

Risky Decision Making for Medications: Age and Social Influence Effects

Amy W. Chong (amywlchong@gatech.edu)
School of Psychology, Georgia Institute of Technology
654 Cherry Street NW, Atlanta, GA 30332-0170 USA

Michael T. Bixter (mbixter3@gatech.edu)
School of Psychology, Georgia Institute of Technology
654 Cherry Street NW, Atlanta, GA 30332-0170 USA

Wendy A. Rogers (wendyr@illinois.edu)
Department of Kinesiology and Community Health, University of Illinois Urbana-Champaign
1206 South Fourth Street, Champaign, IL 61820 USA

Abstract

Prior studies on older adults' risk taking have paid little attention to the healthcare domain or social influences on decision making. This study examined age-related differences in medication risk taking and the effects of a collaborative decision-making experience on individuals' tendency to take risks. We recruited 24 younger (mean age = 19.50, $SD = 1.41$) and 24 older adults (mean age = 70.54, $SD = 2.30$), and asked them to choose between hypothetical medications that differed in probabilities and outcomes of treatment success. To investigate the effects of risk-neutral versus risk-advantageous trials, participants chose between a risky option and a sure option that had equal expected values (risk-neutral) or between a risky option and a sure option that had a lower expected value (risk-advantageous). Participants completed the decision task first individually (the pre-collaboration phase), then in dyads (the collaboration phase), and once again individually (the post-collaboration phase). During the pre-collaboration phase older adults showed a smaller increase in risk-taking tendency in response to risk-advantageous trials compared to younger adults. The pre- and post-collaboration data showed that older adults' risk preferences converged towards their partner's preference to a greater extent following collaboration relative to younger adults. These findings highlight the importance of designing decision aids to encourage older adults to take risks when risk taking is beneficial, and considering how social processes influence patients' medication decisions.

Keywords: risky decision making, health, aging, social influence

When choosing between options in health care, the degree of risk involved is an important consideration that younger and older individuals must make. For example, an individual may have to choose between painkillers that have different probabilities of treatment success. A National Health Interview Survey in 2012 showed that 86% of US older adults aged 65 or older have at least one chronic condition, and 61% have at least two chronic conditions, compared to 27% and 7% of US adults aged 18 to 44 (Ward, Schiller, & Goodman, 2014). As older adults are more likely to have multiple chronic conditions, they may need to make more medical choices involving risks.

Individuals often discuss their health care decisions with family members, friends, or physicians. Despite the plentiful literature on shared decision making between patients and physicians, the emphasis is rarely on how a collaborative experience would affect subsequent health-related behavior of individuals. The lack of research on this area demands attention because it is common for individuals to make a number of choices on their own after their discussion with other people. There is evidence that family and friends influence the health-related attitudes and beliefs of patients, particularly those who are less educated and non-white (Thompson, 2013). Therefore, research should consider how discussions about health care decisions take place within patients' social networks and how to improve the resulting decisional outcomes. One of the most common health care decisions facing patients is medication risk taking.

Age-related Differences in Risk Taking

Risk-Neutral Decisions

Most studies on aging and risk taking asked participants to make risk-neutral choices, which involve a risky option and a sure option that have equal expected values. The expected value of an option is calculated by multiplying outcomes by their respective probabilities, and taking the sum of the products (Bernoulli, 1954). A higher expected value represents a higher average value in the long run assuming the same option is chosen repeatedly.

A recent meta-analysis of these studies found that older adults were more risk averse than younger adults in making positively framed decisions (Best & Charness, 2015). Positively framed decisions refer to choices in which positive aspects of the scenarios are highlighted using wordings such as "keep" and "save". This finding can be explained by fuzzy-trace theory.

Fuzzy-trace theory postulates that people simultaneously store and access two types of representations (Reyna & Brainerd, 2011). A verbatim representation reflects the precise information. In contrast, a gist representation captures the subjective interpretation of information based on emotion, experience, level of development, and is vague

and qualitative. In the context of the Asian disease problem (Tversky & Kahneman, 1981), a gist representation of a sure option of “saving 200 people” would be “saving some people” whereas a gist representation of a risky option of “a one-third probability of saving 600 people and a two-thirds probability of saving no people” would be “some probability of saving some people and some probability of saving no people.” Hence, fuzzy-trace theory suggests that people would choose the sure option when they represent the positively framed situation at the gist level. Older adults are more likely than younger adults to rely on gist processing because they may have learned that it is a more effective means of making decisions (Peters, Hess, Västfjäll, & Auman, 2007). In addition, gist processing is relatively well preserved with normal aging although verbatim processing declines as people age (Reyna & Brainerd, 2011). Older adults’ decisions are more gist-based, which may account for their tendency to be more risk averse in the positive frame.

