Toward understanding everyday decision making by adults across the autism spectrum

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Abstract

We focus on the everyday decision making challenges faced by high functioning adults across the Autism Spectrum using both between- and within-group comparisons. We used Mturk, backed by a combination of recruiting and screening procedures, to recruit large samples using an online survey. The main differences between groups were: greater relationship problems at home, school and work for the ASD group compared to the control group; greater difficulty in a variety of everyday decisions and the negative consequences of their decisions; greater aversion to social risks; lower levels of Rational Ability; and greater personal endorsement of socially undesirable acts. Poorer decision outcomes within the ASD group were predicted by lower levels of Rational Ability and higher personal endorsement of socially undesirable acts. Some of the same predictor-outcome relations were found within the Control group. These results illustrate how the study of unique groups can increase our overall understanding of individual differences in decision making within the general population, and the need to include both between-group and within-group analyses.

Keywords: autism spectrum, decision making, individual differences

1 Introduction

The overarching goal of this paper is to focus on the challenges that adults who are on the autism spectrum encounter as they seek to be successful in everyday life. To do this, we provide a comparison between adults with Autism Spectrum Disorder (ASD) and controls using a variety of measures that reflect the quality of decision making in everyday life and its underlying roots. Compared to the relatively few studies of decision making among adults on the autism spectrum, our study is unique in several ways. First, we include a large number of tasks and measures to better understand the profile of strengths and weaknesses in our ASD sample. Second, we examine within-group as well as between-group differences on these measures. Finally, we develop an online survey methodology to increase sample size in our ASD group.

We uncover large differences between groups in the difficulty of making relatively simple life-decisions, the negative consequences of such decisions, and how these decisions are affected by factors such as social-emotional predispositions, thinking style, risk-attitude and perceptions of others'

attitudes. We also find that some of these same factors discriminate within as well as between individuals in each group.

About 1 in 68 children are diagnosed with a disorder on the autism spectrum, and the prevalence of the diagnosis is rising (Christensen et al., 2016). Autism is a lifetime diagnosis, and the children that make up the prevalence rates are growing up. Many of these young adults are gaining independence in areas such as education, employment and consumer choices. Nevertheless, this group is known for its deficits in social functioning as well as its difficulties in decision making. For example, Luke et al. (2012) and Brosnan et al. (2014) reported that persons with ASD take longer to make decisions and are more apt to avoid decisions altogether. De Martino et al. (2008) found that people on the spectrum were less apt to employ heuristics that others use to reduce the cognitive demands of decision-making. Comparisons between those with ASD and controls will provide a way of examining how extreme differences in social functioning affect decision making. Individual differences within both the ASD group and the Control group will reveal the extent to which subtler differences in our measures relate to decision making.

Those diagnosed with ASD represent a multifaceted and diverse set of conditions often relating to social communication and behavioral difficulties (American Psychiatric Association [APA], 2013; Tager-Flusberg, 2007). The most popular theory, "theory of mind" (Baron-Cohen, Leslie & Frith 1985), postulates that individuals with ASD possess a lesser capacity to understand the feelings, thoughts, intentions, beliefs, and potential behavioral reactions of others.

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Nevertheless, those who are older or have higher cognitive functioning may rely on language, decision rules and other nonsocial cognitive functions rather than on social insight to solve problems (Frith & Frith, 2003). Thus it is important to compare persons with ASD and controls on a variety of tasks and measures, including social, emotional and cognitive.

We have recently applied a variety of measures, some developed in our laboratory and some from others' past work, to study decision making in adults with ASD. In a pilot study (Levin et al., 2015), we examined the relative strengths and weaknesses of persons with ASD based on an expanded analysis of the constructs of "decision making competence" in an attempt to uncover factors predictive of the consequences actually experienced by these decision-makers.

In this pilot study, a battery of tests was administered in personal laboratory sessions to 15 high-functioning college students with ASD, focusing on elements from the Decision Making Competence index (DMC), a tool to assess decision making processes and style (Parker & Fischhoff, 2005; Bruine de Bruin et al., 2007; Levin et al., 2014) as well as other aspects of decision making that could potentially discriminate between persons with ASD and age-matched controls. First, as a test of a key social deficit associated with autism, the ASD group scored much lower on the Empathy Quotient scale (EQ; Baron-Cohen & Wheelwright, 2004). Then we looked at traditional elements of DMC such as Numeracy, application of decision rules, and framing effects and found that the measures were comparable across groups. However, there were differences in thinking style based on Pacini and Epstein's (1999) Rational-Experiential Inventory, with the ASD group showing lesser engagement in intuitive thinking. Those in the ASD group had more difficulty with everyday decisions; they were less risk-taking; and they tended to distort norms of socially undesirable acts. These results got us even more interested in the challenges faced by individuals on the spectrum and motivated us to pursue the study described here, and especially to seek a much larger sample size.

