**Research Strategy**

**Significance**

**Autism Spectrum Disorder (ASD)** refers to a group of neurodevelopmental disorders of yet unknown etiology. The main characteristics of ASD include atypical social cognitive capacities such as theory of mind and cognitive empathy1,2. Recently there has also been a growing interest in sensory processing in autism as a core phenotype. Sensory symptoms serve as an independent diagnostic criterion, show a persistent relationship to clinical measurement of higher-level social behavior, and are evident early in development3-5. Researchers estimate that atypical sensory processing occurs in as many as 90% of autistic individuals6,7 and in every sensory modality7 8,9 10,11 12,13 14,15. Thus, investigating potential mechanisms that bridge across alterations in sensory perception and cognition may shed light on core mechanisms of ASD and their role in altering both simple and complex behaviors. Here we propose to investigate a key process at the interface of perception and cogntion: perceptual decision making.

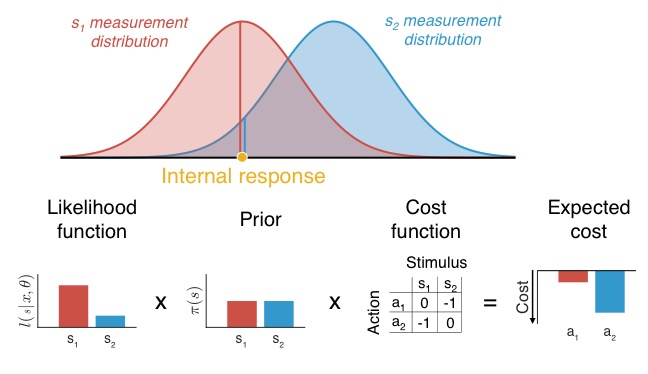
Perceptual decision-making is the process of making an inference about a world state based on sensory information. For example, you might want to infer the emotional state of your friend based on her facial expression. Perceptual decision-making involves uncertainty due to both noisy sensory information (you are meeting your friend in a dimly lit bar) and ambiguity (your friend’s lack of a smile might mean that she is sad or that she is relaxed). Therefore, combining the sensory evidence with prior knowledge (your friend just broke up with someone) can help you correctly determine her emotional state. Your perceptual decision can also be influenced by the expected rewards or costs of actions that follow from your decision. For example, failing to comfort your friend when she is sad may be more costly than trying to comfort her when she is just relaxed. Thus, different sources of context can affect perceptual decisions even with the same sensory evidence. These three sources of information—sensory evidence, prior information, and the rewards or costs of actions—are the three components of Bayesian decision theory, a standard and highly general formal approach to understanding decision behavior. The purpose of this proposal is to test how each Bayesian component contributes to perceptual decision making and metacognition in individuals with ASD.

Given the important role of perceptual decision-making in everyday life, it is surprising that relatively few studies have investigated perceptual decision-making in ASD. Nonetheless, one insight from these studies is that relative to neurotypicals, perceptual decision-making in ASD is less flexible [CITE[[AY2]](" \l "_msocom_2" \t "_blank) ] and less able to adjust to changing context [CITE]. Relatedly, it has been proposed that individuals with ASD have “weak priors” [CITE]. However, empirical tests of the weak priors idea have been limited, with mixed results [CITE], so it is still unclear what computational mechanisms underlie decision inflexibility in ASD. Here we use straightforward experiments founded on Bayesian decision theory to address this question.

Importantly, when faced with uncertainty, reflecting on your own decision process using metacognition can lead to adaptive strategies to reduce uncertainty and improve decision accuracy. For example, knowing that you have low confidence about whether your friend looks sad can lead you to rely more heavily on your prior knowledge of her breakup, or to seek more information (e.g., look at her from a different angle). These strategies may improve your perceptual decision. Perceptual decision confidence is a basic metacognitive capacity. Metacognition, in turn, has been proposed to be linked to theory of mind, making it especially relevant for autism, and is associated with real-world outcomes like academic success [CITE]. A recent meta-analysis indicates that individuals with ASD have impaired metacognition [CITE], but results are heterogeneous, and the computational principles underlying such impairments are unclear. No study has investigated how individuals with ASD incorporate the components of Bayesian decision theory into metacognitive decisions.