The meta-analysis revealed that the presence of the age effect depended on the amount and the scenario type (Best & Charness, 2015). That is, the age effect was found in small-amount financial and large-amount mortality scenarios, but not in large-amount financial and small-amount mortality scenarios. Younger and older adults’ levels of risk taking depended on the scenario. Owing to the primary use of either financial risk seeking scenarios or the Asian disease problem in the aging literature, past findings on age-related differences in risk taking may not generalize to medication decision making.

Risk-Advantageous Decisions

Studies have also explored younger and older adults’ risk taking tendencies in situations where risk seeking is advantageous and disadvantageous. From an economic perspective, an option with a higher expected value is better than an option with a lower expected value. Analyzing trials on which the expected value of the risky option was more favorable than that of the sure option, older adults were shown to be more risk averse than people of age 5 to 64 (Weller, Levin, & Denburg, 2011). That is, older adults were less risk taking than younger adults when risk taking was beneficial. However, that study used very broad age ranges.

Based on Peters et al. (2007), and Reyna and Brainerd (2011), older adults have an increased tendency to use gist processing relative to younger adults. Thus, they may be less sensitive to the expected values of the sure and risky options and more likely to stick to their preferred options on risk-neutral trials than younger adults.

Collaborative Decision Making

If we consider how common it is for people to exchange views with others in everyday situations of making health care decisions, it is necessary to understand medical decision making in a collaborative context. Collaboration in patient-physician relationships is not emphasized in the

traditional care model, which depicts patients as passive followers of the orders set by physicians. However, a new collaborative care model is replacing the traditional model (Mitzner, McBride, Barg-Walkow, & Rogers, 2013). In the collaborative model, patients and physicians share the primary caregiving responsibility and make decisions together. Hence, investigating collaborative decision making and how it influences decision makers’ subsequent decisions would help people make better use of others’ opinions.

Collaborative decision making has been studied in social psychology. Group decision-making phenomena that have been observed include group polarization and group convergence. The former occurs when the decisions made by groups are more extreme than the initial position of its members (Sunstein, 2002). Group convergence was found in Bixter, Trimmer, and Luhmann’s (2017) study that focused on intertemporal monetary preferences. Individuals’ post-collaboration decisions converged towards their respective group decisions. The social comparison process was proposed to explain the findings. Participants might have changed their preferences in accordance with their group members’ preferences because they viewed others’ behavior as a source of information about normatively appropriate behavior. Using a risky decision task, another study demonstrated a similar behavioral change (Suzuki, Jensen, Bossaerts, O’Doherty, 2016). Participants’ risk preferences shifted towards the observed person’s preferences. Research is needed to better understand whether a group polarization or group convergence effect would be present in medication risky decision-making scenarios.

Age Differences in Susceptibility to Social Effects

Given evidence suggesting age-related differences in decision making between younger and older adults, it is reasonable to ask whether younger and older adults’ experience of making decisions in a group would influence their individual decisions differently. Age-related differences in the tendency to be influenced by others have been investigated for young age groups. In Gardner and Steinberg’s (2005) study, participants made riskier decisions and exhibited more risky behavior when in peer groups, and the influence of peers on risky decision making and risk taking was stronger among adolescents and youths than adults. However, no research has assessed age-related differences between younger adults and older adults.

One finding which suggested that older adults might be more prone to social influence than younger adults in making decisions is the age-related difference in perceived decision-making competence. Older adults rated themselves as less competent decision makers than did younger adults (Bruine de Bruin, Parker, & Fischhoff, 2012). Despite older adults’ accumulation of experience, they may have rated their decision-making competence based on perceived declines in their fluid cognitive abilities. Owing to their lower perceived competence, older adults might change their decisions more easily when different views are

presented. This prediction is supported by the finding that participants who lacked confidence in their answers to health knowledge questions were significantly more likely than those who were confident to change their answer after receiving online social feedback (Lau & Coiera, 2008). Furthermore, previous research has demonstrated that higher uncertainty strengthened social effects on memory reports (Walther et al., 2002). If older adults are less confident and thus more uncertain about their decisions, they might be more susceptible to social influence.

