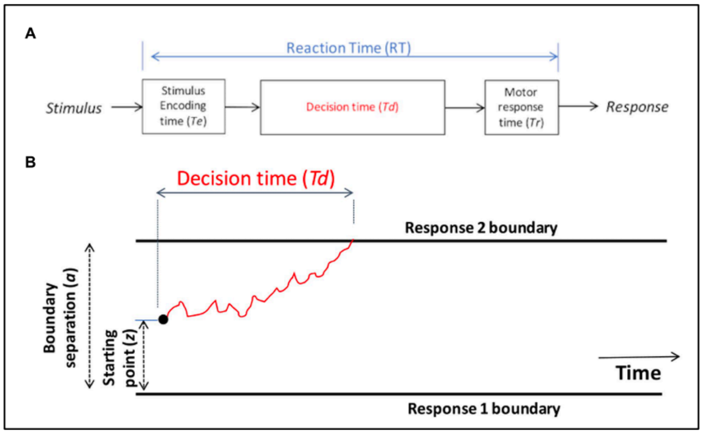

Fig. 4 Illustration of the drift diffusion model. Top: decomposition of response time into stimulus encoding time, decision time, and motor response. Bottom: schematic of core DDM parameters (drift rate, decision threshold, starting point, and non-decision time). Adapted from Myers (2022).

DDM also shows how much evidence an individual accumulates on average before making a decision, which reflects their decision threshold or caution. See Fig. 4. The goal of the proposed study is to use these DDM parameters to adjudicate between two hypotheses that explain our previous results: the Relative Skill Hypothesis, which predicts that people process their preferred modality more efficiently (reflected in drift rate), and the General Decision Strategy Hypothesis, which predicts that differences in response time arise from broader decision strategies, such as how much evidence individuals require before responding (reflected in decision threshold).

A limitation of DDM analyses is that they require correct and incorrect responses to calculate drift rate. Incongruent trials in the Card Sorting Task are ambiguous by nature and do not have correct answers, as they are used to categorize people as visual or verbal attenders. To remedy this, we have created a modified version of the Card Sorting Task. Card Sort Rule has the same parameters as the Card Sorting Task, with the addition of blocks where participants are asked to select either only the picture or only the word. This gives us a correct answer that can be analyzed by the DDM and show the strategies behind individuals' decision-making.

To further examine whether our biased vs. neutral result patterns reflect general decision-making strategies, we created another task that has an ambiguous sorting option. The Circle Sorting Task shows cards with clusters of red and blue circles where one of the colors has a higher count of circles, while the other color has circles that are larger in area. See Fig 5. Its goal is also to determine whether people attend more to one modality or the other, and will be used to determine whether Card Sorting Task results generalize to other mediums.

If the data support the Relative Skill Hypothesis, we expect that people who are more visual may have faster response times when they are asked to sort based on the picture, as the decision will be more automatic. Conversely, people who are more verbal may have faster response times when asked to sort according to the words, because it will be a more automatic process than sorting based on the picture. If the General Decision Strategy Hypothesis is true, we expect that neutral attenders will be more perceptive to conflict than biased attenders, having a longer decision period than biased attenders when selecting an answer in incongruent trials. We predict that biased attenders will have shorter decision periods than neutral attenders, as their decision-making process is more automatic, and they perceive conflict less. Alternatively, neutral attenders and biased attenders have a similar decision period length, which will show that neutral attenders are selecting at random, and not considering options/ engaging in a strategy.

Using Drift Diffusion Modeling, we will be able to follow up on our previous study investigating the individual differences in information perception in the Card Sorting Task. This study will show what strategies are used by individuals in decision-making, and to what degree information processing and bias have an impact on it. It will also show to what extent Card Sorting Task results generalize to other modalities.

Methods

Participants

Data were collected from 175 participants total, 17 of whom were removed after cleaning. 9 of those participants were removed for having incomplete data, and 8 participants were removed for having an accuracy < 75%. All individual trials with response times outside three standard deviations of the mean were removed as well. Less than 1% of all trials were removed. Of these, data was collected for both card sort switch and circle sort from 114 participants. This is lower than the goal of 256 participants, computed using a power analysis at the 0.8 level. Participants were recruited through the subject pool and through campus advertising.