Bayesian inference is a general computational model that optimally combines likelihood (e.g., sensory evidence), prior belief (e.g., sensory expectation) and cost (expected outcome) (**Fig 1**). Bayesian computations may be widespread in cortical processing, from lower-level sensory processing to higher-level cognitive processing. At the interface of perception and cognition, **perceptual decision making is the domain in which Bayesian computations are most straightforwardly testable**. The components of Bayesian decision theory can be directly manipulated, and the resulting behavior can be measured with sensitive psychophysical methods and analyzed with well-developed analytical tools. Understanding basic perceptual decision computations in ASD may therefore shed light on how cortical computations more generally may be altered (or intact) in ASD.

**Fig 1**. **Graphical depiction of Bayesian inference**. An observer is deciding between two possible stimulus orientations – s1 (e.g., counterclockwise from horizontal) and s2 (e.g., clockwise from horizontal) – which produce Gaussian measurement distributions of internal responses. The observer’s internal response varies from trial to trial. On a given trial, the likelihood function is equal to the height of each of the two measurement densities at the value of the observed internal response (lines drawn from the yellow circle) – that is, the likelihood of each stimulus given an internal response. The action ai corresponds to choosing stimulus si. We obtain the expected cost of each action by multiplying the likelihood, prior, and cost corresponding to each stimulus and then summing the costs associated with the two possible stimuli. The optimal decision rule is to choose the action with the lower cost (the bar with less negative values). In this example, the prior and cost function are unbiased, so the optimal decision depends only on the likelihood function. (Rahnev & Denison, 2018).

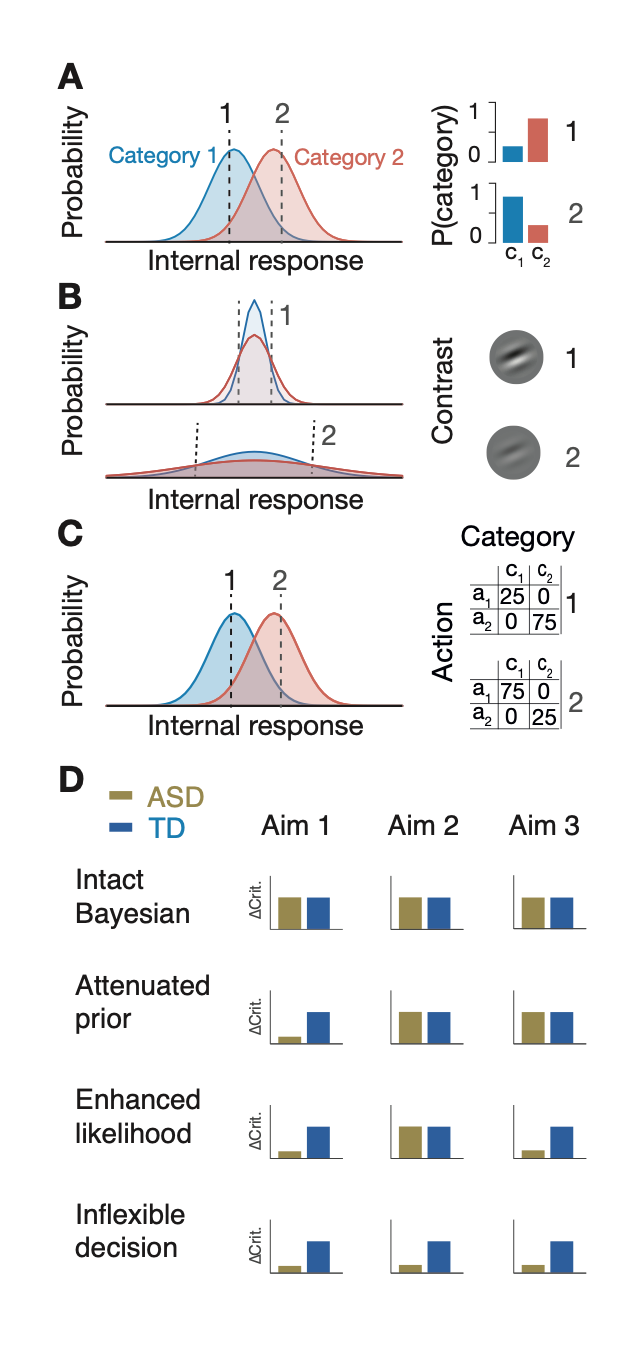


Attempts to explain ASD sensory processing using Bayesian inference have postulated atypical integration of prior belief with likelihood. However, no study has provided direct evidence for an atypical effect of prior belief in ASD sensory processing, and investigations of prior belief on perceptual-decision making in ASD yielded mixed results [28,29, 21,26]. These studies, along with the vast majority of studies applying Bayesian theory to ASD, focused on the prior and its integration with likelihood and did not test the independent contribution of each Bayesian component to the decision process in ASD.