Overview of Study

Although older adults often have multiple medical conditions and need to make health care choices involving risks, past research has not assessed age-related differences in risk taking for medication decision tasks. The goal of the current study was to study age differences in medication risk taking when risk taking was advantageous or neutral. Younger and older adults were asked to make choices between medications that involved varying probabilities and outcomes of treatment success. On risk-neutral trials, they chose between options that were equally favorable. On risk-advantageous trials, they chose between options that favored risk taking. To investigate the effect of collaboration on subsequent individual decisions, they were asked to complete the decision task first independently, then in dyads, and finally independently. Hypotheses were:

H1: older adults are less risk taking than younger adults.

H2: people are more risk taking on risk-advantageous trials than on risk-neutral trials.

H3: there is an age by trial type interaction such that older adults show a smaller increase in risk taking when risk taking is beneficial.

H4: older adults, compared to younger adults, are more likely to be influenced by others.

Method

Participants

Participants were 24 English speaking younger adults (14 females) between the ages of 18 and 23 ($M = 19.50$, $SD = 1.41$) and 24 English speaking older adults (14 females) between the ages of 67 and 74 ($M = 70.54$, $SD = 2.30$). Participants in each age group formed 12 age-group matched dyads. All participants had at least 20/50 visual acuity for near vision (corrected or uncorrected) to ensure that they could see the stimuli. The majority of older adults were highly educated, with 83% reporting having some college or higher. Other descriptive variables were demographics and health, numeracy (Lipkus, Samsa, & Rimer, 2001), personality (Gosling, Rentfrow, & Swann, 2003), social intelligence (Silvera, Martinussen, & Dahl, 2001), perceived decision-making competence (Greene, Hibbard & Tusler, 2005), processing speed (Wechsler, 1997), verbal working memory span (Wechsler, 1997), and verbal ability (Shipley, 1986). Due to limited space, results

involving some of these variables are not included in this paper. Table 1 provides descriptive data.

Table 1: Younger and older adults' scores on health and cognitive measures.

	Younger Adults		Older Adults		t-value
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	
Health ^a	4.05	.54	3.79	.60	1.59
Numeracy ^b	10.55	.67	7.04	3.29	5.10***
Processing speed ^c	72.45	9.63	45.83	13.84	7.51***
Verbal working memory ^d	8.86	2.30	7.63	2.50	1.75
Verbal ability ^e	32.08	3.28	32.96	4.85	-.726

^aSelf-reported health (1=poor, 5=excellent); ^bNumeracy (number of correct items from 0 to 11 on the numeracy scale); ^cProcessing speed (number of correct items on the digit-symbol substitution task from 0 to 100); ^dVerbal working memory (number of correct items from 0 to 14 on the digits backward task); ^eVerbal ability (number of correct items from 0 to 40 on the Shipley institute of living scale); *** $p < .001$.

Materials

The experiment had three phases: pre-collaboration, collaboration, and post-collaboration. Participants made decisions independently in the pre- and post-collaboration phases, but in dyads in the collaboration phase.

Participants were asked to choose a medication for a family member who is the same age as them. We asked them to give advice to a family member rather than choose one for themselves because this was more ecologically valid with respect to the collaboration phase in which they have to interact with each other and reach a consensus. Every trial of the decision task consisted of a choice between two medications which had different probabilities and outcomes of treatment success. The sure option had 100% chance of some treatment success whereas the risky option had a variable outcome of treatment success.

There were two trial types, 20 risk-neutral trials and 20 risk-advantageous trials in each phase. On risk-neutral trials, the medications had equivalent expected values. On risk-advantageous trials, the medication with a sure outcome had a lower expected value than the medication with a variable outcome. Figures 1 and 2 show an example of each trial type. For both trial types, the risk magnitudes were 20%, 40%, 60%, and 80% on different trials and the number of days of sickness were 20, 30, 40, 50, and 60 on different trials. Within each phase of the experiment, the decision trials were presented in a randomized order to minimize

order effects. The percentage of time that participants chose the riskier option indicated their level of risk taking.

