Journal: Research in Autism Spectrum Disorders
Submission type: Registered Report (Special Issue)
Running head: Prosocial decision-making and recipient neurotype
Word count: 7470 words
Initial Stage 1 submission date: 1st April 2022
Resubmission date: 14th October 2022
Stage 1 in principle acceptance: March 2023

Autistic and non-autistic prosocial decision-making: The impact of recipient neurotype

Peter Rush, Connor T. Keating, Patricia L. Lockwood, Matthew Apps, Sophie Sowden*

Author Note

Centre for Human Brain Health, School of Psychology, University of Birmingham, UK and Institute for Mental Health, School of Psychology, University of Birmingham, UK.

* Correspondence concerning this article should be addressed to Dr Sophie Sowden, School of Psychology, University of Birmingham. Birmingham, B15 2TT, UK, s.l.sowden@bham.ac.uk

This work is funded by pump priming funds from the School of Psychology, University of Birmingham, awarded to Sophie Sowden. Connor Keating is funded by the Medical Research Council (Grant MR/R015813/1).

Abstract

A body of research suggests cross-neurotype interpersonal interactions may be more challenging, and non-autistic individuals show less interest in interactions with their autistic peers. However, it is not clear whether such cross-neurotype differences extend to prosocial decision-making behaviour – something that is vital for forming and maintaining social bonds. Using a well-established physical-effort-based decision-making paradigm, in combination with computational modelling, we aim to examine autistic and non-autistic prosocial willingness to exert physical effort for oneself and others, as a function of whether they know the beneficiary of those actions to be of the same or cross-neurotype. We will collect data from 60 individuals; 30 with and 30 without a clinical diagnosis of autism. We will compare decisions to exert effort as well as subsequent effort put into those actions when participants are making decisions for the *self*, *other same-neurotype* and *other different-neurotype*. Finally, we will explore whether prosocial effort differences can be explained by biases (explicitly or implicitly) held about autism. This work has important implications for understanding how interactor neurotypes and autism-specific biases may feed into prosocial decision-making contexts such as employment, health and education settings, where autistic individuals face the everyday consideration whether to disclose their diagnostic status.

Keywords: Autism; adults; prosocial behaviour; decision-making; neurotype-matching;

Introduction

Many autistic individuals[1] face the everyday consideration as to whether they disclose their diagnostic status (e.g., to peers, employers, service providers) and whether doing so will lead to negative outcomes and discrimination (Thompson-Hodgetts et al., 2020). For example, whilst one third of a sample of UK-based autistic adults with employment experience were willing to disclose their diagnosis to employers, disclosure has mixed outcomes (Romualdez, Walker, et al., 2021) and most report being concerned about how this would affect the attitudes of, and treatment by, others in the workplace (Romualdez, Heasman, et al., 2021). Within friendship groups and amongst peers, disclosure has been reported for some individuals to contribute to higher self-esteem and acceptance of one's diagnosis (Kiely et al., 2020), whilst for others has perceived negative outcomes and increases in stigma (Thompson-Hodgetts et al., 2020).

But are these fears about disclosure reflected in poorer experiences for autistic individuals in social interactions? Recently it has been demonstrated that cross-neurotype interpersonal interactions are more challenging (Crompton, Ropar, et al., 2020; Crompton, Sharp, et al., 2020), and non-autistic individuals show less interest in interactions with their autistic peers (Sasson et al., 2017). However, it does not necessarily follow that people will be less willing to act prosocially towards people who are cross-neurotype. As a result, it is unclear whether fears about disclosing one's autism diagnosis is a significant concern in decision-making contexts. Whilst some reports suggest correct – relative to no – labelling of autism diagnostic status may even improve impressions of autistic individuals (Gillespie-Lynch et al., 2021; Sasson & Morrison, 2017), this is not the case across all attitude and

[1] We use identity-first language (e.g., autistic person) rather than person-first language (e.g., person with autism) in line with the preferences of the autistic community (Keating et al., 2022; Kenny et al., 2016) and guidance for avoiding ableist language (Bottema-Beutel et al., 2020).

judgment domains (Matthews et al., 2015; White et al., 2019). Thus, here we examine whether people are willing to act prosocially towards people they know to be of the same or cross-neurotype and whether any prosocial differences here can be explained by biases (explicitly or implicitly) held about autism.

Prosocial decision-making and recipient characteristics

Prosocial behaviour is integral to the formation and maintenance of human social bonds (Fehr & Fischbacher, 2003). Whilst often coming at a cost to the actor and benefit to the recipient (such as donating money to a charity), behaving prosocially also brings the actor higher perceived warmth (Kawamura et al., 2021), increased trust (Barclay, 2004), and improved positive mood and wellbeing (Harris, 1977; Martela & Ryan, 2016). Moreover, prosocial behaviour, such as adhering to government social distancing measures, proved vital for protecting public health during the recent COVID-19 pandemic (Pavlović et al., 2022). Thus, understanding factors that influence prosocial decision behaviour is advantageous for not only individual actors and beneficiaries of prosocial behaviour, but for society as a whole.

It is well established that both adolescents and adults modulate prosocial behaviour on the basis of attributes known about their interaction partner (Güroğlu et al., 2014; Mills et al., 2018). For example, participants in economic games typically give more prosocial monetary offers to friends or neutral acquaintances than to anonymous or antagonistic peers (Güroğlu et al., 2014). Moreover, adults are significantly more altruistic in their offers to individuals they consider to be more similar to them, such as being part of the same football team (Mills et al., 2018), cultural group (Candelo et al., 2019), and even when group allocation is experimentally manipulated (Rahal et al., 2020). Such modulation in decision-making behaviour based on partner attributes most likely comes from preferences or biases for those belonging to one’s own group (ingroup) as opposed to the outgroup and a desire to benefit those individuals accordingly (Buttelmann & Böhm, 2014). Despite increasing question and concern regarding the treatment of autistic people in decision-making contexts such as in employment and education settings (Pellicano et al., 2014; Solomon, 2020; Walkowiak, 2021), no study has confirmed whether similar such biases exist when non-autistic individuals make social decisions about their autistic counterparts.

Non-autistic impressions of and interaction with autistic individuals

Non-autistic individuals indeed show biases in their impressions of autistic individuals across a range of contexts. For example, when provided with 'thin slice' (i.e., brief) videos of both autistic and non-autistic individuals, non-autistic people make more negative trait judgments of, and are less willing to interact with, their autistic counterparts, and this persists across children and adults (DeBrabander et al., 2019; Sasson et al., 2017). When considering unscripted verbal interactions, autistic adults are rated as more awkward, less attractive and less socially warm, and non-autistic individuals express reduced interest in future interactions with their autistic than non-autistic peers (Morrison et al., 2019). Finally, higher autistic traits, as indexed by the Broad Autism Phenotype Questionnaire (Hurley et al., 2007) in both autistic and non-autistic individuals, are associated with less favourable first impressions, particularly when male (Sasson & Morrison, 2017).

It is pertinent that we understand how biases and mismatches in communication styles feed into behaviour towards autistic people and success in everyday social interaction between autistic and non-autistic peers. Work by Jones and colleagues (2021) suggests that reducing biases via autism acceptance training indeed improves social interest between autistic and non-autistic conversation partners. However, not all communication difficulties can be attributed to psychological biases alone. The *double empathy problem* (see Milton, 2013; Milton, 2012) describes the communication gap between autistic and non-autistic people as a bi-directional problem caused by communication differences on both sides. For instance, we see that not only do autistic individuals struggle to infer the mental states and emotions of their non-autistic peers (Mathersul et al., 2013; Uljarevic & Hamilton, 2013), but they exhibit differences in the production of such behaviour themselves (Faso et al., 2015; Keating & Cook, 2020; Trevisan et al., 2018), leading to similar difficulties observed in the interpretation of these emotion and mental state cues by non-autistic individuals (Alkhaldi et al., 2019; Brewer et al., 2016; Edey et al., 2016; Sheppard et al., 2016). This may indeed feed into poorer interaction between cross-neurotype (i.e., autistic-non-autistic) pairs than neurotype-matched (i.e., autistic-autistic) pairs when it comes to effectiveness of information transfer (Crompton, Ropar, et al., 2020), social understanding (Crompton, Hallett, et al., 2020), interpersonal rapport (Crompton, Sharp, et al., 2020) and experiences that promote interest in future interactions (Morrison et al., 2019).