Materials

Card Sorting Task

Participants completed the Card Sorting Task, which measures how much an individual attends to visual or verbal information (Alfred, 2020). In this task, participants were simultaneously shown a picture and a word description of one of three card suits: ‘club’, ‘heart’, or ‘spade’, and asked to select which suit is shown using the ‘f’, ‘g’, and ‘h’ keys, respectively. 75% of the trials were congruent trials, meaning that the visual (picture) and verbal (word) representations of the card suit match (e.g., participant is shown a picture of a heart and the word heart). 25% of trials were incongruent, meaning that the visual and verbal representations of the card suit do not match (e.g., participant is shown a picture of a spade and the word heart). The suit representations were aligned one above the other on the screen: on 50% of the trials, the picture was on top, and on the other 50%, the word was on top, counterbalancing across the experiment. See Fig. 1. Stimuli were presented in two blocks of 48 trials each (36 congruent and 12 incongruent), with a break in between each block.

Card Sort Rule Task

To investigate our hypotheses of interest about decision making, we created the Card Sort Rule Task. This task contains the same stimuli as the Card Sorting Task, but the instructions are modified. Rather than allowing participants to freely choose which type of information to use when sorting stimuli, they were instructed to use only one type of information (i.e., pictures) to sort stimuli into 'heart', 'spade', or 'club' categories using the 'f', 'g', and 'h' keys (See Fig. 5).

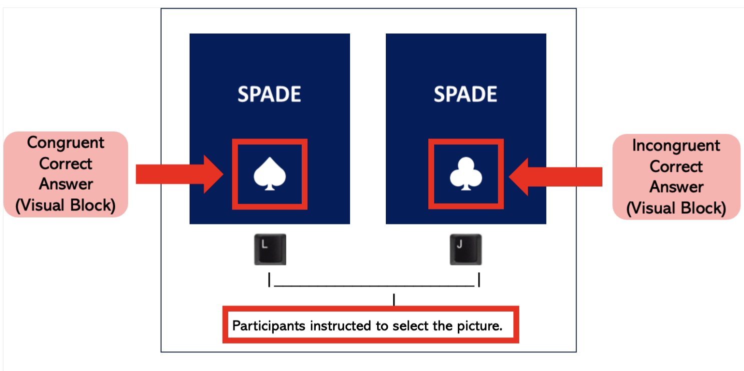

Fig. 5 Congruent and incongruent examples of Card Sort Rule trials.

The Card Sort Rule Task consists of 4 blocks of 48 trials per block, with breaks in between. Incongruent and congruent trial ratios were balanced across blocks. Participants completed two blocks in a row of picture sorting and two blocks in a row of word sorting, the order of which was counterbalanced across participants.

Circle Sorting Task

Each stimulus on the Circle Sorting Task consisted of a combination of red and blue circles differing in number and area. Participants were asked to indicate which color they saw more of using either the 'q' or 'p' keys. The instruction was intentionally ambiguous so that "more" could refer either to the number of circles or to the aggregate area they occupied. Across trials, the two colors always differed in count, with possible pairings of two versus three, three versus four, two versus four, and two versus five circles. There were 64 trials of each count pairing. The two colors also differed in total area, with one color being either 20% or 30% smaller than the other; 128 trials were generated for each area difference, making 256 trials total.

Circle sizes were computed so that the individual circle areas and the summed areas matched the intended relationships between the two colors. All circles were generated by first determining the required total area for each color set and then converting that area into individual circle diameters. To make sure individuals weren't using individual circle size as a shortcut, we created two congruent trial types. In the first type, the color with the fewest number of circles also had smaller individual circles and a smaller total area (e.g., a card is shown with three red circles that have a total area 20% smaller than the area of four blue circles on the same card, and each individual red circle is smaller than each individual blue circle). To create these stimuli, the diameter of the larger circles (the higher-count set) was used as a starting point, and the diameter of the smaller circles was scaled by the square root of the proportion remaining after the 20% or 30% reduction. This ensured that each individual circle in the lower-count set was proportionally smaller and that the summed area of that set was correspondingly reduced.