2   Present study: Overview

In the present study we selected the most promising tasks and measures from the pilot study but we faced the challenge common to many studies of unique populations, of obtaining a meaningful number of participants. For those unfamiliar with work using special populations, and ASD in particular, recruiting participants can be difficult. We admit we were not sure it would be successful, but our colleagues were using Mturk for their "traditional" research so we decided to design an Mturk study with ASD participants as the target group. Mturk is a nation-wide network of people who complete surveys for compensation, and a system now used frequently by the academic community (Horton, Rand & Zeckhauser,

2011; Paolacci, Chandler & Ipeirotis, 2010). Our goal was to obtain at least 50 viable participants for both the ASD and control groups. A specific call was sent out for persons self-identified with ASD. This allowed us the potential to greatly expand our sample of ASD participants, as well as offer a very broad geographic and age distribution. Importantly, the process required that we have a way to verify self-reports of ASD. To our surprise, the process worked extremely well. Using a set of screening items based on clinical diagnostic criteria to eliminate respondents with unsubstantiated self-reports, we ended up with sample size of 72 in the ASD group and 68 in the control group (non-ASD).

As another way of increasing the validity of this process, we used the transcripts obtained from the personal interviews in the pilot study to create a series of questions that could be administered online dealing with inter-personal problems in the areas of relations at school, relations at work, living arrangements, and friendship networks. Responses to these questions strongly supported the final classification of participants in the ASD and control groups.

Our primary goal was to build on our prior pilot study and take it in new directions using a larger and more diverse sample. We also hoped to test a more efficient sampling methodology via Mturk to have enough data to conduct within-group analyses. Because we are adding new measures beyond the pilot, we still consider this an exploratory study and frame our propositions in terms of testable research questions, rather than as formal hypotheses. We are able to successfully address these questions using the expanded methodology and with Mturk data collection processes.

3   Research questions

1. Does our early evidence of problems with everyday decisions in autism extend to a wider variety of behaviors, including measures of life satisfaction in various domains?

2. To what extent do group and individual differences in thinking style, perception of social norms, and risk-attitudes predict problems in everyday decision making?

3. Using our measures developed for discriminating between ASDs and Controls, can we detect parallel differences within each group that support a continuum of autistic-like characteristics?

4   Method

4.1   Participants

We recruited our participants using the Amazon Mechanical Turkers (Mturk) panel. We targeted ninety for both the "ASD" and control groups and developed a survey that would take about fifty minutes to complete. To avoid confusion, we recruited the two groups in temporal sequence. For the ASD

group, an announcement on Mturk was created that invited participants to join the study only if they had been diagnosed, either formally or informally, as being on the autism (or Asperger's) spectrum. We confirmed this by explicitly asking the participants about their diagnosis. Following this, for the Control group, we recruited another ninety participants, with no constraints (and removed the ASD diagnosis question), although those who had participated in the previous ASD version of the survey were not allowed by the software to participate again. Because of the way the Mturk system works, we ended up with 91 individuals in each group. Each participant received $6 for their participation. The survey instrument we used was identical for both groups, only the recruitment constraints differed.

We anticipated that some of the "ASD" participants would not qualify as being on the spectrum, and some Control participants would in fact be on the spectrum. To ensure that our two groups were appropriately filtered, we used their score on the Iowa Screener (Foley-Nicpon, et al., 2016). The Iowa Screener (IS) is an instrument developed to assist in what is a complex diagnosis process for ASD. While we understand that the IS score is clearly not by itself a diagnosis of ASD, validation of this classification is provided by large revealed differences in our Social Functioning index across groups.

We classified our participants as ASD or Control based on a two-step process of whether they were recruited on Mturk as ASD, or with no constraints (referred to as "MturkGroup" in the supplement), and then each group was filtered by their score on the clinically-based Iowa Screener (referred to as Iowa_Screener in the supplement). The lower end of that scale which can range from 0 to 100 represents more self-reported autistic-like behaviors. We used a cutoff of 61 where the combination of self-identified ASD and an IS score less than or equal to 61 was our criterion for classification as ASD. From the 91 "control" surveys, we removed those who scored less than 61. The choice of the cutoff score of 61 served the dual purposes of eliminating overlap between the two groups and achieving approximately equal sample sizes. It is interesting to note that 23 of the 91 "controls" had an IS score that was less than the cutoff for the "ASD" group, thus potentially overlapping with the ASD group and thus were eliminated. From the 91 self-identified ASDs, 19 were excluded based on scores greater than 61.

In summary, the "ASD" group was self-identified through Mturk recruitment as on the spectrum and had an IS score less than or equal to 61 and the "Control" group was not screened on recruitment but filtered by having an IS score greater than 61.

Once these two groups were determined, we compared basic demographics, as shown in Table 1. As can be seen, for most variables there was no difference between the two groups. Age was an exception. We conducted additional analyses that included age or gender (see comments below)

Table 1: Comparison of demographics for ASD versus Control group.