Whilst it is clear that there may be biased impressions and/or interpersonal difficulties in cross-neurotype interactions, it is unclear whether this translates into changes in our willingness to perform behaviours that help others we know to be of a same or different neurotype. Correspondingly, research so far has again taken a one-sided approach in examining the integrity of prosocial behaviour and decision-making in autistic children and adults (e.g., Jameel et al., 2014; Mosner et al., 2017; Rum et al., 2020; Zhao et al., 2019) and neglected the role of bi-directional social decision-making in everyday social interaction. Mosner et al. (2017) investigated effort-based decision-making in autistic and non-autistic adolescents. Their task was to complete a series of button presses in a specified time window to win monetary rewards for themselves or others. On each trial they were given the option to play a "hard" or "easy" task (varying in effort difficulty) and told that they were playing for the self or other, as well as the reward magnitude and reward probability. When choosing for the self, similar patterns of effort-based decision-making across reward parameters were found in both autistic and non-autistic groups, whilst autistic adolescents showed reduced sensitivity to reward magnitude when choosing for others. However, given the body of research outlined above whereby certain parameters of 'other-related' social behaviour are modulated based on the neurotype of one's interaction partner (Crompton, Hallett, et al., 2020; Crompton, Ropar, et al., 2020; Crompton, Sharp, et al., 2020; Morrison et al., 2019), this study falls short by presuming that both groups will hold the same impressions of the 'other' person and their motivations to put in effort for this person. If all individuals presumed they were playing for a neurotypical (i.e., non-autistic) person in the 'other' condition (indeed plausible based on population prevalence of autism), this may explain reduced motivation and thus sensitivity to reward magnitude in the autistic group. Additionally, although Mosner et al.'s paradigm facilitates the measurement of both self- and other-regarding preferences, the use of financial-based rewards in this study again casts doubt as to participants' true motivations to exert effort. Groups may in fact differ in how they value economic rewards.

Effort based prosocial decision behaviour

How can we measure people's willingness to exert effort to help others and be prosocial? Previous research has often used economic games such as the dictator game and ultimatum game to measure prosociality (Güth et al., 1982; Kahneman et al., 1986). In such tasks, people must decide how much money to keep for themselves and how much to give up to offer to another individual. Although useful, such paradigms fail to capture everyday social motivations and explain the mechanisms behind reported other-regarding preferences. Firstly, whilst prosocial decisions in these paradigms come at a financial cost to the proposer, the cost of everyday prosocial decisions is often not financial. Instead, many prosocial acts require motivation to put in effort as the main cost to benefiting someone else (Inzlicht & Hutcherson, 2017; Lockwood et al., 2017), such as opening a door for a stranger or helping a friend with an assignment. Secondly, whether one's motivation to be prosocial is driven by self or other-regarding preferences cannot be disentangled with these tasks. An individual may indeed be motivated to benefit another person, or they may simply value their own monetary gain less. This may be particularly pertinent when comparing groups where differences in wealth lead to different valuations of economic rewards (Mayr & Freund, 2020). Thus, such tasks do not adequately capture motivations for everyday prosocial acts, or *willingness* to put in effort to benefit someone else.

Theoretical accounts of motivation for effort suggest two key stages in this process. First, one must weigh up their willingness to exert effort for the reward on offer (Apps et al., 2015; Vassena et al., 2014). Humans are typically effort averse and rewards are 'devalued' or 'discounted' by the amount of effort needed to obtain them (Chong et al., 2017; Hartmann et al., 2013; Pessiglione et al., 2018). Second, one must then actively exert that required amount of effort such that their actions meet the target outcome. This actual effort exertion will be referred to from here on as 'action energisation'. As an example in practice; although adults choose to be prosocial towards others, both young and older adults say they are willing to exert higher levels of effort to gain rewards for themselves than others, and young adults energise their subsequent prosocial actions (i.e., actively exert effort) less than identical self-benefiting actions (Lockwood et al., 2021; Lockwood et al., 2017; Mosner et al., 2017).

We have previously shown that it is possible to disentangle and quantify how individuals devalue rewards by their effort costs for both themselves and others using computational models of effort-based decision-making task behaviour (Lockwood et al., 2021; Lockwood et al., 2017). Participants are given choices between exerting physical effort by squeezing a handheld dynamometer to reach targets of varying effort and credit (translated into monetary rewards) for themselves or another person, or to rest and receive only a single credit. Before beginning the experiment, baseline grip force strength (maximum voluntary contraction; MVC) is measured to ensure that effort targets are determined with respect to each individual's strength threshold. On each trial (see Figure 1) participants have two options; a baseline low-effort, low-reward option (0% MVC for 1 credit); or a higher-effort (variable between 40% and 70% MVC) for higher-reward (variable between 2 and 8 credits) option. After making their choice, participants are then required to squeeze the dynamometer to the required level of force to obtain the credits. Thus, in this paradigm, action energisation refers to the actual physical force exerted in squeezing the dynamometer. Pertinently, this paradigm with varying effort and reward levels allows the independent measure of effort sensitivity and reward sensitivity for both self- and other-benefiting actions.

The current study

Using a physical-effort-based decision-making paradigm (Lockwood et al., 2021; Lockwood et al., 2017) the current study seeks to investigate how motivated autistic and non-autistic adults are to exert effort for both themselves and others, as a function of the diagnostic status of the beneficiary of their actions. The experimental task will measure their prosocial motivation to exert physical (grip force) effort when the rewards resulting from this effort are won across three conditions: (1) the self condition (the participant puts in effort and they themselves receive the reward); (2) the other *same neurotype* condition (the participant puts in effort themselves, but the reward goes to another person of the same neurotype as them); (3) the other *different neurotype* condition (the participant puts in effort themselves, but the reward goes to another person of a different neurotype to them). Employing this paradigm in combination with computational modelling will allow us to examine how much people devalue rewards as a function of the amount of effort required to obtain them for themselves, others of the same neurotype and others of a different neurotype, as well as the subsequent amount to which they energise those actions across the three conditions.

By employing measures of both implicit bias (Implicit Association Test; Greenwald et al., 1998) and explicit bias (the Social Distance Scale; Gillespie-Lynch et al., 2019), we will explore whether differences in effort devaluation and effort exerted when one's interaction partner is of the same versus different neurotype are driven by implicitly and/or explicitly held biases about autistic people. We may expect that greater biases lead to greater effort devaluation and less effort exerted for those of a different neurotype compared to those of the same neurotype to oneself.

We first aim to replicate the self-other recipient effect found in previous studies (Lockwood et al., 2021; Lockwood et al., 2017), whereby individuals will devalue rewards by effort to a lesser extent, by choosing the higher effort task option more often during self trials (i.e., when putting in effort for their own reward) than during other trials (when putting in effort towards a reward for another person). We also expect to see greater levels of actual physical effort exerted (i.e., greater energisation of actions) for self compared to other trials, even when required effort and rewards levels for self and other are equal. With respect to our main manipulation of interest (recipient neurotype), we have two competing hypotheses. If differences in effort discounting are indeed driven by whether one's partner is of the same versus different neurotype, we would expect the same direction of effects in both our autistic and non-autistic groups, such that all participants show lower effort discounting (i.e., greater motivation to put in effort) and greater energisation (i.e., greater physical force exerted) for actions for others of the same versus different neurotype to them. This is in line with literature showing ingroup preferences in decision-making (Candelo et al., 2019; Mills et al., 2018; Rahal et al., 2020). However, if, as has been noted in previous accounts of social exchanges between autistic and non-autistic individuals (Morrison et al., 2019), non-autistic adults specifically hold biased impressions of, and decreased interest in engaging with, their non-autistic counterparts, we may expect to see this effect of recipient neurotype on effort discounting and energisation of actions in the non-autistic group only, whilst the autistic group show no distinction between recipients.