In the second type of trial, the color with the fewest number of circles contained larger individual circles, but a smaller total area (e.g., a card is shown with three red circles that are in total 20% smaller than the four blue circles on the same card, but each individual red circle is larger in area than each individual blue circle when compared individually). To construct these stimuli, the total area of the higher-count set was first calculated from its diameter and number of circles. This total area was then reduced by the appropriate percentage to determine the required total area for the lower-count set. Dividing this reduced total area by the number of circles in the lower-count set yielded the target individual circle area, which was then converted back into a diameter. This produced stimuli in which each circle in the lower-count set was larger than each circle in the higher-count set, while the summed area remained smaller.

In incongruent trials, the higher-count set consisted of smaller circles, whereas the lower-count set consisted of larger circles, creating a conflict between number and area. (e.g., a card is shown with two big blue circles and three small red circles). See Fig. 6. These stimuli were generated by first calculating the total area of the lower-count set from its initial radius, then reducing this area by 20% or 30% (in equal numbers) to determine the required total area for the higher-count set.

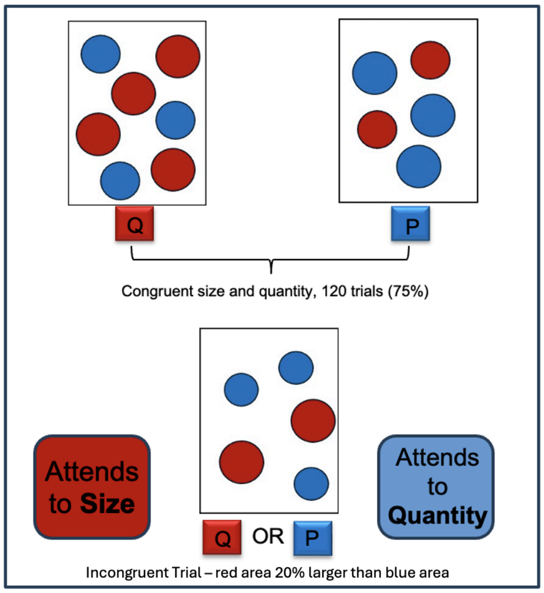

Fig. 6 Example congruent (top) and incongruent (bottom) trials from the Circle Sorting Task, showing how count and area information can align or conflict.

Dividing this reduced total area by the number of circles in the higher-count set yielded the individual circle area for that set, which was then converted into a radius and used to generate the stimuli. This procedure ensured that the higher-count set always had smaller individual circles and the lower-count set had larger individual circles, producing the intended conflict. Incongruent trial responses were used to categorize participants as relying more on count-based information (associated with left-hemisphere processing) or area-based information (associated with right-hemisphere processing).

The task consisted of eight blocks of 32 trials, with 75% congruent and 25% incongruent trials. All circle configurations had color-flipped counterparts, and congruent and incongruent trials, area differences, count differences, and response-key mappings were counterbalanced across participants.

Procedure

All tasks for this study were administered synchronously on Zoom and the online platform PsyToolkit (Stoet, 2010; 2017). Participants were required to complete the tasks on laptops with working keyboards. Participants gave consent, completed a brief demographics questionnaire, and then completed the Card Sorting Task, Card Sort Rule, and Circle Sorting Task. The Card Sorting Task took approximately five minutes, with breaks in between both blocks. The Card Sort Rule immediately followed the Card Sorting Task. It contained four blocks with breaks in between and took approximately ten minutes to complete. Two of the four blocks instructed participants to select only the word, while the other two blocks instructed participants to select only the picture. The Circle Sorting Task was administered last and contained eight blocks with breaks in between each one. It took approximately fifteen minutes to complete. The battery of tasks took approximately 30 minutes to complete, including breaks.