Variable	Group	Mean	S.D.
Age[+]	ASD	30.03 (n=72)	8.86
	Control	37.28 (n=68)	12.27
Number of jobs in life*	ASD	5.4 (n=71)	4.3
	Control	6.3 (n=68)	4.0
Years in current job*	ASD	3.9 (n=58)	2.35
	Control	4.5 (n=54)	3.82

		Group	
		ASD (n=72)	Control (n=67)
Gender*	Female	31	29
	Male	41	38
Employment status[+]	Full-time	50%	65%
	Part-time	18%	13%
	Occasionally	14%	3%
	Not employed	18%	19%
Education*	Less than high school	1%	1%
	High school/GED	19%	13%
	Some college	29%	32%
	2-year college degree	7%	15%
	4-year college degree	35%	34%
	Masters degree	8%	4%
	Terminal or prof degree	0%	0%
Current living arrangement[+]	Living alone	28%	32%
	Living with friends	8%	6%
	Living with spouse or significant other	28%	40%
	Living with parents	35%	19%
	Living in a group home	0%	0%
	Living with college roommates	1%	3%

+Difference between groups, $p < .1$. *Does not differ between groups.

as an interaction term. In general, these interactions between ASD group and age or gender were not significant. We include in the Results section the few instances for which the interaction was significant. Several of the other results are noteworthy in that they tend to support our screening process. The data on living arrangements where persons in the ASD

Table 2: Group comparisons of social functioning: means (95% confidence interval). Scale was 0 to 10.

	ASD	Control	Effect size	Difference
Satisfied with schooling	5.26 (±0.60)	6.65 (±0.48)	0.60	p < .001
Get along with teachers	5.73 (±0.62)	7.75 (±0.33)	0.95	p < .0001
Get along with fellow students	4.18 (±0.57)	7.21 (±0.52)	1.32	p < .0001
Satisfied with employment	6.31 (±0.62)	6.65 (±0.68)	0.14	NS
Get along with supervisors	6.46 (±0.55)	7.77 (±0.59)	0.52	p < .01
Get along with fellow workers	5.75 (±0.53)	7.95 (±0.49)	1.14	p < .0001
Satisfied with living arrangement	6.81 (±0.61)	7.86 (±0.61)	0.41	p =.02
Get along with people you live with	6.80 (±0.70)	8.33 (±0.62)	0.56	p < .01
Satisfied with friendship network	6.18 (±0.67)	6.57 (±0.69)	0.14	NS

group were more likely to be living with parents and less likely to be living with a spouse or significant other certainly fits the characterization of ASDs as having social problems, as does the lower percentage of full-time employment. The fact that our ASD group was comparable to controls in higher education supports our classification of this sample as being "high-functioning."

It is also interesting to note the large percentage of females in the ASD sample in comparison to reports in the population, which has been reported at a ratio of 4.5:1 males to females (Christensen et al. 2016). The relatively high percentage of females in the ASD sample is undoubtedly a function of the large number of females who participate in Mturk surveys. However, an interesting question for the future is whether the percentage of females with ASD is greater for high-functioning ASDs than for low-functioning ones.

5 Tasks and measures

In the following material we describe in detail all of the scales that obtained a significant relationship to our key measures of ASD. We used several other items that did not show any relationships and were not included in our presentation of the results. These were: 1) Cups risk assessment task; 2) susceptibility to framing; and, 3) the Dictator Game. In addition, we included three open-ended questions asking for "descriptions of relationships with parents, roommates and friends" and "relationships with co-workers, supervisors and clients." The qualitative data were not considered in this paper because they have parallel representations in the quantitative data in the survey.

5.1 Iowa Screener

As mentioned above, we used a scale called the Iowa Screener (IS) which was developed by a clinical psychologist primarily for parents to communicate their children's

status on the autism spectrum (Foley-Nicpon et al., 2016). Foley-Nicpon reports high levels of success in predicting ultimate "formal" classification of children with ASD. For the present purpose, and under the guidance of Foley-Nicpon, we modified the screener to use as an instrument for self-report applied to adults. We used this mainly to validate the self-selection process used for the Mturk data collection. However, as we discuss in more detail later, it also turned out to be an interesting index relating to individual differences within groups.

The Iowa Screener consists of a set of 36 questions that capture the commonly used diagnostic criteria for ASD. These questions were formulated with the preface, "How frequently within the last 6 weeks were you engaged in the following behaviors?" Examples include: "Use eye contact while interacting with others", "Contribute verbally and/or nonverbally during conversations with others", "Am able to understand another person's point of view", and "Prefer online interactions compared to face-to-face interactions." Because of its importance, we make the full set of instructions and questions available online.

5.2 Empathy Quotient

The Empathy Quotient (EQ) was designed to measure emotional social intelligence in areas such as emotional-social awareness, awareness and understanding of how others feel, self-motivation, and ability to adapt and adjust one's feelings. Because the EQ has been frequently used in adult autism studies (Wakabayashi et al., 2007; Warrier et al., 2013), while IS is relatively new, it is important to note the significant relationship between EQ and the Iowa Screener ($r = 0.695$, $p < .001$).