Finally, when exploring the relationship between these findings and biases about autistic individuals, we will assess how both explicit, self-reported biases about autism and implicit autism biases relate to differences in both effort discounting and eventual energisation of actions between those of the same versus different neurotype to oneself.

Methods

Participants

Sixty adult individuals aged 18-60 years, 30 with and 30 without a clinical diagnosis of autism, will be recruited to the study. The autistic group will be recruited via a pre-existing autism research database (where diagnosis has already been verified) held by the final author and non-autistic individuals will be recruited from the community (via university networks and social media). All participants will provide written informed consent prior to participation, in accordance with the revised Declaration of Helsinki (World Medical Association, 2013). Remuneration for participation will be £8 per hour and participants will be told they and the other recipients they are playing for will receive a bonus of up to £5 at the end of the study on the basis of the number of credits they earn in the decision-making task. In reality, all participants will receive this £5 bonus. The study has approval from the University of Birmingham Research Ethics Committee across two approved applications (ERN_16-0281AP5 and ERN_20-1897PA), requiring only small modifications before testing begins should a Stage 1 proposal be accepted. Groups will be matched for age, gender and IQ. Individual participant data will be excluded prior to data analysis if they report not believing in the deception (that they were indeed playing with real other participants), fail to complete the entire procedure, or if any technical problems occur. Further exclusion criteria include previous or current neurological disorder or non-corrected-to-normal vision (as reported by participants). We will recruit until we have 30 full datasets per group after the described exclusion criteria have been applied.

The chosen sample size is based on a priori power analyses conducted using GLIMMPSE (Kreidler et al., 2013), focused on replicating both the basic effect of recipient (self/other) on effort discounting, as well as a group by recipient condition interaction found in Lockwood et al. (2021), whereby group represented young and old adults. To replicate the former effect, a sample of 10 individuals gives 95% power to detect this effect at an error probability of 0.05, whilst for the latter effect, a sample of 60 gives 95% power to detect the effect at an error probability of 0.05. Thus, we will test a total sample of 60 individuals, 30 from each of our groups.

Materials & Design

Autistic traits. Autistic traits will be measured using two scales in order to provide descriptive information about our two groups. Firstly, the commonly used 50-item Autism Spectrum Quotient (AQ; Baron-Cohen et al., 2001) will be administered and scored via the online platform Qualtrics (https://www.qualtrics.com/). This is a self-report scale on which participants will respond to statements using a 4-point Likert scale from "definitely agree" to "definitely disagree". The scale is then scored from 0 to 50, with higher total scores representing higher autistic traits. The AQ has been widely used in both general and autistic populations (Ruzich et al., 2015, 2016), and has strong psychometric properties, with both high internal consistency ($\alpha \geq 0.7$) and test–retest reliability ($r \geq 0.8$; Stevenson & Hart, 2017). Given discussion regarding the unidimensionality and sensitivity of the AQ-50 to measure population level autistic traits (e.g., Lundqvist & Lindner, 2017), we will also use the Ritvo Autism & Asperger Diagnostic Scale 14-item version (RAADS-14; Eriksson et al., 2013). The original RAADS-R comprises 80 items designed to closely match the diagnostic criteria for ASD in the DSM-IV and assesses their presentation currently and in the past. The RAADS-14 was developed from the RAADS-R via a three-phased process designed to identify the items that successfully differentiate autistic and non-autistic individuals in the general population and those with other psychiatric diagnoses. Participants respond to each statement on a 4-point Likert scale (3 = 'true now and when I was young', 2 = 'true only now', 1 = 'true only when I was younger than 16' and 0 = 'never true'). All item scores are summed to a total score which has shown high sensitivity and specificity in both psychiatric and non-psychiatric groups (Eriksson et al., 2013).

Explicit Autism Bias. We will measure explicit biases about autistic people using the Social Distance Scale (SDS; Gillespie-Lynch et al., 2019). In this 11-item questionnaire, participants are required to respond to statements (e.g., "I would be willing to marry or date an autistic person"; reverse scored) on a 5-point Likert scale from 'strongly disagree' to 'strongly agree'. Each item is scored from -2 to 2, producing total scores on the SDS which range from -22 to 22. Higher scores represent elevated stigma. The SDS has strong psychometric properties, boasting high internal consistency ($\alpha \geq 0.8$; Gillespie-Lynch et al., 2019; Kim et al., 2021) and a strong factor structure (Gillespie-Lynch et al., 2019).

Implicit Autism Bias. To index implicit biases about autism, we will use an autism-focused, adapted version of the Implicit Association Test (IAT; Greenwald et al., 1998). IATs are used to probe automatic associations between cognitive concepts (e.g., black, white) and attributes (e.g., good, bad). Participants will complete an adapted version of the IAT used by Jones et al. (2021) using Gorilla.sc (Anwyl-Irvine et al., 2020), and presented on a 21.5-in. iiyama display. This task will examine the degree to which participants unconsciously associate autism diagnostic labels with unpleasant personal attributes. The target words (see Table 1) used for each category are taken from Jones et al. (2021).

Table 1. IAT stimulus categories and words.

Category	Stimulus words
Diagnosis	
Autism spectrum	Autistic, Autism, Asperger's
Typically developing	Normal, Neurotypical, No diagnosis
Personality traits	

Pleasant	Nice, friendly, likeable, safe, popular, honest, compassionate, independent
Unpleasant	Awkward, creepy, weird, dangerous, antisocial, needy, unpredictable, helpless

Effort-based decision-making. We will use an adapted version of the grip-force effort decision-making task employed by Lockwood et al. (2021). Stimulus presentation has been programmed using MATLAB (MathWorks, Natick, MA) and Psychophysics Toolbox (Version 3.0; Kleiner et al., 2007). Grip force will be recorded using a handheld TSD121B-MRI clench dynamometer (Biopac systems, Goleta, CA). Task presentation as well as real-time visual feedback on the force being exerted will be provided on a 21.5-in. iiyama display.

Regarding task structure, participants will complete an adapted version of the task used in Lockwood et al. (2021), with a reduced number of effort and reward levels (4 as opposed to 5 in the original task) and a total of 144 trials. Trials will be split into 3 blocks with sufficient rest breaks between each block (with the option to pause during blocks if needed). Each block will comprise trials from all three recipient conditions, presented in random order within each block. The full set of trials comprises 48 trials per recipient condition (self / other *same neurotype* / other *oppositive neurotype*) and the same number of trials for each recipient condition will be presented in each of the 3 blocks. Each trial (see Figure 1) will involve a choice between a baseline option (gaining 1 credit for no effort) or an alternative experimental offer varying in effort level required (40%, 50%, 60% or 70% MVC) and level of reward offered (2, 4, 6 or 8 credits). Lockwood et al. (2017) designed the task to minimise effects of fatigue, with participants being required to squeeze for only 1 second out of a 3 second window to obtain the reward (in trials of roughly 10 seconds duration). Moreover, many of the high effort trials are not that demanding (e.g., ≤ 50% of MVC) and trials are split into mini blocks of 48 trials. To monitor and control for discomfort or fatigue, we will ask participants to rate their levels of discomfort and tiredness on a scale from 1 (not at all) to 10 (very) prior to starting the main experiment, during each break and following completion of the task. If discomfort or tiredness ratings increase by more than 3 points on the scale from one break to the next, testing will be paused until the participant feels ready to continue.

Full Scale Intelligence Quotient. In order to match participant groups for IQ, we will complete the Two-Subtest version of the Wechsler Abbreviated Scale of Intelligence (WASI-II; including the vocabulary and matrix reasoning subscales; Wechsler, 1999) with each of our participants to produce a Full Scale Intelligence Quotient (FSIQ) score.