Pre-Analysis

Card Sorting Task

Before analyzing data from our new tasks, the Card Sorting Task was used to characterize and categorize visually-biased, verbally-biased, and neutral attenders. First, participants were given a bias score calculated by subtracting the number of picture responses from the number of word responses for incongruent trials and dividing that number by the number of correct trials. Incorrect trials are incongruent trials in which the participant chooses a suit that is not presented on the screen (e.g., the screen shows a picture of a heart and the word spade, and the participant sorts the trial as a club), and these trials were discarded. The remaining incongruent trial responses were used to categorize participants as having a visual or verbal attentional bias; sorting according to words much more frequently than pictures reflects a verbal bias, and sorting according to pictures much more frequently than words reflects a visual bias. The bias score lies between -1 and +1, with -1 indicating a purely visual bias, 0 representing no bias, and +1 indicating a purely verbal bias. Individuals with a bias score above 0.8 and below -0.8 (90% of trials selected in either visual or verbal) were categorized as biased attenders in group analyses, and others (those equal to or between -0.8 and 0.8) were categorized as neutral attenders. 76 participants were categorized as neutral attenders, and 82 were categorized as biased attenders (Fig. 7).

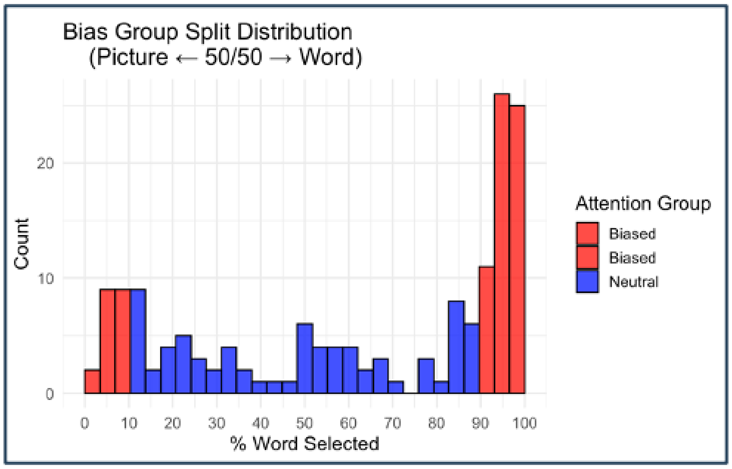

Fig. 7 Distribution of attentional bias in the Card Sorting Task.

Absolute bias score was also calculated due to biased attender categorization having either a high verbal/count preference or a high visual /spatial information preference, which are on opposite sides of the bias scale. Using an absolute bias score folds the data in half and assesses individuals based on the degree of bias, regardless of visual or verbal bias.

Circle Sorting Task

Another bias score was calculated for the Circle Sorting Task. For each participant, the number of spatially big circle responses was subtracted from the number of higher count responses and divided by the total number of

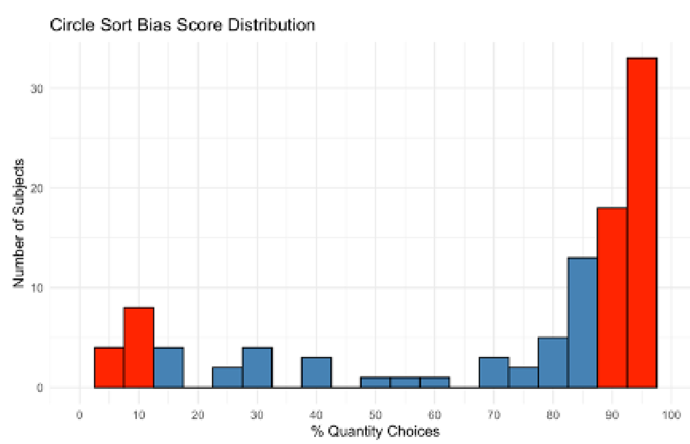

Fig. 8 Plot showing attentional bias distribution in the Circle Sorting Task.

trials. There were no incorrect trial responses. This bias score also lies between -1 and +1, -1 to 0 indicating a spatial bias and 0 to +1 indicating a count bias. A score of +1 indicated that the participant chose the circles with a higher count on each trial, and a score of -1 indicated that the participant chose the circles with a larger area on every trial. A score of zero indicated that the participant selected both bigger area and higher count circles an equal amount. A bias score above 0.8 and below -0.8 indicated a biased attender, while a score between those indicated a neutral attender (Fig. 8). Absolute bias score was also calculated.