5.3 Social Functioning

We developed our own set of questions based on the pilot study to assess what we called, "Social Functioning". The

following items, each scored 0 to 10, were included: "How well did you get along with your fellow students?" "How well did you get along with your teachers?" "How well did you get along with your fellow workers?" "How well did you get along with your supervisors?" "How well do you get along with the people you live with?" "How satisfied are you with your current friendship network?"

5.4   Difficulty with everyday decisions

We also developed a scale to assess our participants' degree of difficulty with everyday decisions. We based these questions on the results from our pilot study (Levin et al., 2015) and considerable personal communication with caretakers of ASD individuals. The items we used for everyday decision making were ones that we speculated would distinguish between ASDs and Controls, including: "when to go to bed", "when to wake up," "what clothes to wear," "what food to eat." (The complete list is shown with the results in Table 3.)

5.5   Decision Outcome Inventory

To investigate aspects of the quality of everyday decision making, we employed the Decision Outcome Inventory (Parker & Fischhoff, 2005). This scale focuses on outcomes that are often the result of poor consumer decisions, such as making purchases that go unused or going into debt, with the idea that these distinguish between participants who make good decisions and those who do not. (See Table 4 for a complete list of items.)

5.6   Domain Specific Risk Attitude Scale (DOSPERT)

The DOSPERT scale (Blais & Weber, 2006) measures the likelihood that respondents might engage in risky behaviors originating from five domains of life (ethical, financial, health/safety, social, and recreational risks). We employ a 7-point rating scale ranging from –3 (Extremely Unlikely) to +3 (Extremely Likely). Sample items include "Having an affair with a married man/woman" (Ethical), "Investing 10% of your annual income in a new business venture" (Financial), "Engaging in unprotected sex" (Health/Safety), "Disagreeing with an authority figure on a major issue" (Social), and "Taking a weekend sky-diving class" (Recreational). Item ratings are added across all items of a given subscale to obtain subscale scores. Higher scores indicate greater risk taking.

Because social risk-taking is highly related to problems faced by persons with ASD, we place special importance on this domain.

5.7   Rational Experiential Inventory (REI)

This dual component scale is used to measure preferences in the way we process information with a focus on the degree to which a person uses analytic and logical thinking or the extent to which he or she uses intuition and personal experience to make decisions (Pacini & Epstein, 1999; Epstein et al., 1996). "Rationality" is measured by the Need for Cognition scale (e.g., "I prefer complex over simple problems.") and "Experientiality" by the Faith in Intuition scale (e.g., "I trust my initial feelings about people."). The rationality component is measured with two subscales, Rational Ability, which reflects the ability to think logically and analytically and Rational Engagement, which reflects reliance on and enjoyment of thinking in an analytical, logical manner. The Experientiality component is also measured with two subscales, Experiential Ability, which is the ability to use intuitive impressions and feelings, and Experiential Engagement, which is the reliance on and enjoyment of feelings and intuitions in making decisions.

5.8   Perception of Social Norms

The recognition or perception of social norms is an assessment based on responses across two contexts (Jacobs et al., 1995; Parker & Fischhoff, 2005). In one context (that we call Social Norms-Self), the participant indicates the likelihood of *personally* saying that it is okay to perform each of a set of 14 socially undesirable acts (on a scale of 1=Always, 2=Sometimes and 3=Never). In the second context (Social Norms-Other), the participant estimates the percentage of his or her peers who would say it is okay to perform each of the same acts.

We used items from the original list which range from more commonly violated norms, such as "not being on time for an appointment," "not returning a borrowed item," and "keeping things found in the street," to more serious violations of norms, such as "using violence to solve an argument," and "not telling the police after witnessing a crime." To these we added items we thought would be especially sensitive to the social issues faced by those with ASD, including "not saying hello to someone you know," and "sitting by yourself at a party." We combined the individual items to create revised scales for "Social Norms-Self" and "Social Norms-Other," and assessed the reliability of the indices obtaining coefficient alpha of .81 and .90, respectively. We provide all items in the survey online. Because we deem these measures to be especially sensitive to social deficits in ASD, we also calculate the correlation between the two measures as an index of the extent to which persons in the ASD group compared to persons in the Control group see themselves as more or less similar to others in the tendency to commit socially undesirable acts.

Table 3: Group comparisons of difficulty in everyday decisions: means (95% confidence interval). Scale was 1=extremely difficult to 10=not difficult.