Procedures

All participants will attend the lab and be told they are one of three participants attending on the same day. Labels for ‘Participant 1’, ‘Participant 2’ and ‘Participant 3’ will be displayed on three neighbouring testing cubicles. In reality, there will be only one real participant taking part in each session and the other two individuals will be confederates, also attending the testing session and sitting in neighbouring cubicles without completing the task. Confederate names will be kept constant (e.g., ‘Hannah’ and ‘Alice’ when participant identifies as female; ‘Samuel’ and ‘Joshua’ when participant identifies as male; and ‘Alex’ and ‘Charlie’ when the participant does not identify as male of female). One confederate will always arrive 5 minutes before the testing session and one on time for the testing session. Once all have been shown to their testing cubicles, they will provide written informed consent. To ensure that participants believe they are making decisions for real recipients, they will be asked to write 1-2 sentences about themselves and to tick a box to indicate whether they are autistic or non-autistic. They will do this on two separate pieces of card which, when they have finished, will be passed to the experimenter in the corridor and handed out to the two other participants so they know who they are playing with. Descriptions will remain on the desk in front of the participant throughout the experiment so they have a visual reminder of the neurotype of each interaction partner. Confederate descriptions will be set for all testing sessions and counterbalanced as to whether they describe an 'autistic person' or a 'non-autistic person'. Following this they will complete the effort-based decision-making task. After a short break participants will complete the autism IAT, the Social Distance Scale and the AQ. Finally, participants will finish the study by completing the Two-Subtest WASI-II IQ assessment. Total study duration will be roughly 80 minutes per participant.

Effort-based decision-making task. Participants will first be asked to grip the handheld dynamometer with as much force as they can to determine their MVC. This measurement, repeated three times with verbal encouragement[2], will be used as a participant-specific threshold for the levels of effort required to obtain rewards in the main task, thus controlling for individual differences in absolute strength. The measure of MVC will be completed prior to participants receiving instructions about the main task to avoid participants squeezing less than their maximum in order to lessen the effort required to collect rewards in the main task.

On each trial (see Figure 1) participants will have two options. Option 1 is always a baseline low-effort, low-reward option (always 0% MVC) for which 1 credit is awarded. Option 2 is a higher-effort (variable from 40%, 50%, 60% or 70% MVC, represented by segments in a pie chart) for high-reward (variable from 2, 4, 6 or 8 credits) option. After making their choice, participants will squeeze the dynamometer to the required level of force to obtain the credits for themselves or the other person. On one third of the trials, participants

[2] Note the first squeeze they see a white bar fill up in red. The second and third times they see a yellow line that is 105% and 110% of their maximum, encouraging them to try and reach the yellow line. Employed by Lockwood et al. (2021), this procedure gives the best measure of MVC.

will exert effort to win credits for themselves, on one third of trials they will win credits for another person of the same neurotype as them (i.e., an autistic person if they themselves are autistic) and on the final third of trials they will win credits for another person of a different neurotype to them (i.e., a non-autistic person if they themselves are autistic). Effort and reward levels will be varied independently over trials, with each effort-reward level being sampled 3 times.

There will be 144 trials in total; 48 self trials during which participants choose between the baseline and alternative offer for themselves, 48 other *same neurotype* trials during which participants choose for another person of the same gender and neurotype as them, and 48 other *different neurotype* trials during which participants choose for another person of the same gender and different neurotype to them. To achieve the defined reward on each trial, participants must apply force to the grip device that exceeds the required level for a total of 1 second out of a 3 second window. The baseline condition with the offer of 1 credit is used to incentivise participants to choose this baseline if the value of the alternative is not considered worth it, as opposed to choosing the alternative offer and then not exerting any effort at all. 0 credits are given if participants fail to exceed the chosen effort level or if no choice is selected. Success rates in this task have previously been shown to be high, at >97% in both young and older adults (Lockwood et al., 2021). The duration of all trials is the same, regardless of the choice made, or if no response is made. This ensures that choices are not influenced by discounting effects of temporal delay rather than level of effort.

Prior to the main decision-making task, participants will experience each effort level (including the rest) three times across 15 trials. This will also help them to learn to associate each level of effort with the elements in the pie chart. They will be instructed that if only one element of the pie chart was shown, then 0% force is required and that this is the baseline offer, equivalent to a rest. However, they still have to grip the dynamometer in their hand.

During the training session, only 1 credit is on offer; participants will be told that this credit will not count towards their payment.

Post task rating. After the study, participants will be asked to confirm what they remember about the other two participants (probing memory of their neurotype), as well as how positive they felt when receiving rewards for themselves and the other recipients, and how much they identify with their group (i.e., autistic or non-autistic). They will indicate their ratings using a sliding scale ranging from 0 (not at all) to 10 (very positive/very much). Participants will also complete the Social Desirability Scale-17 (SDS-17; Joachim, 2001) to measure their tendency to attribute themselves socially desirable behaviours. This includes responding to 17 items as 'True' or 'False' such as "I always stay friendly and courteous with other people, even when I am stressed out". Post task ratings will be administered using Qualtrics (https://www.qualtrics.com/). Task duration will be 35-40 minutes in total.

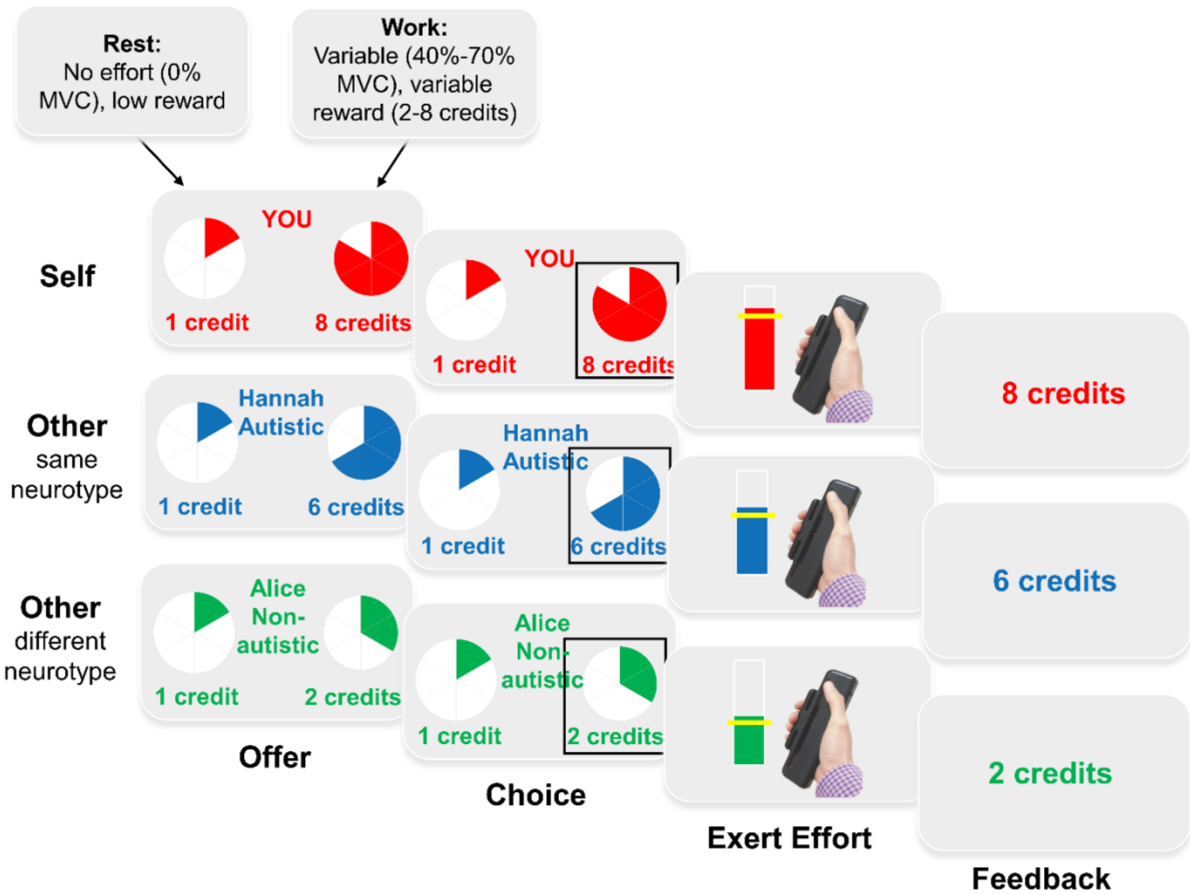

Figure 1. Example trial structure for all three recipient conditions (self, other *same neurotype*, other *different neurotype*) in the effort-based decision-making task.