Drift Diffusion Modeling

Drift diffusion models were fit using the *brms* package (Bürkner, 2017) with the Wiener diffusion family, which implements a standard four-parameter DDM. Reaction times were recorded in milliseconds and converted to seconds prior to model fitting, as required by the Wiener parameterization. Models were estimated separately for each participant to obtain individual-level estimates of drift rate (v), decision threshold (a), non-decision time (t_0), and starting point (z). Although the Card Sort Rule task involved three possible keypresses, the drift diffusion model was applied to a binary decision by coding responses as upper boundary crossings and incorrect responses as lower boundary crossings. Each model used the default *brms* parameterization: rt | dec(response = "upper")~1 and was fit using Monte Carlo with 4 chains, 2000 iterations per chain, and the *cmdstanr* backend. Priors were left at *brms* defaults. The resulting participant-level parameters were used in subsequent analyses of the Card Sort Rule.

Results

Card Sorting Task

Behavioral Results

To replicate our original study, a 2 (congruency) x 2 (bias group) ANOVA was computed using correct item response times, with congruency being a within-participant manipulation and bias group being a between-subject manipulation based on a post-hoc grouping of subjects into “biased” and “neutral” groups.

Neutral attenders responded more slowly overall (M = 989.5 ms, SD = 249.3 ms), whereas biased attenders responded more quickly (M = 861.5 ms, SD = 197.8 ms). Consistent with expectations, participants responded more slowly on incongruent trials than on congruent trials (congruent: M = 884.6 ms, SD = 196.7 ms; incongruent: M = 954.4 ms, SD = 244.9 ms; see Figure 9).

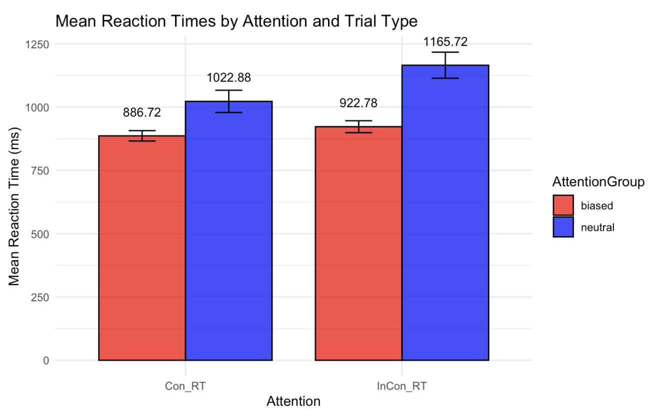

Fig. 9 Replication of prior findings (Fig. 3) showing response time differences between congruent and incongruent trials as a function of attentional bias group.

A main effect of congruency was found, $F(1, 156) = 15.13$, $p < .001$, with longer response times on incongruent trials. A main effect of the bias group was also found, $F(1,156) = 29.60$, $p < .001$, with neutral attenders taking longer than biased attenders. An interaction between bias group and congruency was found with $F(1, 156) = 10.54$, $p = .007$, indicating that biased attenders showed a smaller incongruency effect than neutral attenders.

To follow up the significant interaction, an incongruency effect was computed for each participant (incongruent RT – congruent RT). Neutral attenders showed a larger incongruency effect ($M = 118.87$ ms) than biased attenders ($M = 29.44$ ms), $t(117.67) = -4.07$, $p < .001$, indicating that neutral attenders exhibited greater slowing on incongruent trials relative to congruent trials than biased attenders.

Together, these results replicate our previous finding that attentional bias relates to how much conflicting information affects response times.

Card Sort Rule

We analyzed the Card Sort Rule trials using drift diffusion modeling to examine the differences between response times of biased and neutral attenders as well as the differences between response times in visual and verbal biased attenders, as affected by the congruency of the trial block to the participant's modality bias. As is necessary, error trials were included in the DDM analysis.