	ASD	Control	Effect size	Difference
When to go to bed	6.26 (±0.67)	8.60 (±0.55)	0.90	p <.0001
When to wake up	6.40 (±0.69)	7.89 (±0.55)	0.57	p <.0100
What clothes to wear	6.17 (±0.68)	8.03 (±0.55)	0.72	p <.0001
What to eat	4.83 (±0.54)	6.43 (±0.56)	0.69	p <.0001
When to shower	6.61 (±0.64)	8.93 (±0.50)	0.96	p <.0001
What and when to take medications	7.08 (±0.64)	8.78 (±0.49)	0.70	p <.0001
When to pay bills	5.94 (±0.65)	7.25 (±0.65)	0.48	p <.0100
Making and keeping medical appointments	5.90 (±0.63)	6.99 (±0.68)	0.40	p =.0200

We also computed a measure that can be interpreted as the "Accuracy of Social-norm Perception". We calculated this score by first aggregating the responses to each of the 14 Social Norm-Self questions (across both controls and ASD groups). This reflects a "standard" for social behavior on each question. Then, for each participant, we correlated their 14 Social Norm-Other responses with these standard responses to obtain a correlation value for each participant, thus reflecting the accuracy of their perception of the social-norm standard. We thought that this would be a particularly useful tool in understanding differences between persons with ASD and those without, because deficits in processing of social cues could manifest in misperceptions of others and/or in relating personal values to societal norms.

5.9   Life Satisfaction Index

We were interested in comparing the degree to which our two groups were happy with their life situations. This is an intriguing construct, since how one feels about this is a function of expectations for satisfaction. For this measure, we used the well-established Life Satisfaction Index (Diener et al., 1985) which consists of the sum of the following 5 ratings, each on a scale of 1 to 7: "In most cases my life is close to ideal," "The conditions of my life are excellent," "I am satisfied with my life," "So far I have gotten the important things I want in life," "If I could live my life over, I would change almost nothing." This measure was not included in the original survey and inserted after the data collection was underway. As a result, we have 39 observations for this index for each group. The index received a coefficient alpha of .94.

6   Results

Our two-step plan for data analysis is: 1) To compare persons in the ASD group and Controls on our measures of decision making in everyday life and on our behavioral disposition measures; and 2) To perform within-group analyses, both within the ASD group and within the Control group, of individual differences on these measures.

6.1   Between-group comparisons

Tables 2–4 summarize differences between the ASD and Control groups in measures of social functioning and decision making in everyday life and their consequences. In Table 2 we summarize how the groups compare on our measures of social functioning as operationalized by how well people function at home, in school, and in the workplace.

In response to Research Question 1 which asked the extent to which problems in autism apply to measures of life satisfaction, it can be seen in Table 2 that the groups differ on almost every measure of satisfaction and getting along with others, with some of the differences being particularly large in the direction of poorer self-perceptions by persons in the ASD group than those in the Control group. However, the two non-significant results with substantially lower effect sizes are also interesting. The ASD group did not differ from controls on Satisfaction with Employment despite the fact that it gave lower ratings for Getting Along with Fellow Workers and Getting Along with Supervisors. Similarly, the ASD group did not differ from controls on Satisfaction with Friendship Network. It is as if persons with ASD recognized problems with personal relations but failed to acknowledge the significance in their lives.

Table 3 compares groups on rated difficulty with a variety of everyday decisions. It can be seen that the ASD group gave significantly lower ratings, which on a scale of 1=Extremely Difficult to 10=Not Difficult, means greater difficulty for each item. Especially large differences occurred for the following: "When to Go to Bed," "What Clothes to Wear," "What to Eat," "When to Shower," and "What and When to Take Medications." The latter of course are particularly important for the many persons with ASD for whom medications are a key to managing their condition but are less

important to our control participants if medications are not part of their daily lives.

Again, because of the significance for quality of life, Table 4 also provides individual-item analyses, this time for group comparisons on items from the Decision Outcomes Inventory that we refer to here as Bad Decision Outcomes. Almost every item showed a significantly higher rate of reported bad outcomes by persons in the ASD group compared to Controls, with 10 out of the 14 items reaching a significance level of .0001. The ones that seem most likely to affect quality of life include "Quitting a Job After a Month", "Being Late on a Rent Payment", "Borrowing Money and Not Paying Back a Debt", and "Having to Use an Emergency Credit Card to Get out of Debt". Taken together, results displayed in Tables 3 and 4 are consistent with previous research of decision-making difficulties experienced by adults with ASD, including greater avoidance of those decisions that need to be made quickly (Luke et al., 2012).

In response to Research Question 2, Table 5 summarizes group comparisons on dispositional measures which may underlie some of the behavioral differences described in Tables 2–4. These include the subscales of the Rational/Experiential Inventory (REI) of Thinking Styles, Perception of Social Norms for self and other, the subscales of the DOSPERT index of risk taking, and the Life Satisfaction Index. For the REI, none of the effects was large, but the ASD group scored significantly lower on Rational Ability and Experiential Engagement, with a trend in that direction for Experiential Ability. While our respondents were adults, these results for Experiential Engagement are consistent with those for adolescents where persons on the spectrum were found to be less impulsive in their decision-making (Brosnan et al, 2014). There was a statistically significant interaction ($p < .03$) between group and gender for levels of Rational Engagement. Males within the control group, but not in the ASD group, showed higher levels of engagement than females.