Autism IAT. Following the procedures of Jones et al., (2021), the IAT task will employ a counterbalanced five-block design (see Table 1). In the first block, participants will be instructed to categorise words (e.g., “Neurotypical,” “Autistic”) based on diagnostic concepts (e.g., “Typically developing” and “Autism spectrum”) presented on the left and right sides of the screen. Participants will press the “e” key to categorise a term as “Typically developing” or the “i” key to categorise it as “Autism spectrum.” The second block will focus on personal attributes, with participants categorising words (e.g., “Friendly,” “Awkward”) as either “Pleasant” or “Unpleasant”. In the third block, the concept and attribute categories will then be displayed simultaneously in a prejudice consistent manner (e.g., “Typically developing or Pleasant” on the left of the screen and “Autism spectrum or Unpleasant” on the right of the screen), and participants categorise both concept and attribute words one at a time as they appear. The fourth block will be identical to the first block, except the positioning of the two concepts will be reversed, with participants pressing the “e” key to categorise a word as “Autism spectrum” and the “i” key to categorise a word as “Typically developing.” In the fifth block, the diagnostic concept and attribute terms will be displayed simultaneously in a prejudice inconsistent manner (e.g., “Autism spectrum or Pleasant” on the left, “Typically developing or Unpleasant” on the right), and again participants categorise stimulus words into their respective categories.

Within blocks one, two and four (the learning phases), each word will be displayed 3 times at the centre of the screen in a random order, with each word appearing once before any repeats occurred. For blocks three and five (testing blocks), each word will be displayed once at the centre of the screen in a random order over 22 trials. The inter-trial interval is set at 100ms. Scoring for the IAT is based on the D-score, representing the standardised difference in response times for prejudice inconsistent and prejudice consistent pairings (Greenwald et al., 2003); positive scores indicate a relationship between a concept and negative attributes. The task will take roughly 8 minutes to complete.

Two-Subtest WASI-II. This assessment provides a short and reliable measure of cognitive ability (FSIQ) suitable for research use (Wechsler, 2011), lasting approximately 15 minutes. Participants first complete the vocabulary subtest, consisting of 3 picture items, which the participant should name, and 28 verbal items, during which the participant should define words presented visually and orally. Following this, participants complete the matrix reasoning subtest, where they view 30 incomplete matrices and are required to select the response option that completes each matrix.

Data Processing & Planned Analyses

We will exclude any participants who do not believe the task deception (previously reported at less than 4% with this task; Lockwood et al., 2021) and who fail to complete the entire procedure (for personal or technical reasons). In the instance that data violates any assumptions of the planned statistical analyses, standard transformations will be completed such that the data can be analysed with parametric tests. If assumptions remain unmet, non-parametric analyses will be run.

Data from the AQ and Social Distance Scale measures will be scored according to guidelines (Baron-Cohen et al., 2001; Gillespie-Lynch et al., 2019). Scoring of the IAT will follow guidelines reported in Greenwald et al. (2003). For each participant we will gain a 'D-score', representing the standardised difference in response times for prejudice inconsistent and prejudice consistent pairings; positive scores indicate a relationship between a concept and negative attributes. Scoring of the two subtests (vocabulary and matrix reasoning) of the WASI-II will follow guidelines reported in Wechsler (2011) to produce a FSIQ score. In the instance that the FSIQ scores for either group fail to meet the assumption of normal distribution, standard transformations will be completed such that a parametric independent samples t-test may be run to compare scores between the autistic and non-autistic group. If this assumption remains unmet, a non-parametric Mann-Whitney U test will be performed.

Effort-based decision task data. ***Effort discounting.*** Procedures follow the data preprocessing and analysis protocol used in Lockwood et al. (2021). We will fit a computational model of effort discounting to each participant's choice behavior to examine the rate at which the autistic and non-autistic groups discount rewards by effort. Model comparison will follow the procedure in Lockwood et al. (2021) to select the best fitting computational model. It has previously been shown (Lockwood et al., 2021; Lockwood et al., 2017) that a model with separate k parameters for self and other trials, plus an additional noise parameter characterising the stochasticity of choices (β) best explains behavior in neurotypical young and older adults. From the model comparison we will select the winning model and extract the k and β parameters to compare between groups. Specifically, we will assess whether there are differences in the discounting rate as a function of group (autistic, non-autistic) and recipient (self, other same neurotype, other different neurotype). The k parameter precisely quantifies the rate at which rewards are devalued by effort, with higher k parameters indexing steeper discounting, or lower motivation, and lower k parameters indicating shallower discounting, or higher motivation. We will analyse the estimated k parameters using robust linear mixed-effects regression, which is robust to the influence of outlier data (using the rlmer function from the robustlmm package in R; robustlmm Version 2.3; Koller, 2016). With the estimated k parameters from the model as the outcome variable, we will define recipient, group, and their interaction as fixed effects and include a subject-level random intercept.

As stated in our predictions, we will look for a main effect of recipient. We expect participants to show different effort discounting across self, other same neurotype and other different neurotype conditions, whereby they devalue reward by effort less for themselves than for others. Under a same-neurotype-preference hypothesis (i.e., preference for autistic others when you yourself are autistic and vice versa), we may expect the absence of a recipient × group interaction, showing only a main effect of recipient, whereby both groups (to the same extent) devalue effort more when choosing for another person of a different neurotype to them. Under the alternative hypothesis, we would expect to see a recipient × group interaction, whereby the non-autistic group only show greater devaluation of effort when choosing for others of a different neurotype compared to those of the same neurotype to them.

Therefore, this analysis allows us to assess how much autistic and non-autistic groups devalue reward by the effort required for both themselves and others. It also allows us to test two competing hypotheses regarding whether only non-autistic people show a bias in prosocial effort between those who are autistic and non-autistic or whether all individuals show a form of ingroup preference by devaluing effort less for those who are of the same versus different neurotype to themselves.

Given previous reports of impaired distinction between the self and other in autistic individuals (Cook & Bird, 2012; Sowden et al., 2016; Spengler et al., 2010), as in Lockwood et al. (2021), we will confirm whether autistic and non-autistic individuals indeed differentiated between themselves and others by comparing the self and other discount parameters separately in the two groups. We will make this comparison between the self and both other *same neurotype* and other *different neurotype* conditions. We will employ tests of difference (i.e., repeated samples t-tests or a non-parametric comparison) to assess this, with the prediction that both groups will successfully distinguish between self and others. We will also assess this through the model comparison procedure to evaluate whether the same model explains behavior in the two groups, for example whether one group needs only one k parameter to explain their choice behavior.

Next, we will analyse choice data with a generalised linear mixed-effects model using the glmer function from the lme4 package in R (lme4 Version 1.1.26; Bates et al., 2015). Analyses of the choice data in this way enables us to test separately for the influences of effort and reward on choices, which are combined in the computational k-parameter analysis. With choice coded as a binary outcome variable, we will define group, recipient, effort level, reward level, and their interactions as fixed effects. We will include a subject-level random intercept and test the fixed effects for statistical significance using a Type II Wald $\chi 2$ test. Once again, we predict a main effect of recipient, such that participants will choose to make higher effort options for themselves than others but also for others of their own neurotype than different neurotype. Under the alternative hypothesis, we may expect differences in choice behaviour between same and different neurotype conditions only in non-autistic individuals.