``A **barrier to progress** in understanding whether and how Bayesian computations are altered in ASD is the lack of research that manipulates each Bayesian component and examines its effects on perceptual decision behavior. **This systematic investigation of all Bayesian components in ASD is the core of our proposal.** Using a common stimulus set and analytical framework, we will test the influence of prior (**Aim 1**, **Fig 2A**), sensory uncertainty (**Aim 2**, **Fig 2B**), and reward (**Aim 3**, **Fig 2C**) on perceptual decision making (decision criterion) in ASD. We will test whether the results generalize to social behavior (**Aim 4**). In all aims, we will test both first-order perceptual decision making and higher-order metacognitive decision making to probe the generalizability of our findings from more perceptual to more cognitive decisions. We will compare clinical ASD and control typically developed (TD) groups, and we will relate decision behavior to the symptom severity and sensory profile of participants. Our team is ideally suited to carry out this proposal, with one of only a few ASD research groups in the world doing multi-session psychophysics, expertise in Bayesian perceptual decision making, and a history of successful collaboration on these topics33,34. With the proposed suite of investigations, **we will acquire a unique dataset and apply rigorous modeling to determine which aspects of perceptual decision making are altered in ASD** (**Fig 2D**).

**Perceptual decision-making as a bridge between perception and cognition in ASD**

**Fig 2. Aims and predictions**. (**A**) In Aim 1, we will manipulate prior by varying the base rate probability of each category in a categorization task (Task A). Optimal use of the prior predicts a criterion shift to more liberally choose the more probable category. (**B**) In Aim 2, we will test whether and how a likelihood manipulation affects decision boundaries in the embedded category task (Task B). Optimal use of likelihood predicts a criterion shift to more liberally choose the lower variance category as stimulus contrast decreases. (**C**) In Aim 3, we will manipulate the cost function by varying the category-specific reward on correct trials in a categorization task (Task A). Optimal use of reward predicts a criterion shift to more liberally choose the more rewarded category. (**D**) Predicted results for criterion shift (condition 1 vs. 2) in each group and in each aim, for the different hypotheses.



Whereas many studies applying a Bayesian framework to ASD have explored perceptual effects like illusions35, our approach is to focus squarely on explicit perceptual decision making, using choice tasks that have been widely used in studies of perceptual decision making in TD populations. This strategy embraces the fact that the Bayesian framework is, fundamentally, a theory of decision making under uncertainty, and it disentangles learning (e.g., of implicit priors) from decision processes. It also addresses an important **gap in knowledge** of ASD: there has been much research into sensory processing and higher-level cognition (like social cognition), but less work on the decision processes that mediate between perception and high‑level cognition. Our proposed investigation will address this gap.

To further strengthen the bridge between perception and high-level cognition in this proposal, **we will investigate not only first-order perceptual decisions about sensory categories, but also higher-order, metacognitive decisions** about the perceptual decisions themselves—that is, decision confidence. Perceptual metacognition in ASD has rarely been investigated. Doing so will allow us to test, using a common set of stimuli and tasks, whether and how metacognitive decisions are altered in ASD and how metacognitive decision processes compare to perceptual decision processes. Our preliminary data show that our ASD participants can make meaningful simultaneous category and confidence reports, with a strong first indication that perceptual metacognition is intact in ASD (**Fig 3D**).

**Clinical significance of the proposed research**

Determining whether and how perceptual and metacognitive decision processes are altered in ASD has potential clinical and practical impacts for this population: 1) Understanding basic decision computations can give insight into underlying cortical mechanisms, which in turn may allow the development of new treatments. 2) Understanding which Bayesian components are affected in ASD can guide rehabilitation protocols. Currently it is unclear whether decision making (decision criterion) is altered in ASD, which could potentially benefit from tailored instructions and training. It is also unclear whether reward processing is intact in ASD, with implications for motivation during training and education. 3) Findings of either improved or impaired Bayesian computations could open vocational avenues for individuals with ASD, as reduced prior or reward integration can actually improve decisions in settings in which only sensory evidence matters for the task at hand. 4) Knowing whether and how metacognition is affected in ASD can guide how clinicians and educators interpret the explicit reports of people with ASD about their own decisions and knowledge. 5) We will directly relate perceptual decision making and metacognitive skills to standard clinical metrics. **6) We will test the dissociation between ADHD and ASD in decision making. 7) We will generalize our finding to the perception of emotion, which may explains alteration in social behavior.**