Perception of Social Norms as a composite index did not differ significantly between groups when participants were asked to estimate the number of persons out of 100 who would perform the socially questionable acts but the difference was in the direction of higher estimates for participants in the ASD group. For specific items dealing with personal interactions, the ASD group did provide significantly higher estimates of others' performance of socially questionable acts. These items include "Not giving directions to someone who is lost", "Not returning something you borrowed", "Not keeping secrets that a friend told you", and "Not spending time with friends in need".

Furthermore, there was a statistically significant interaction between group and gender for the Perception of Social Norms-Other. Within the ASD group, but not within the control group, males were higher than females in estimating the frequency of socially undesirable acts among their peers. This is an important result because within the general population the vast majority of persons with ASD are male.

When asked to indicate whether they personally thought it was okay to perform the acts, persons in the ASD group scored significantly lower than controls on a scale ranging from complete agreement to complete disagreement, meaning that persons with ASD are more likely to endorse socially questionable acts. This effect, however, must be qualified due to a significant interaction with age, such that the ASD versus Control differences increased as a function of age ($F(2,176)=4.19$, $p < .02$) of the participant. This result may be a reflection of the accumulated negative experiences in social encounters experienced by persons with ASD.

Individuals in the ASD group ($r = -0.48$, $p < .0001$) but not those in the Control group ($r = .14$, p $> .05$) showed a significant correlation between the "self" and "other" measures (these correlations are significantly different from each other, $z = 3.84$, $p < .0001$). Those in the ASD group who were more likely to personally endorse socially questionable acts were also the ones who thought more of their peers engaged in the behavior.

We found a difference in a measure of the Accuracy of Social-norm Perception. This measure reflects a participant's ability to correctly predict aggregate societal behaviors for actions that reflect social norms. The higher the correlation between the "standard" frequency of each behavior and his or her prediction of the frequency, the more accurate the person is. We found the average correlation for the ASD group to be $r =.493$ and for the Controls to be $r =.639$. This difference in the mean correlation scores was significant ($t(133) = -3.75$, $p < .001$). We find that persons in the ASD group were less accurate in their perception of "others" social norms.

The DOSPERT subscales revealed significantly lower levels of risk taking by the ASD group only in the domain of Social Risks which is the domain most closely related to traditional accounts of deficits in social functioning. This result provides support for using DOSPERT as an instrument for detecting domain specific differences that differentially affect special populations (Blais & Weber, 2006). Risk-taking in the domain of Ethical Risks was actually higher for the ASD group but it should be noted that both groups were on the low risk-averse side of the scale. However, we see this result as consistent with the result reported above that persons with ASD are more apt to endorse socially undesirable acts.

Notably, the groups did not differ on self-rated Life Satisfaction. This, despite the fact that persons with ASD reported lower levels of functioning in a number of specific domains.

6.2　Within-group comparisons

Research Question 3 asked whether the differences detected between groups are mirrored in differences within groups.

Table 4: Group comparisons of bad decision outcomes: means (95% confidence interval). Scale was "In the last year, have you ever" where 0 = "never" and 10= "frequently."

	ASD	Control	Effect size	Difference
Rented movie but unwatched	3.26 (±0.72)	1.18 (±0.54)	0.78	p < .0001
Bought clothes never worn	3.79 (±0.76)	1.99 (±0.66)	0.60	p < .001
Quit a job after a month	2.03 (±0.70)	0.35 (±0.31)	0.73	p < .0001
Spent at least $500 to fix car	2.04 (±0.71)	0.15 (±0.21)	0.85	p < .001
Kicked out of an apartment	1.64 (±0.68)	0.09 (±0.18)	0.73	p < .0001
Have a large credit card debt	3.49 (±0.85)	2.69 (±0.96)	0.21	NS
At least 2 weeks late on a rent payment	2.50 (±0.51)	0.69 (±0.48)	0.65	p < .0001
Had a check bounce	1.59 (±0.62)	0.22 (±0.26)	0.69	p < .0001
Pay utility bill late	2.47 (±0.79)	1.44 (±0.66)	0.34	p = .05
Loan that was not paid back	2.85 (±0.80)	0.78 (±0.55)	0.72	p < .0001
Wasted groceries	5.43 (±0.75)	4.60 (±0.66)	0.28	NS
Borrowed money from parent	3.33 (±0.77)	0.81 (±0.46)	0.94	p < .001
Borrowed money from a friend	2.58 (±0.77)	1.07 (±0.61)	0.52	p < .01
Use emergency credit	3.07 (±0.81)	1.16 (±0.59)	0.64	p < .001

In this section we summarize the most important within-group analyses of correlations between behavioral measures and dispositional measures, separately for the ASD group and the Control group. These analyses are meant to help explain the source of the behavioral differences summarized in Tables 2–5, as well as to highlight the fact that ASD is indeed a continuum with substantial individual differences. For purposes of reducing the number of inter-correlations, and to produce more stable measures, we combined the difficulty in everyday decision making items into a composite measure which we labeled, "Life Difficulty", and we combined satisfaction with life measures (see Table 2 for items) into a composite index, and an additional index based on the "getting along with others" questions (see Table 2 for items).