Behavioral Results

An independent-samples *t*-test showed no significant difference in response times between biased and neutral attenders in the Card Sort Rule task, $t(93.99) = -1.239$, $p = 0.2184$ (biased: $M = 792$ ms, $SD = 387$; neutral: $M = 849$ ms, $SD = 515$). Verbally biased individuals responded faster on word-sorting trials than on picture-sorting trials ($M = 738$ ms, $SD = 360$; picture: $M = 869$ ms, $SD = 454$). Visual attenders also showed faster responses on word trials, but the difference was small ($M = 749$ ms, $SD = 319$; picture: $M = 767$ ms, $SD = 297$).

A 2 (Trial Type: word, picture) × 2 (Bias Group: verbal, visual) mixed ANOVA revealed a significant main effect of Trial Type, $F(1, 80) = 25.14$, $p < .001$, with faster responses on word trials than picture trials. The main effect of Bias Group was not significant, $F(1, 80) = 1.62$, $p = .206$, indicating that verbal and visual attenders did not differ in overall response speed.

The Trial Type × Bias Group interaction was significant, $F(1, 80) = 14.25$, $p < .001$, demonstrating that the magnitude of the word–picture RT difference was much larger for verbally biased individuals than for visually biased individuals.

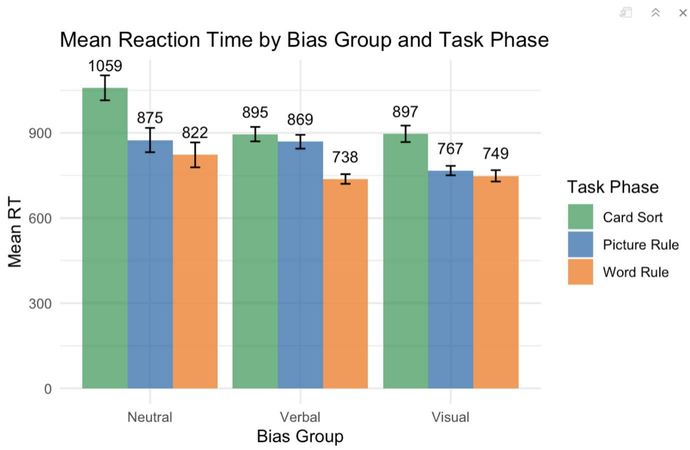

Fig. 10 Histogram of mean response times across task conditions for neutral, visually biased, and verbally biased participants.

To follow up the significant Trial Type × Bias Group interaction, a difference score was computed for each participant (word RT – picture RT). Verbal attenders showed a larger difference score (M = −131.24 ms) than visual attenders (M = −18.49 ms), $t(66.19) = -5.22$, $p < .001$, 95% CI [−155.87, −69.63], indicating that verbally biased individuals exhibited greater slowing on picture-sorting trials relative to word-sorting trials.

Neutral attenders followed the same pattern as visual attenders with relatively similar response times in both sorting categories. Figure 10 illustrates these response-time patterns across trial types.

DDM

Comparing Drift Rates. The Relative Skill Hypothesis predicts faster evidence accumulation, as measured by DDM drift rates, when trial type (visual versus verbal sort) matches an individual's processing bias. As expected, verbal attenders had faster drift rates on trials where they were instructed to select the word than on picture trials. Unexpectedly, visual attenders also showed faster drift rates on verbal trials.

A 2 (trial type, visual rule vs. verbal rule) x 2 (bias group, visual biased vs. verbal biased) ANOVA, where trial type is within subjects and bias group is between subjects, yielded a significant main effect of trial type, $F(1, 77) = 15.13$, $p < .001$, with faster drift rates on verbal trials regardless of bias. A trending main effect of bias group, $F(1, 77) = 3.87$, $p = .053$, suggested that visually biased individuals had faster drift rates than verbally biased individuals.