**Innovation**

Our proposal is innovative at both theoretical and methodological levels. **Theoretical innovation:** 1) We will systematically investigate all components of the Bayesian framework of perceptual decision making in a clinical ASD population. Experimentally manipulating rather than inferring Bayesian components will allow us to determine which Bayesian component (if any) is altered in perceptual decision making in ASD. 2) To bridge the gap between perception and high-level cognition, we investigate both perceptual decision making and metacognition, a novel focus in ASD research. **Methodological innovation:** We apply experimental and model fitting methods, developed to study perceptual and metacognitive decision making in TD populations, to ASD. Critically, we use SDT to separate the influence of sensory uncertainty (or noise) from those of biases (due to priors or rewards) on perceptual decision making. Although straightforward, this approach has hardly ever been used to study clinical ASD populations34. We also employ a recently developed experimental method to determine how changes in sensory uncertainty alone are incorporated into perceptual decisions, which is not possible using standard SDT. This will allow us to determine whether ASD individuals have difficulty adjusting their decision criteria, independent of needing to incorporate priors or rewards, which involve extra computations. Furthermore, previous studies manipulated priors implicitly, which confounded prior use with prior learning. Here we isolate use of priors by manipulating them using explicit instruction. Finally, we include innovative knowledge indication tasks to test whether participants correctly understand the prior and reward instructions, thereby avoiding the pitfall of being unsure whether participants have learned the experimenter-defined priors and rewards34, which can complicate interpretation of results. We will directly link perceptual decision makng with basic stimulus and that with emotional faces.

**Approach**

**Fig. 3.** Preliminary data for Aim 1. (**A**) Sensitivity (d’) as function of contrast. (**B**) Criterion shift as a function of contrast. (**C**) Deviation of observers’ criterion shift from optimal. (**D**) Proportion correct as a function of confidence (H=high to L=low). Error bars ±1 SE.



To disentangle the effects of prior, likelihood, and reward on decision criteria, we will independently manipulate each component. To confirm the success of our manipulations, we will also measure their effects independently, separate from the main decision task. This approach will enable us to control for a variety of possible group-difference confounds, such as task comprehension, understanding of probabilities and rewards, learning, sensory sensitivity, and task difficulty. To allow findings to be compared across aims, in all experiments we will use the same stimuli and basic procedure of orientation categorization tasks. To disentangle decision criterion and perceptual sensitivity from overall performance, we will use SDT and other modeling approaches.

**General Protocol**

*The protocol is the same for all experiments unless otherwise specified. In all experiments, counterbalancing is included but not described for lack of space.*

**Participants.** Forty adults diagnosed with high-functioning ASD, with typical IQs, will participate in each experiment, as well as 40 matched TD controls. We will recruit male and female ASD participants according to their proportions in the general population. Our goal is to employ a within-subjects design, with all participants completing all experiments (in different sessions). Dr. Hadad’s lab has a reliable ASD subject pool, with participants routinely completing multiple sessions. However, the project does not rely on a within-subject design across aims, and we will be able to complete our data collection even if some participants only completed one session. ASD diagnosis will be confirmed using the DSM-V, the Autism Diagnostic Observation Schedule (ADOS-2) and the Autism Diagnostic Interviews (ADI-R). TD and ASD participants will be matched on chronological age (within two years), IQ (within one standard deviation) as measured by the Hebrew versions of the abbreviated IQ scales from the appropriate Wechsler Intelligence Scale (WAIS-III/WISC-IV/WASIII). Participants will complete the Sensory Profile to examine possible associations between sensory and decision behavior. Participants will also complete the Autism Quotient, a well-validated measure of broader autism phenotype traits. Dr. Hadad’s lab has already measured ADOS scores and sensory profiles for many of the participants in the subject pool. A power analysis based on previous studies28,29,31 and pilot data indicates that 40 participants per experiment will be sufficient to detect reliable mean differences and correlations within and between groups in each experiment.