6.2.1 ASD group

The best predictors of our selected criteria in the ASD group were the individual differences captured by Rational Ability, Perception of Social Norms-Self and Other, and Total Risks.

Rational Ability was significantly correlated with Life Satisfaction ($r = .25$, $p = .03$) and bad decision outcomes ($r = -.30$, $p <.01$) and approached significance for overall life satisfaction, employment satisfaction, get along with others, and with life difficulty. Each of these was in the direction where better outcomes occurred for those with higher Rational Ability. Lesser personal endorsement of socially undesirable behaviors was significantly associated with higher education satisfaction ($r = .37$, $p < .01$), higher employment satisfaction ($r = .35$, $p <.01$), higher levels of getting along with others ($r = .27$, $p < .05$) and fewer bad decisions out-

comes ($r = -.26$, $p < .05$). Lower perceived levels of others' socially undesirable behaviors were associated with higher employment satisfaction ($r = -.27$, $p <.05$), higher levels of getting along with others ($r = -.26$, $p <.05$) and fewer bad decision outcomes ($r = .33$, $p <.01$). Lower total risk taking was associated with greater employment satisfaction ($r = -.40$, $p <.01$), higher levels of getting along with others ($r = -.33$, $p <.01$), less difficulty with life decisions ($r = -.30$, $p <.01$) and fewer bad decision outcomes ($r = .46$, $p <.001$).

Within the ASD group, scores on the Screener were significantly correlated with Life Satisfaction and Thinking Style (scores on the REI). Those showing the greatest autistic-like tendencies, i.e., those scoring lower on the IS, had lower Life Satisfaction ($r = .357$, $p < .03$). On the REI they showed higher levels of Rational Ability and Rational Engagement ($r = -.350$, $p < .01$ and $r = -.332$, $p < .01$, respectively) while they showed lower levels of Experiential Ability and Experiential Engagement ($r = .288$, $p < .02$ and $r = .397$, $p < .001$, respectively). In summary, those showing the most extreme levels of autistic-like tendencies were more apt to be deliberative decision makers and less apt to be intuitive/impulsive decision makers, and they expressed lower life satisfaction.

6.2.2 Control group

The best predictors of our criterion measures in the Control group were Rational Ability and Perception of Social Norms-Self. In this regard, the two groups shared common tendencies. For both groups, the higher the levels of Rational Ability, the better the reported relationships with others. Rational Ability within the Control group was also predic-

Table 5: Group comparisons on dispositional measures: means (95% confidence interval).

	ASD	Control	Effect size	Difference
Empathy Quotient Index (EQ)	20.49 (±2.45)	39.93 (±2.73)	1.79	p < .001
Rational/Experiential Inventory (REI) (Scale: 1–5)				
Rational Ability	3.66 (±0.19)	3.97 (±0.17)	0.42	p=.02
Rational Engagement	3.61 (±0.21)	3.73 (±0.22)	0.14	NS
Experiential Ability	2.93 (±0.23)	3.21 (±0.20)	0.30	p=.07
Experiential Engagement	2.76 (±0.19)	3.11 (±0.21)	0.41	p =.02
DOSPERT Index (higher numbers represent greater risk)				
Social risks	1.66 (±1.79)	5.35 (±1.58)	0.55	p<.01
Financial risks	−7.44 (±1.81)	−8.65 (±1.87)	0.16	NS
Recreational risks	−7.52 (±2.00)	−8.65 (±1.83)	0.14	NS
Ethical risks	−8.15 (±1.85)	−12.40 (±1.06)	0.67	p<.0001
Health/Safety	−6.62 (±1.95)	−7.59 (±1.57)	0.13	NS
Life Satisfaction Index	18.69 (±2.26)	20.10 (±2.78)	0.18	NS
Social norms				
Social norms-self (Scale: 1=Always to 3 =Never)	2.17 (±0.07)	2.41 (±0.06)	0.84	p<.001
Social norms-other (Scale: 0 to 100)	39.82 ((±4.35)	36.80 (±2.66)	0.20	NS

tive of less difficulty with everyday decisions, less negative consumer consequences, and greater life satisfaction. Perception of Social Norms-Self was again a factor with less personal endorsement of negative social acts predicting better social relations, and in this instance, less difficulty with everyday decisions. Perception of others' social norms was not a major factor for the Control group nor were scores on the DOSPERT.

Higher Rational Ability was associated with greater life satisfaction ($r = .36$, $p < .05$), greater educational satisfaction ($r = .34$, $p< .01$), greater social satisfaction ($r = .40$, $p < .001$), greater levels of getting along with others ($r = .29$, $p <.05$), less life difficulty ($r = .31$, $p < .01$), and fewer bad decision outcomes ($r = −.24$, $p <.05$). Less personal endorsement of negative social behaviors was associated with higher life satisfaction ($r = .53$, $p < .001$), higher educational satisfaction ($r = .28$, $p < .05$), higher employment satisfaction ($r = .27$, $p <.05$), higher social satisfaction ($r = .46$, $p < .001$), greater levels of getting along with others ($r = .46$, $p <.001$), and less life difficulty ($r = .51$, $p < .001$).