Action energisation. Also measured with the current paradigm is to what extent participants actually exert effort (i.e., energise the actions) required once they have decided the specific amount of effort they are willing to exert. Previous studies have shown young adults energise their actions less at higher effort levels when their actions will benefit others than for themselves (Lockwood et al., 2017), whilst older adults show no such self-bias (Lockwood et al., 2021). Whilst we may find differences in prosocial choice behaviour between autistic and non-autistic individuals and in how they differentiate between self and others of the same versus different neurotype, do they energise their actions to the same extent across these conditions? We will test this using the lmer function in lme4 (Bates et al., 2015) to run a linear mixed-effects model to predict the force that participants exerted on each trial. For this analysis, we will normalise participants' force as a proportion of their maximum force to account for between-subjects variability in force exerted; we will then calculate the area under the curve for the 3 second window in which they exerted force. We use normalised force as a continuous variable with a subject-level random intercept. Effort level, reward level, recipient, group, and their interactions will also be included in the model. In line with our choice behaviour predictions, we would expect to see greater energisation for actions made for the self than others across both autistic and non-autistic participants, along with greater energisation for actions made for the benefit of same versus different neurotype individuals. Moreover, we predict that even if participants' choice behavior is consistent for both those of the same and different neurotype, people may exert less force to benefit an individual of a different neurotype compared to same neurotype to themselves.

Positivity and effort towards self and others. Previous accounts suggest that the more positive individuals feel in gaining rewards for themselves and others, the more effort they put in (as indexed by lower effort discounting) for themselves and for the other person (Lockwood et al., 2021). To explore whether this is the case in both our autistic and non-autistic groups we will correlate post task positivity scores for each of our recipient conditions with each of our recipient k parameters. If positivity ratings for any group or condition fail to meet the assumption of normal distribution, standard transformations will be completed such that the data can be analysed using Pearson's correlations. In instances where assumptions remain unmet, non-parametric Spearman's Rho correlations will be run. False discovery rate multiple comparisons correction will be applied to account for repeated analyses (6 correlations). We predict that in both groups and across all recipient conditions, higher positivity ratings will be accompanied by lower k parameters (i.e., lower discounting indicative of higher motivation for effort).

Implicit and explicit biases and prosocial motivation for effort. Given the impact of non-autistic people's biases on impressions and treatment of autistic individuals (DeBrabander et al., 2019; Morrison et al., 2019; Sasson et al., 2017; Sasson & Morrison, 2017), we will explore whether implicit and explicit biases towards autism predict differences in effort discounting and action energisation (effort exerted) between others of the same versus different neurotype to oneself. To do this we will create two new variables ('neurotype effort discounting difference' and 'neurotype energisation difference') for all participants. The former variable will be calculated as the difference between their k parameter estimates for the 'other same neurotype' and 'other different neurotype' conditions, whilst the latter variable will be calculated as the difference in mean energisation of actions for 'other same neurotype' and 'other different neurotype' conditions.

Positive IAT D-scores represent increased stigma towards autistic individuals, whilst we may consider more negative D-scores to represent greater stigma towards neurotypical individuals. Thus, separately in our two groups, we will run two hierarchical regression analyses (controlling for age, gender, the difference in positivity scores given for same and different neurotype individuals and one's score on the SDS-17) to assess the relationship between both the 'neurotype effort discounting difference' and 'neurotype energisation difference' and implicit autism biases (IAT D-scores). Implicit autism bias will serve as the predictor variable in these regression analyses whilst neurotype effort discounting difference and neurotype energisation difference will serve as outcome variables. Moreover, in the non-autistic group we will run two analogous hierarchical regressions, controlling for the same variables, to assess the association between Social Distance Scale scores (i.e., explicit stigmatising attitudes towards autistic people) and both the 'neurotype effort discounting difference' and 'neurotype energisation difference'. This will not be completed in the autistic group, as the Social Distance Scale does not provide an equivalent index of explicit biases towards neurotypical individuals. We expect greater bias scores will predict greater neurotype effort discounting differences and greater neurotype energisation differences. These analyses will allow us to test whether prosocial decisions to put in more or less effort, as well as subsequent effort expended, to help those of the same or different neurotype to oneself are related to explicit and/or implicit biases.

References

Alkhaldi, R. S., Sheppard, E., & Mitchell, P. (2019). Is there a link between autistic people being perceived unfavorably and having a mind that is difficult to read? *Journal of Autism and Developmental Disorders*, *49*(10), 3973-3982. https://doi.org/10.1007/s10803-019-04101-1

Anwyl-Irvine, A. L., Massonnié, J., Flitton, A., Kirkham, N., & Evershed, J. K. (2020). Gorilla in our midst: An online behavioral experiment builder. *Behavior Research Methods*, *52*(1), 388-407. https://doi.org/10.3758/s13428-019-01237-x

Apps, M. A. J., Grima, L. L., Manohar, S., & Husain, M. (2015). The role of cognitive effort in subjective reward devaluation and risky decision-making. *Scientific Reports*, *5*(1), 16880. https://doi.org/10.1038/srep16880

Barclay, P. (2004). Trustworthiness and competitive altruism can also solve the "tragedy of the commons." *Evolution and Human Behavior*, *25*, 209–220

Baron-Cohen, S., Wheelwright, S., Skinner, R., Martin, J., & Clubley, E. (2001). The autism-spectrum quotient (AQ): evidence from Asperger syndrome/high-functioning autism, males and females, scientists and mathematicians. *Journal of Autism and Developmental Disorders*, *31*(1), 5-17. https://doi.org/10.1023/a:1005653411471

Bottema-Beutel, K., Kapp, S. K., Lester, J. N., Sasson, N. J., & Hand, B. N. (2020). Avoiding Ableist Language: Suggestions for Autism Researchers. *Autism in Adulthood*, *3*(1), 18-29. https://doi.org/10.1089/aut.2020.0014

Bottema-Beutel, K., Kim, S. Y., & Miele, D. B. (2019). College Students' Evaluations and Reasoning About Exclusion of Students with Autism and Learning Disability: Context and Goals may Matter More than Contact. *Journal of Autism and Developmental Disorders*, *49*(1), 307-323. https://doi.org/10.1007/s10803-018-3769-5

Brewer, R., Biotti, F., Catmur, C., Press, C., Happé, F., Cook, R., & Bird, G. (2016). Can neurotypical individuals read autistic facial expressions? Atypical production of emotional facial expressions in autism spectrum disorders. *Autism Research*, *9*(2), 262-271. https://doi.org/10.1002/aur.1508

Buttelmann, D., & Böhm, R. (2014). The Ontogeny of the motivation that underlies in-group bias. *Psychological Science*, *25*(4), 921-927. https://doi.org/10.1177/0956797613516802

Candelo, N., Eckel, C., & Johnson, C. (2019). The proposer's behavior in the ultimatum game in 11 Mexican villages. *Economics Letters*, *177*, 5-8. https://doi.org/10.1016/j.econlet.2019.01.006

Chong, T. T. J., Apps, M., Giehl, K., Sillence, A., Grima, L. L., & Husain, M. (2017). Neurocomputational mechanisms underlying subjective valuation of effort costs. *PLOS Biology*, *15*(2), e1002598. https://doi.org/10.1371/journal.pbio.1002598

Cook, J. L., & Bird, G. (2012). Atypical social modulation of imitation in autism spectrum conditions. *Journal of Autism and Developmental Disorders*, *42*(6), 1045-1051. https://doi.org/10.1007/s10803-011-1341-7

Crompton, C. J., Hallett, S., Ropar, D., Flynn, E., & Fletcher-Watson, S. (2020). 'I never realised everybody felt as happy as I do when I am around autistic people': A thematic analysis of autistic adults' relationships with autistic and neurotypical friends and family. *Autism*, *24*(6), 1438-1448. https://doi.org/10.1177/1362361320908976

Crompton, C. J., Ropar, D., Evans-Williams, C. V. M., Flynn, E. G., & Fletcher-Watson, S. (2020). Autistic peer-to-peer information transfer is highly effective. *Autism*, *24*(7), 1704-1712. https://doi.org/10.1177/1362361320919286