**Apparatus.** All studies will be performed in Dr. Yashar's lab at the University of Haifa, where our pilot data was collected. Stimuli will be presented on a gamma-corrected monitor.

**Stimuli and procedure**. Stimuli and procedure are based on Adler and Ma (2018)36. **Fig 4** illustrates the general stimuli and tasks. Each trial will begin with fixation followed by the stimulus display. The stimulus will be a sinusoidal grating presented at the center of the screen. In each trial, the grating orientation will be drawn from one of two orientation categories with Gaussian distributions (**Fig 4B**). Observers will report both their category choice (category 1 vs. 2) and their degree of confidence on a 4-point scale using one of eight keys, ranging from high-confidence category 1 to high-confidence category 2 (**Fig 4C**). Using a single key press for choice and confidence minimizes post-decision influences on the confidence judgment37 and emphasizes that confidence should reflect the observer’s perception rather than their motor response. In all experiments we will vary stimulus contrast across seven values to control for performance level and to manipulate likelihood. This will enable us to obtain a contrast response function for each observer and to compare decision criterion across the same sensitivity values.

*Categories.* We use continuous orientation distributions for each choice category, which, critically, will allow us to disentangle the observer’s sensory noise from their decision rule (Denison et al., 2018; Lee, Denison, Ma in revision). In Task A, used in the prior and reward experiments (Aims 1 & 3), stimulus orientations will be drawn from Gaussian distributions with means μ1 = −4 ̊ (category 1) and μ2 = 4 ̊ (category 2) and standard deviations σ1 = σ2 = 5 ̊ (**Fig 4B**, Task A). In Task B, used in the likelihood experiment (Aim 2), stimulus orientations will be drawn from Gaussian distributions with means μ1 = μ2 = 0 ̊, and standard deviations σ1 = 3 ̊ (category 1) and σ2 = 12 ̊ (category 2) (**Fig 4B**, Task B). We chose these category means and standard deviations such that the accuracy of an optimal observer would be around 80%.

### **Instructions.** We will follow instruction and task protocols from Denison et al. (2018)31 and Adler & Ma (2018)36 and so for brevity, give only the critical points here. Observers will be provided with a printed graphic (as in **Fig 4B**) showing the category distributions and will undergo extensive, explicit training to ensure that they know them well before starting the main experiment. They will also receive training on the confidence key mappings. During the main experiment, there will no trial-to-trial feedback, but feedback scores will be shown after each block to provide motivation. In each session, observers will perform 840 trials over a period of around 1 hour.

**Data analysis and modeling.** We will follow the data analysis procedures described in Denison et al. (2018)31. First, we will fit Bayesian and alternative heuristic models to trial-by-trial behavioral responses to examine decision behavior. We will determine whether and how ASD observers adjust their choice and confidence criteria to account for prior information, sensory uncertainty, and reward. Model fitting will allow us to obtain separate estimates of sensory uncertainty and decision criteria, which we will then compare across conditions within each observer and between ASD and TD groups. For Task A, we will also use SDT to estimate perceptual sensitivity (*d’*) and choice criterion (*c*) as a function of contrast, prior, and reward. (Task B cannot be analyzed using SDT.) In Aims 1 and 3, we will account for observers’ explicit knowledge by correlating independent measures of prior or reward knowledge (from knowledge indications, see below) with criterion shifts due to those manipulations.

**Fig 4**. **Task**. (**A**) Illustration of the sequence of events within a trial in all proposed experiments. All stimuli will be presented on a gray background. (**B**) Stimulus orientation distributions for each category in Task A (Aims 1 & 3) and Task B (Aim 2). (**C**) Category and confidence report: each key corresponds to a category choice with confidence rating.



### **Specific Aim 1: Determine whether and how individuals with ASD account for prior knowledge**

**Rationale.** To investigate the effect of prior knowledge on decision making, in **Aim 1** wewill manipulate category priors by varying the base rate probabilities of the stimulus categories. An optimal criterion will shift to favor the category that is more likely to be presented.If individuals with ASD use prior probability less than TD individuals, they will demonstrate a smaller criterion shift. Importantly, fitted model parameters will reveal whether smaller criterion shifts are accompanied by more precise likelihood functions (i.e., lower sensory noise), and thus whether individuals with ASD shift similarly to TD individuals when their level of sensory noise is taken into account or, alternatively, if they are more conservative than would be expected from their sensory noise. **Fig 3** shows preliminary data of 10 TD and 10 ASD participants for Aim 1. The results show that both the TD and the ASD groups can perform the joint category and confidence report and that both groups adjust their category decision based on the prior of category base rate.