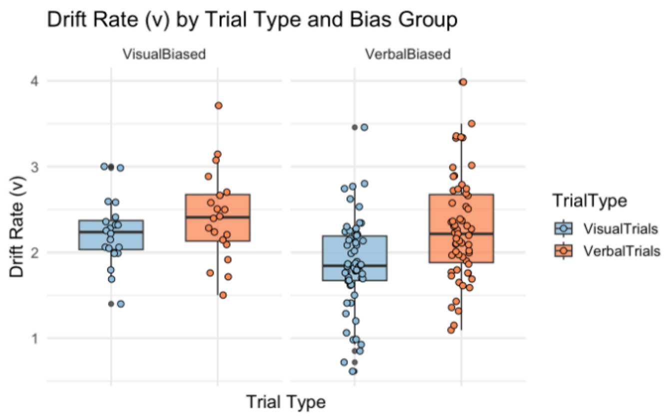

Fig. 11 Drift rates for visual-biased and verbal-biased attenders during picture-sorting and word-sorting blocks of the Card Sort Rule Task.

A trending interaction was also observed, $F(1, 77) = 3.27$, $p = .075$ (Fig. 11).

This suggests that although both groups showed faster drift rates on verbal trials, the size of this advantage differed by bias group. Verbal attenders showed a larger verbal trial benefit than visual attenders, whose drift rate difference between picture and word trials was smaller.

Comparing Decision Thresholds in Neutral and All Biased Attenders. A t-test analyzing differences between decision thresholds in neutral and biased individuals was not significant, $t(146) = -0.036$, $p = 0.97$, indicating that the amount of evidence required before making a decision did not differ between groups (Fig. 12). These results do not support the idea that biased and neutral attenders differ in their general decision strategy.

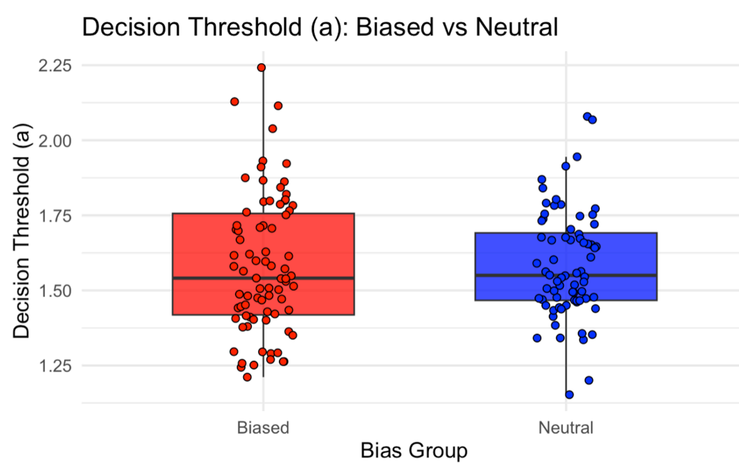

Fig. 12 Decision thresholds for biased and neutral attenders, illustrating group differences in level of certainty needed before making a decision.

Cross-Task Results

Decision Strategy Analysis

A chi-square test indicated no significant association between categorization as a biased or neutral attender (bias score > 0.8 or < -0.8 categorized as biased, everyone else neutral) in the Card Sorting Task and the Circle Sorting Task, $\chi^2(1, 103) = 1.624$, $p = .20$. The decision strategy group in the Card Sorting Task did not predict decision strategy group in the Circle Sorting Task.

Individual Differences Analysis

A Pearson correlation (Fig. 13) assessing the relationship between **absolute bias scores** in the Circle Sorting and Card Sorting tasks showed **no significant association**, suggesting that the magnitude of participants' bias was task-specific rather than reflecting a shared underlying tendency.

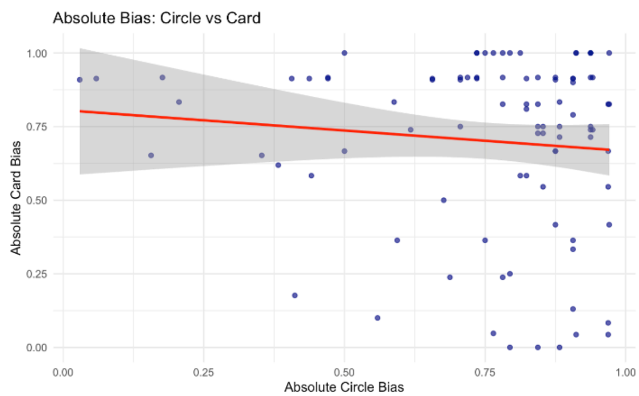

Fig. 13 A scatterplot showing the correlation between absolute bias score in the Card Sorting Task and Circle Sorting Task.