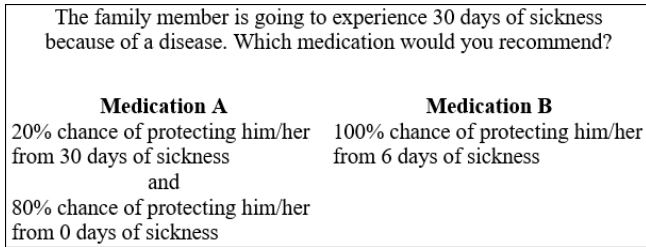


Figure 1: An example of a risk-neutral trial.

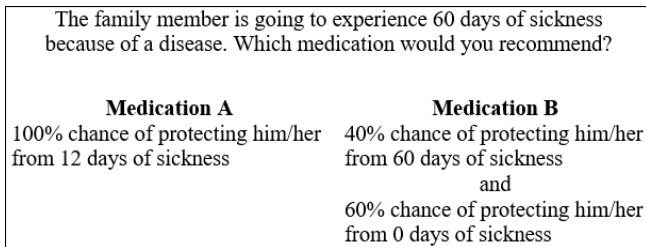


Figure 2: An example of a risk-advantageous trial.

Design

Age was a grouping variable. Trial type and decision-making phase were the independent variables. Level of risk taking and difference in risk taking between dyad members were the dependent variables.

Procedure

Before the experiment, participants received a consent form explaining the research study. After consent, they completed a questionnaire regarding demographics and health, and four ability tests. After that, participants were given both oral and written instructions about the decision task. Collaboration with other participants was not mentioned at this stage. The first phase of the experiment was the pre-collaboration phase. Participants made medication decisions involving risks individually. When the pre-collaboration phase was completed, participants moved on to the collaboration phase. They were notified that each of them would have to collaborate with another participant to give one answer as a group. The process of collaborative decision making was videotaped (with permission from the participants) for analysis in a separate study. When the collaboration phase was completed, participants entered the post-collaboration phase. Once again, they made similar decisions individually. After all decision trials were completed, participants filled out the self-report items, followed by other questionnaires, and then they were debriefed.

It took younger adults approximately one hour and older adults approximately two hours to complete the entire experiment.

Results

Individual Medication Risk Taking

First, individual risk taking data in the pre-collaboration phase were analyzed. Mixed-design ANOVA was conducted with age as the between-participants variable, and trial type as the within-participants variable.

As expected, older and young adults were significantly more risk taking on risk-advantageous trials ($M = .77, SD = .26$) than on risk-neutral trials ($M = .41, SD = .32$), $F(1, 46) = 82.66, p < .001, \eta_p^2 = .64$. Overall, older adults ($M = .58, SD = .30$) were not significantly less risk taking than younger adults ($M = .60, SD = .18$), $F(1, 46) = .024, p = 0.877, \eta_p^2 = .001$. However, there was an age by trial type interaction such that older adults showed a smaller increase in risk taking in response to risk-advantageous trials than did younger adults, $F(1, 46) = 8.52, p < .01, \eta_p^2 = .16$. Figure 3 shows the results.

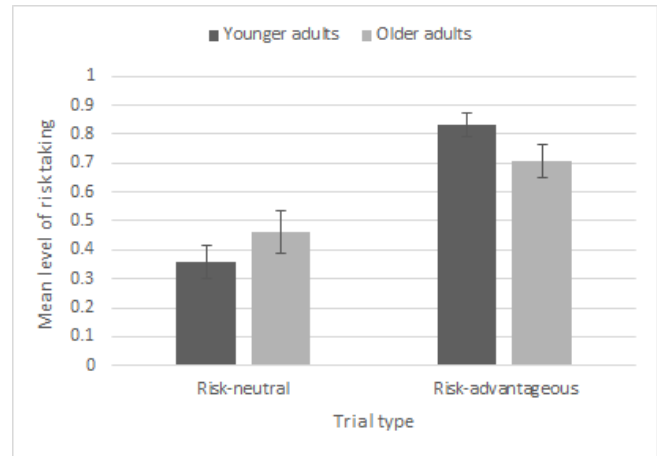


Figure 3: Younger and older adults' level of risk taking on risk-neutral and risk-advantageous trials (error bars represent the standard error).