**Method.**Observers will perform Task A (**Fig 4B)** with three base rate blocks: 75%-25%, 50%-50%, and 25%-75% for category 1 and category 2, respectively. There will be 280 trials in each prior probability block, 40 per contrast (840 trials total). **Base rate instructions:**At the start of each prior block, observers will be informed of the base rate of each category. Using the graphic of the distributions, we will explain the percentage of trials that will be drawn from each distribution. **Base rate training:** At the start of each prior block, observers will perform 40 base rate training trials. After each training trial, a message telling them their reported category will appear on the screen along with auditory correctness feedback. **Base rate knowledge indication:** To test whether observers adopted the appropriate prior, at ten random times during each block, observers will be asked to gamble on the category of the upcoming trial by placing a bet that divides 100 points between the two categories.

**Predictions.** The hypothesis that individuals with ASD have reduced prior integration predicts a reduced effect of prior probability on categorical choice SDT criterion (i.e., more conservatism) in the ASD group compared to the TD group (**Fig 2A**). If this occurs, concurrent estimates of sensory noise, along with the pattern of results across experiments, will indicate whether a reduced prior effect may be mediated by differences in likelihood width or decision flexibility (**Fig 2D**). Alternatively, similar criterion shifts in the ASD and TD groups would indicate that ASD individuals can use explicit priors, and impaired prior integration is not a general computational feature of ASD. If perceptual and metacognitive decision making act in the same way in ASD, then we should see similar shifts of choice and confidence criteria.

### **Specific Aim 2: Determine whether and how individuals with ASD account for sensory uncertainty**

Rationale. In **Aim 2** we will test the effect of sensory uncertainty (likelihood) on decision criteria. Testing whether observers take sensory uncertainty into account for both categorical decision and confidence requires a task in which such decision flexibility stands to improve categorization performance. The left versus right categorization (Task A) used in Aim 1 does not meet this condition since the optimal choice boundary is the same (halfway between the means of the left and right category distributions) regardless of the level of uncertainty. To overcome this limitation, we will use an “embedded category task,” which was specifically designed to test whether decision criteria depend on uncertainty31,38. Observers will categorize stimuli as belonging to one of two distributions, which have the same mean but different variances (**Fig 4C**, Task B). The task requires distinguishing a more specific from a more general perceptual category, which is typical of object recognition39. In the embedded category task, the optimal choice criteria shift as uncertainty increases, which will allow us to determine whether observers' behavior tracks these shifts, along with analogous shifts in confidence criteria. As in Aim 1, we will manipulate sensory uncertainty by varying stimulus contrast.

**Method.** Observers will perform a categorization and confidence report for Task B (**Fig 4C**) to assess criterion shifts based on sensory uncertainty—in the absence of the need to incorporate additional information, such as prior or reward (**Fig 2B**). To manipulate sensory uncertainty, we will vary the stimulus contrast across seven contrast values (General Protocol). There will be 120 trials in each contrast level (840 total).

**Predictions.** If the ASD group has a general difficulty in adjusting decision criteria, we would expect to see less adjustment compared to TD individuals in response to changes in sensory uncertainty alone (**Fig 2B**). If individuals with ASD take into account sensory uncertainty during perceptual confidence judgments, as TD individuals do, we expect to find a near-optimal adjustment of criteria to account for sensory uncertainty in both groups. On the other hand, reduced adjustment of confidence criteria may indicate a general difficulty in criterion adjustment, extending across processing levels.

### **Specific Aim 3: Determine whether and how individuals with ASD account for reward**

**Rationale.** To investigate the effect of reward (cost function) on decision making, in **Aim 3** we will manipulate the rewards (number of points) for correct categorical judgments, such that correct categorization of one category will yield a higher reward compared to the other category. If individuals with ASD incorporate cost functions similarly to TD individuals, their decision criteria will shift to a similar extent to favor the more rewarded category. If confidence ratings in individuals with ASD are entirely tied to choice accuracy, there will be no effect of reward on confidence ratings, because the reward level is irrelevant to choice accuracy.