Discussion

Neither the Relative Skill Hypothesis nor the General Decision Strategy Hypothesis fully explain how people make decisions when there is conflicting information present. One conclusion is clear: the General Decision Strategy Hypothesis is rejected, while there is some evidence that relative skill—and specifically people's familiarity with verbal information—plays a role in shaping how quickly they make decisions.

The General Decision Strategy Hypothesis proposed that differences in Card Sorting Task performance were driven by reduced sensitivity to conflict. Across several analyses of data from two tasks, none of the predictions of this hypothesis were supported. First, DDM analysis of the Card Sort Rule Task found no differences in the decision thresholds of biased and neutral attenders. If biased attenders were simply “fast” or impulsive decision makers who require less evidence to make a decision, or if neutral attenders were “slow” or more cautious and needed to accumulate more information before making a decision, we should have seen clear separation in threshold parameters. Instead, the thresholds were statistically identical, indicating that both groups approach the decision process with similar levels of information. Second, there was no correspondence between the strategies people used in the Card Sorting Task and the Circle Sorting Task. The degree and direction of bias in the Card Sorting Task were not related to Circle Sorting Task performance. This indicates that if the results in the Card Sorting Task were driven by a general decision strategy rather than relative skill, that strategy is not the same one as is used in the Circle Sorting Task.

Although the Relative Skill Hypothesis was not fully supported, several patterns are consistent with its prediction, suggesting that modality-specific processing still plays a role in how people approach the task. Verbal attenders were faster and had higher drift rates when sorting by words than when sorting based on pictures. Verbal attenders also had higher drift rates and faster response times than visual attenders on word-sort trials. Visual attenders showed faster response times and higher drift rates when sorting based on pictures compared to verbal attenders. Unexpectedly, word-sorting was consistently faster than picture-sorting for all participants. This indicates that although everyone is faster with words, visual attenders still have an advantage over verbal attenders when it comes to picture sorting.

The fact that visual attenders were still faster on word-sorting than picture-sorting points to a larger, experience-driven advantage for verbal information. People read constantly, while naming pictures is comparatively rare. This everyday familiarity and exposure to reading likely accelerates verbal processing for everyone, including individuals who otherwise prefer visual information. In this sense, the relative skill hypothesis is partially supported, but it operates on top of a strong, experience-based advantage for words.

Several limitations should be considered when interpreting these findings. First, the study did not reach the planned sample size of 256 participants; instead, usable data were obtained from 158 individuals for the Card Sorting Task, and 114 individuals for both the Card Sort Rule and the Circle Sorting Task. Though we had to stop and analyze data, we plan to continue collecting data until we reach our target. Only 20 participants qualified as visual attenders, compared to 62 verbal attenders. As a result, estimates for visual attenders are based on relatively sparse data, which increases uncertainty and limits the strength of conclusions specific to visual-biased participants.

Additionally, the Circle Sorting Task is a new task with entirely visual parameters, as compared to the Card Sorting Task, which had both verbal and visual components. As with the Card Sorting Task, the Circle Sorting Task was developed to measure ambiguous decision-making. Unlike the Card Sorting Task, the Circle Sorting Task included almost no neutral attenders, and biased attenders were actually *slower* than neutral attenders when resolving conflict. This pattern may stem from the second type of "congruent" trials used in the task, in which a large number of small circles made up the larger total area. This may have created something like a Stroop effect because the correct answer to which color had "more" is one with smaller circles. Responses to these types of trials were slower and less accurate overall.

A key next step is collecting a larger sample so that the planned analyses can be carried out with the power they were designed for. In order to investigate decision-making in the Circle Sorting Task further, we will look at just congruent type 1 trials so as to eliminate the more ambiguous congruent trials.

Taken together, these preliminary results look promising for helping us adjudicate between our two hypotheses about individual differences in decision making.

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