Interestingly, the Iowa Screener test, which was originally designed to discriminate between the ASD and Control groups, also discriminated within the Control group. Those reporting less ASD-like responses on the Iowa Screener expressed less difficulty with everyday decisions ($r = .31$, $p <.01$) and fewer negative consumer consequences ($r = .33$, $p <.01$).

7 Discussion

In this research we focus on high-functioning adults on the autism spectrum because they are an under-researched group of decision makers. We know that they are high-functioning because of the academic achievements of our sample, but we also know that they have difficulties making decisions in their everyday lives. Present results dramatically illustrate this by revealing highly significant ASD-Control differences on almost every item. Increased understanding of the decision making of this group could lead to concrete suggestions for improving their everyday decisions.

By comparing decision makers between a group known to have difficulties in areas of social decision making with a control group, we can learn more about dispositional factors that affect us all. Including both between-group and within-group analyses allowed us to do that. And, by including dispositional measures, we gained more insight into those factors that influence everyday decision making.

Specifically, we find that Thinking Style, Attitude Toward Risk and Perception of Social Norms are predictive of difficulties in everyday decision making as well as with personal relations. These findings are particularly important because they deal with the crucial issue of the external validity of our tasks and measures.

We are intrigued by the results for Accuracy of Social-norm Perception, where we find persons with ASD to be less able to accurately predict social norms than the Controls.

Considering this more closely, we find that, in general, ASD participants feel that the inappropriate social behavior happens more often than it actually does. This suggests the need for those on the spectrum to understand the importance of following social norms (even if it doesn't come naturally).

While our results are correlational and not cause-and-effect, the findings lead us to recommend the following training procedures for high-functioning adults on the spectrum: a) Learning to adjust degree of careful thought and deliberation to the importance of the decision at hand (e.g., what clothes to wear at work versus at play); b) Learning when it is in the decision maker's best interest to take more risks in the social domain (nothing ventured, nothing gained), perhaps through structured role playing exercises; c) Teaching realistic social norms as a model for their own behavior (e.g., the importance of "keeping secrets" learned from a friend, or "not interrupting" when others are talking), and d) Creating, in simulated settings, positive social experiences.

We also find when looking at the within-group results, a relationship between an individual's score on the Iowa Screener, which measures ASD-like tendencies, and other decision making measures when looking at within-group results. We anticipated this for the ASD group, believing the lower the score the more profound the impact on all aspects of life. We did not anticipate that we would find a similar relationship for the Control group who score in the higher range of the Iowa Screener. To us this supports the contention that autistic-like characteristics represent a continuum that spans the general population.

7.1 Limitations and directions for future research

Because our sampling of participants was from a nationwide network of persons who self-identified as autistic and who had a history of completing surveys for compensation, the distribution of personal characteristics would not match those of the complete population of high-functioning adults on the autism spectrum. For example, we obtained a disproportionate number of women compared to the general population. However, our tests of gender differences revealed few systematic gender effects on our primary measures. The one notable exception was that males within the ASD group had higher estimates than females of others' socially inappropriate behaviors. Perhaps more importantly, those who successfully completed the survey may represent an exceptionally high level of functioning and thus are less distinct from controls than would be typical for studies comparing ASDs and controls. However, this would tend to reduce the observed differences in our tasks and measures, thus making the observed results even more impressive.

Because of our firm belief that high-functioning adults on the autism spectrum are an especially important subject for research in the area of human judgment and decision making, we have plans for continuing research in this area, narrowing focus in specific studies to topics such as the role of social cues in consumer behavior and risk-taking, and responsiveness to visual versus verbal presentations of framed information.

We are also hoping that our success in online recruiting of a special population will encourage other JDM researchers to similarly consider the importance of informed decision making in the daily lives of other special groups such as persons with attention deficit disorder, schizophrenia or learning disability. We find it encouraging for continuing studies that using Mturk (or another large online panel) and online surveys, with appropriate screening or filtering tools, it is possible to conduct large sample research using unique populations as participants. In the current case, this allowed us to obtain more females with ASD in our sample than would otherwise be the case. While we make no claim to the clinical significance of any single study, we believe that accumulated knowledge about the decision-making skills and weaknesses of special populations can be used by clinicians to inform interventions designed to improve decision making and quality of life.

Finally, we illustrate that the measurement of individual characteristics of an extreme group such as those with ASD can be used to better understand the role of parallel individual differences within the general population. These could include more detailed analyses of underlying processes such as those defining decision making competence or the utilization of maximizing strategies in choice behavior. We hope that other researchers will adopt this approach.

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