Social Influence Effects

Risk taking data in the pre- and post-collaboration phases were compared. Mixed-design ANOVA was conducted with age as between- and phase as within-participants variable. The absolute difference between dyad members' level of risk taking was the dependent variable.

The difference in risk taking between dyad members was smaller in the post-collaboration phase ($M = .20, SD = .19$) than in the pre-collaboration phase ($M = .33, SD = .22$), $F(1, 22) = 7.80, p < .05, \eta_p^2 = .26$. The overall within-dyad difference in risk taking was not significantly different between younger ($M = .22, SD = .12$) and older adults ($M = .31, SD = .16$), $F(1, 22) = 2.54, p = 0.125, \eta_p^2 = .10$. By contrast, the age by phase interaction was significant, $F(1, 22) = 10.41, p < .01, \eta_p^2 = .32$. Older adults' risk preferences converged towards their partner's preferences to a greater extent following collaboration relative to younger adults'. Figure 4 shows the results.

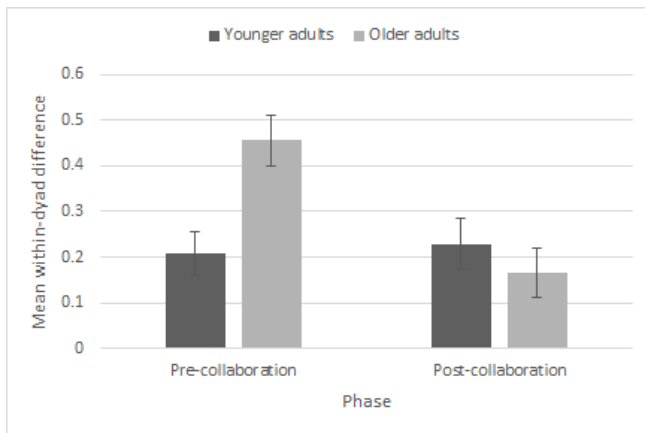


Figure 4: Younger and older adults' within-dyad difference in risk taking in pre- and post-collaboration phases (error bars represent the standard error).

Discussion

Findings from the present study provide insights into younger and older adults' individual risky decision making for medications, and the effects of collaborating with a partner on subsequent risk-taking tendency. Confirming our expectation, younger and older adults took more risks when risk taking was beneficial than when risk taking and risk aversion were equally favorable. However, this effect of trial type differed between the two age groups such that the increase in risk taking among older adults was smaller than the increase in risk taking among younger adults when the risky option was favored. Regarding social influence effects, dyad members' risk-taking tendency was more similar to each other's after the collaborative decision-making experience compared to their initial difference. Older adults demonstrated a convergence effect, whereas the younger adults did not.

Theoretical Implications

The present study adds to the literature in that it investigated age differences in risk taking in the medical domain, which has heretofore been understudied. Based on fuzzy-trace theory, when people represent positively framed scenarios at the gist level, they tend to be risk averse. Therefore, we predicted that older adults would be less likely to take risks than younger adults when choosing between medications that had different probabilities and outcomes of treatment success, consistent with the recent meta-analytic findings on age differences in the risky-choice framing effect (Best & Charness, 2015). In our study, which focused on decision making in the medical domain, older adults were not significantly less risk taking than younger adults in making medication decisions. Because prior research mainly focused on financial and mortality domains, the pattern of finding in the present study could be additional evidence that age differences in risk preferences are context dependent (Best & Charness, 2015).

Additionally, an interaction was found in the present study between age and trial type. Younger adults exhibited a substantially larger increase in risk taking than did older adults when comparing risk-advantageous trials with risk-neutral trials. This finding is consistent with our expectation that younger adults are more sensitive to the expected values of options. When presented with a risky option and a sure option with a lower expected value, younger adults were more likely to choose the risky option that maximized their expected value gain in terms of the number of days protected from sickness. Relative to younger adults, older adults showed a more similar risk-taking tendency on risk-neutral and risk-advantageous trials, suggesting that they were not as sensitive as younger adults to the expected values of options. This is consistent with the idea that older adults are more likely to use gist processing whereas younger adults are more likely to use verbatim processing in making medication risky decisions.