Crompton, C. J., Sharp, M., Axbey, H., Fletcher-Watson, S., Flynn, E. G., & Ropar, D. (2020). Neurotype-Matching, but Not Being Autistic, Influences Self and Observer

Ratings of Interpersonal Rapport [Original Research]. *Frontiers in Psychology*, *11*(2961), 586171. https://doi.org/10.3389/fpsyg.2020.586171

DeBrabander, K. M., Morrison, K. E., Jones, D. R., Faso, D. J., Chmielewski, M., & Sasson, N. J. (2019). Do first impressions of autistic adults differ between autistic and nonautistic observers? *Autism in Adulthood*, *1*(4), 250-257. https://doi.org/10.1089/aut.2019.0018

Edey, R., Cook, J., Brewer, R., Johnson, M. H., Bird, G., & Press, C. (2016). Interaction takes two: Typical adults exhibit mind-blindness towards those with autism spectrum disorder. *Journal of Abnormal Psychology*, *125*(7), 879-885. https://doi.org/10.1037/abn0000199

Faso, D. J., Sasson, N. J., & Pinkham, A. E. (2015). Evaluating posed and evoked facial expressions of emotion from adults with autism spectrum disorder. *Journal of Autism and Developmental Disorders*, *45*(1), 75-89. https://doi.org/10.1007/s10803-014-2194-7

Fehr, E., & Fischbacher, U. (2003). The nature of human altruism. *Nature* 425, 785–791.

Gillespie-Lynch, K., Daou, N., Obeid, R., Reardon, S., Khan, S., & Goldknopf, E. J. (2021). What contributes to stigma towards autistic university students and students with other diagnoses? *Journal of Autism and Developmental Disorders*, *51*(2), 459-475. https://doi.org/10.1007/s10803-020-04556-7

Gillespie-Lynch, K., Daou, N., Sanchez-Ruiz, M. J., Kapp, S. K., Obeid, R., Brooks, P. J., . . . Abi-Habib, R. (2019). Factors underlying cross-cultural differences in stigma toward autism among college students in Lebanon and the United States. *Autism*, *23*(8), 1993-2006. https://doi.org/10.1177/1362361318823550

Greenwald, A. G., McGhee, D. E., & Schwartz, J. L. (1998). Measuring individual differences in implicit cognition: the implicit association test. *Journal of Personality* *and Social Psychology*, *74*(6), 1464-1480. https://doi.org/10.1037//0022-3514.74.6.1464

Güroğlu, B., van den Bos, W., & Crone, E. A. (2014). Sharing and giving across adolescence: an experimental study examining the development of prosocial behavior. *Frontiers in Psychology*, *5*, 291. https://doi.org/10.3389/fpsyg.2014.00291

Harris, M, B. (1977). Effects of altruism on mood. *Journal of Social Psychology*, *102*, 197–208.

Hartmann, M. N., Hager, O. M., Tobler, P. N., & Kaiser, S. (2013). Parabolic discounting of monetary rewards by physical effort. *Behavioural Processes*, *100*, 192-196. https://doi.org/10.1016/j.beproc.2013.09.014

Hurley, R. S. E., Losh, M., Parlier, M., Reznick, J. S., & Piven, J. (2007). The Broad Autism Phenotype Questionnaire. *Journal of Autism and Developmental Disorders*, *37*(9), 1679-1690. https://doi.org/10.1007/s10803-006-0299-3

Inzlicht, M., & Hutcherson, C. A. (2017). Psychology: People work less hard for others. *Nature Human Behaviour*, *1*(7), 0148. https://doi.org/10.1038/s41562-017-0148

Jameel, L., Vyas, K., Bellesi, G., Roberts, V., & Channon, S. (2014). Going 'above and beyond': Are those high in autistic traits less pro-social? *Journal of Autism and Developmental Disorders*, *44*(8), 1846-1858. https://doi.org/10.1007/s10803-014-2056-3

Jones, D. R., DeBrabander, K. M., & Sasson, N. J. (2021). Effects of autism acceptance training on explicit and implicit biases toward autism. *Autism*, *25*(5), 1246-1261. https://doi.org/10.1177/1362361320984896

Kawamura, Y., Ohtsubo, Y., & Kusumi, T. (2021). Effects of Cost and Benefit of Prosocial Behavior on Reputation. *Social Psychological and Personality Science*, *12*(4), 452–460. https://doi.org/10.1177/1948550620929163

Keating, C. T., & Cook, J. L. (2020). Facial expression production and recognition in autism spectrum disorders: A shifting landscape. *Child and Adolescent Psychiatric Clinics of North America*, *29*(3), 557-571. https://doi.org/10.1016/j.chc.2020.02.006

Keating, C. T., Hickman, L., Leung, J., Monk, R., Montgomery, A., Heath, H., & Sowden, S. (2022, May 10). Autism-related language preferences across the globe: A mixed methods investigation. *PsyArXiv*. https://doi.org/10.31234/osf.io/859x3

Kenny, L., Hattersley, C., Molins, B., Buckley, C., Povey, C., & Pellicano, E. (2015). Which terms should be used to describe autism? Perspectives from the UK autism community. *Autism*, *20*(4), 442-462. https://doi.org/10.1177/1362361315588200

Kim, S. Y., Cheon, J. E., Gillespie-Lynch, K., & Kim, Y.-H. (2021). Is autism stigma higher in South Korea than the United States? Examining cultural tightness, intergroup bias, and concerns about heredity as contributors to heightened autism stigma. *Autism*, *26*(2), 460-472. https://doi.org/10.1177/13623613211029520

Kleiner, M., Brainard, D., Pelli, D., Ingling, A., Murray, R., & Broussard, C. J. P. (2007). Whats new in Psychtoolbox-3? *Perception*, *36*, 1-16.

Koller, M. (2016). robustlmm: An R package for robust estimation of linear mixed-effects models. *Journal of Statistical Software*, *75*(6), 1-24. https://doi.org/10.18637/jss.v075.i06

Kreidler, S. M., Muller, K. E., Grunwald, G., Ringham, B. M., Coker-Dukowitz, Z. T., Sakhadeo, U. R., . . . Glueck, D. H. (2013). GLIMMPSE: Online power computation for linear models with and without a baseline covariate. *Journal of Statistical Software*, *54*(10), 1-26. https://doi.org/10.18637/jss.v054.i10

Lockwood, P. L., Abdurahman, A., Gabay, A. S., Drew, D., Tamm, M., Husain, M., & Apps, M. A. J. (2021). Aging increases prosocial motivation for effort. *Psychological Science*, *32*(5), 668-681. https://doi.org/10.1177/0956797620975781

Lockwood, P. L., Hamonet, M., Zhang, S. H., Ratnavel, A., Salmony, F. U., Husain, M., & Apps, M. A. J. (2017). Prosocial apathy for helping others when effort is required. *Nature Human Behaviour*, *1*(7), 0131. https://doi.org/10.1038/s41562-017-0131

Martela, F., & Ryan, R., M. (2016). Prosocial behavior increases well-being and vitality even without contact with the beneficiary: Causal and behavioral evidence. *Motivation and Emotion*, *40*, 351–357

Mathersul, D., McDonald, S., & Rushby, J. A. (2013). Understanding advanced theory of mind and empathy in high-functioning adults with autism spectrum disorder. *Journal of Clinical and Experimental Neuropsychology*, *35*(6), 655-668. https://doi.org/10.1080/13803395.2013.809700

Matthews, N. L., Ly, A. R., & Goldberg, W. A. (2015). College students' perceptions of peers with autism spectrum disorder. *Journal of Autism and Developmental Disorders*, *45*(1), 90-99. https://doi.org/10.1007/s10803-014-2195-6

Mayr, U., & Freund, A. M. (2020). Do we become more prosocial as we age, and if so, why? *Current Directions in Psychological Science*, *29*(3), 248-254. https://doi.org/10.1177/0963721420910811

Mills, B. M., Tainsky, S., Green, B. C., & Leopkey, B. (2018). The ultimatum game in the college football rivalry context. *Journal of Sport Management*, *32*(1), 11-23. https://doi.org/10.1123/jsm.2017-0094

Milton, D. (2013). "Filling in the gap“ : A micro-sociological analysis of autism. *Autonomy, the Critical Journal of Interdisciplinary Autism Studies*, *1*(2), 2051.