**Method.** Observers will report orientation category and confidence for Task A (**Fig 4C**). To manipulate the cost function, we will vary the number of points for each category across a block of trials, such that one category can have a higher reward within a block (**Fig 2C**). There will be three reward distributions: 75-25 points, 50-50 points, and 25-75 points for category 1 and category 2, respectively. Observers will receive feedback on their points after every 50 trials. **Reward instructions:** At the start of each prior block, observers will be informed about the number of points they will receive for correctly categorizing each category. Using the diagram of the distributions we will explain that each category will receive a certain number of points when it is correctly chosen. Observers will be informed that at the end of the session they will receive a bonus payment based on the total points they accumulated. **Reward training:** At the start of each reward block, observers will perform 40 reward training trials. After each training trial, a message telling them their reported category and number of points rewarded will appear on the screen along with auditory correctness feedback. **Reward knowledge indication:** To test whether observers learned the reward contingencies, at ten random times during each block, observers will be asked to report how many points they will receive for a correct response to a trial of one category.

**Predictions.** If individuals with ASD take reward into account similarly to TD individuals, we expect to find a shift in choice criterion to favor the more rewarded category (**Fig 2C**). If they do not account for reward in their decision behavior to the same degree, it could indicate a narrower likelihood or a general difficulty integrating non-sensory information sources (i.e., both prior and reward, **Fig 2D**). Concurrent estimates of sensory noise will allow us to evaluate the narrower likelihood hypothesis. If ASD and TD observers report confidence based on choice accuracy, then we expect to find no effect of rewards on confidence. Alternatively, we may find that reward “leaks” into confidence reports, similar to other types of information that are independent of choice accuracy but nevertheless affect confidence30, for the ASD group, the TD group, or both.

**Potential pitfalls and solutions**

Comparing results across the three Aims will give us the fullest picture of perceptual and metacognitive decision making in ASD (**Fig 2**). Importantly, however, **each Aim stands on its own and will reveal how prior, sensory uncertainty, and reward each affect decisions in ASD**. Finding no differences between ASD and TD would only arise from significant criterion shifts in both groups, so would be interpretable as intact behavior. We will use Bayesian statistics to quantify the degree of similarity between groups. Finally, we rely on the assumption that all high-functioning individuals with ASD exhibit similar decision behavior. Though this is a reasonable initial assumption, there may be ASD sub-groups with different patterns of behavior. Even in this case, our largely within-subjects design will allow comparisons across the three experiments with high statistical power.

**Conclusions and Future directions**

By systematically investigating how changes in priors, sensory uncertainty, and reward affect decision behavior in ASD, the main key outcome of this proposal will be to determine whether and how visual perceptual decision making—for both categorical and metacognitive choices—follows Bayesian principles. It will also lay the groundwork for the following future directions: 1) The current proposal focuses on clinical populations of adults diagnosed with ASD. In the future, it will be important to test whether any alterations in ASD decision behavior revealed here predict autistic traits in the non-clinical population. Thus, the next step will be to run an online version of the current study with a large sample size from the non-clinical population and correlate criterion shifts with autistic traits (e.g., AQ). 2) Here we explicitly manipulate priors to isolate prior use from prior learning. However, in natural settings, humans implicitly learn the environment's statistics. Thus, the next step will be to test implicit prior learning and updating by running the same experiments without explicit base-rate instructions and training. We will then test prior use across trials. 3) As most decision-making models are based on adult data, we focused on adults with ASD. However, ASD is a neurodevelopmental disorder. Therefore, a promising direction will be to apply the protocols developed in this proposal to children with ASD. This is important whether we show or do not show differences in decision-making between the adult groups. If we show a difference, the next step is to test when it emerges during development. If we show no difference, it could be due to compensation strategies during adulthood, and differences may be, nonetheless, found during development.

**Project timetable**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  | Pre-proposal | Months 1-6 | Months 7-12 | Months 13-18 | Months 19-24 |
| Aim1 | Setup and pilot |  |  |  |  |  |
| Data collection |  |  |  |  |  |
| Analysis |  |  |  |  |  |
| Aim2 | Setup and pilot |  |  |  |  |  |
| Data collection |  |  |  |  |  |
| Analysis |  |  |  |  |  |
| Aim3 | Setup and pilot |  |  |  |  |  |
| Data collection |  |  |  |  |  |
| Analysis |  |  |  |  |  |
|  | Presenting, writing |  |  |  |  |  |