Milton, D. E. M. (2012). On the ontological status of autism: the ‘double empathy problem’. *Disability & Society*, *27*(6), 883-887. https://doi.org/10.1080/09687599.2012.710008

Morrison, K. E., DeBrabander, K. M., Jones, D. R., Faso, D. J., Ackerman, R. A., & Sasson, N. J. (2019). Outcomes of real-world social interaction for autistic adults paired with autistic compared to typically developing partners. *Autism*, *24*(5), 1067-1080. https://doi.org/10.1177/1362361319892701

Mosner, M. G., Kinard, J. L., McWeeny, S., Shah, J. S., Markiewitz, N. D., Damiano-Goodwin, C. R., . . . Dichter, G. S. (2017). Vicarious effort-based decision-making in autism spectrum disorders. *Journal of Autism and Developmental Disorders*, *47*(10), 2992-3006. https://doi.org/10.1007/s10803-017-3220-3

Pavlović, T., Azevedo, F., De, K., Riaño-Moreno, J. C., Maglić, M., Gkinopoulos, T., ... & Keudel, O. (2022). Predicting attitudinal and behavioral responses to COVID-19 pandemic using machine learning. *PNAS nexus*, *1*(3), pgac093.

Pellicano, E., Dinsmore, A., & Charman, T. (2014). What should autism research focus upon? Community views and priorities from the United Kingdom. *Autism*, *18*(7), 756-770. https://doi.org/10.1177/1362361314529627

Pessiglione, M., Vinckier, F., Bouret, S., Daunizeau, J., & Le Bouc, R. (2018). Why not try harder? Computational approach to motivation deficits in neuro-psychiatric diseases. *Brain: A Journal of Neurology*, *141*(3), 629-650. https://doi.org/10.1093/brain/awx278

Rahal, R.-M., Fiedler, S., & De Dreu, C. K. W. (2020). Prosocial Preferences condition decision effort and ingroup biased generosity in intergroup decision-making. *Scientific Reports*, *10*(1), 10132. https://doi.org/10.1038/s41598-020-64592-2

Romualdez, A. M., Heasman, B., Walker, Z., Davies, J., & Remington, A. (2021). "People might understand me better": Diagnostic disclosure experiences of autistic individuals in the workplace. *Autism in Adulthood*, *3*(2), 157-167. https://doi.org/10.1089/aut.2020.0063

Romualdez, A. M., Walker, Z., & Remington, A. (2021). Autistic adults' experiences of diagnostic disclosure in the workplace: Decision-making and factors associated with outcomes. *Autism & Developmental Language Impairments*, *6*, 23969415211022955. https://doi.org/10.1177/23969415211022955

Rum, Y., Zachor, D. A., & Dromi, E. (2020). Prosocial behaviors of children with autism spectrum disorder (ASD) during interactions with their typically developing siblings. *International Journal of Behavioral Development*, *45*(4), 293-298. https://doi.org/10.1177/0165025420971042

Ruzich, E., Allison, C., Smith, P., Watson, P., Auyeung, B., Ring, H., & Baron-Cohen, S. (2015). Measuring autistic traits in the general population: a systematic review of the Autism-Spectrum Quotient (AQ) in a nonclinical population sample of 6,900 typical adult males and females. *Molecular Autism*, *6*(1), 2. https://doi.org/10.1186/2040-2392-6-2

Ruzich, E., Allison, C., Smith, P., Watson, P., Auyeung, B., Ring, H., & Baron-Cohen, S. (2016). Subgrouping siblings of people with autism: Identifying the broader autism phenotype. *Autism Research*, *9*(6), 658-665. https://doi.org/https://doi.org/10.1002/aur.1544

Sarrett, J. C. (2017). Interviews, disclosures, and misperceptions: Autistic adults' perspectives on employment related challenges. *Disability Studies Quarterly*, *37*. https://doi.org/https://doi.org/10.18061/dsq.v37i2.5524

Sasson, N. J., Faso, D. J., Nugent, J., Lovell, S., Kennedy, D. P., & Grossman, R. B. (2017). Neurotypical peers are less willing to interact with those with autism based on thin slice judgments. *Scientific Reports*, *7*(1), 40700. https://doi.org/10.1038/srep40700

Sasson, N. J., & Morrison, K. E. (2017). First impressions of adults with autism improve with diagnostic disclosure and increased autism knowledge of peers. *Autism*, *23*(1), 50-59. https://doi.org/10.1177/1362361317729526

Sheppard, E., Pillai, D., Wong, G. T.-L., Ropar, D., & Mitchell, P. (2016). How easy is it to read the minds of people with autism spectrum disorder? *Journal of Autism and Developmental Disorders*, *46*(4), 1247-1254. https://doi.org/10.1007/s10803-015-2662-8

Solomon, C. (2020). Autism and employment: Implications for employers and adults with ASD. *Journal of Autism and Developmental Disorders*, *50*(11), 4209-4217. https://doi.org/10.1007/s10803-020-04537-w

Sowden, S., Koehne, S., Catmur, C., Dziobek, I., & Bird, G. (2016). Intact automatic imitation and typical spatial compatibility in autism spectrum disorder: challenging the broken mirror theory. *Autism Research*, *9*(2), 292-300. https://doi.org/10.1002/aur.1511

Spengler, S., Bird, G., & Brass, M. (2010). Hyperimitation of actions is related to reduced understanding of others' minds in autism spectrum conditions. *Biological Psychiatry*, *68*(12), 1148-1155. https://doi.org/https://doi.org/10.1016/j.biopsych.2010.09.017

Stevenson, J. L., & Hart, K. R. (2017). Psychometric properties of the autism-spectrum quotient for assessing low and high levels of autistic traits in college students. *Journal of Autism and Developmental Disorders*, *47*(6), 1838-1853. https://doi.org/10.1007/s10803-017-3109-1

Thompson-Hodgetts, S., Labonte, C., Mazumder, R., & Phelan, S. (2020). Helpful or harmful? A scoping review of perceptions and outcomes of autism diagnostic disclosure to others. *Research in Autism Spectrum Disorders*, *77*, 101598. https://doi.org/10.1016/j.rasd.2020.101598

Trevisan, D. A., Hoskyn, M., & Birmingham, E. (2018). Facial expression production in autism: a meta-analysis. *Autism Research*, *11*(12), 1586-1601. https://doi.org/10.1002/aur.2037

Uljarevic, M., & Hamilton, A. (2013). Recognition of emotions in autism: a formal meta-analysis. *Journal of Autism and Developmental Disorders*, *43*(7), 1517-1526. https://doi.org/10.1007/s10803-012-1695-5

Vassena, E., Silvetti, M., Boehler, C. N., Achten, E., Fias, W., & Verguts, T. (2014). Overlapping neural systems represent cognitive effort and reward anticipation. *PloS one*, *9*(3), e91008. https://doi.org/10.1371/journal.pone.0091008

Walkowiak, E. (2021). Neurodiversity of the workforce and digital transformation: The case of inclusion of autistic workers at the workplace. *Technological Forecasting and Social Change*, 168, 120739. https://doi.org/https://doi.org/10.1016/j.techfore.2021.120739

White, R., Barreto, M., Harrington, J., Kapp, S. K., Hayes, J., & Russell, G. (2019). Is disclosing an autism spectrum disorder in school associated with reduced stigmatization? *Autism*, *24*(3), 744-754. https://doi.org/10.1177/1362361319887625

Zhao, X., Li, X., Song, Y., & Shi, W. (2019). Autistic traits and prosocial behaviour in the general population: Test of the mediating effects of trait empathy and state empathic concern. *Journal of Autism and Developmental Disorders*, *49*(10), 3925-3938. https://doi.org/10.1007/s10803-018-3745-0