The present study demonstrated that people's medical risk taking propensities were prone to social influence effects. In addition, it explored the effects of collaborative decision-making on subsequent individual decisions in two different age groups. Consistent with prior studies on intertemporal choices (Bixter et al., 2017) and financial risky decisions (Suzuki et al., 2016), we found a group convergence effect following collaboration in older adults' medication risky decisions. Importantly, older adults' convergence effect was larger than younger adults'. This might reflect their greater tendency to conform to others. Older adults might change their decisions more easily when different views are presented because of their lower perceived decision-making competence (Bruine de Bruin et al., 2012). However, it could also be due to the greater initial difference within older dyads observed in the present sample. Future research should attempt to better understand age differences in social influence effects in risky decision-making contexts.

Limitations and Future Directions

Several limitations have to be noted. The decision task may not resemble an everyday medical context and thus makes the results less generalizable to ecological settings. Asking participants to make third-person medication decisions might introduce bias. Moreover, people might perceive avoiding sickness as categorically different than shortening the duration of sickness. Additionally, numeracy differed between the age groups, and could be an alternative explanation for the individual risk taking and social influence findings. Future research should address these issues.

Practical Implications

Findings from the current study offer some insights into how age and collaboration influence medication risk taking. Examining age differences in medical risk seeking would enable us to devise appropriate decision aids for people of different ages. In particular, it is important to encourage older adults to take risks when risk taking is beneficial.

Examining age differences in choice shift due to social influence would inform the public how social interactions alter patients' subsequent decisions as a function of their age. Current findings suggest that other people might be able to play a significant role in influencing older patients and helping them make improved decisions.

Acknowledgments

This research was supported in part by a pilot grant from the National Institutes of Health (National Institute on Aging) Grant P01 AG17211 under the auspices of the Center for Research and Education on Aging and Technology Enhancement (CREATE; www.create-center.org), and by the Ruth L. Kirschstein National Research Service Award (NRSA) Institutional Research Training Grant from the National Institutes of Health (National Institute on Aging) Grant 2T32AG000175-26A1.

References

- Bernoulli, D. (1954). Exposition of a new theory on the measurement of risk. *Econometrica: Journal of the Econometric Society*, 23-36.
- Best, R., & Charness, N. (2015). Age differences in the effect of framing on risky choice: A meta-analysis. *Psychology and Aging*, 30(3), 688-698.
- Bixter, M. T., Trimber, E. M., & Luhmann, C. C. (2017). Are intertemporal preferences contagious? Evidence from collaborative decision making. *Memory & Cognition*.
- Bruine de Bruin, W., Parker, A. M., & Fischhoff, B. (2012). Explaining adult age-related differences in decision-making competence. *Journal of Behavioral Decision Making*, 25(4), 352-360.
- Gardner, M., & Steinberg, L. (2005). Peer influence on risk taking, risk preference, and risky decision making in adolescence and adulthood: an experimental study. *Developmental Psychology*, 41(4), 625.
- Gosling, S. D., Rentfrow, P. J., & Swann, W. B. (2003). A very brief measure of the Big-Five personality domains. *Journal of Research in Personality*, 37(6), 504-528.
- Greene, J., Hibbard, J. H., & Tusler, M. (2005). *How much do health literacy and patient activation contribute to older adults' ability to manage their health?* (pp. 2005-05). Washington, DC: AARP Public Policy Institute.
- Lau, A. Y., & Coiera, E. W. (2008). Impact of web searching and social feedback on consumer decision making: a prospective online experiment. *Journal of Medical Internet Research*, 10(1).
- Lipkus, I. M., Samsa, G., & Rimer, B. K. (2001). General performance on a numeracy scale among highly educated samples. *Medical Decision Making*, 21(1), 37-44.
- Mitzner, T. L., McBride, S. E., Barg-Walkow, L. H., & Rogers, W. A. (2013). Self-management of wellness and illness in an aging population. *Reviews of Human Factors and Ergonomics*, 8(1), 277-333.
- Peters, E., Hess, T. M., Västfjäll, D., & Auman, C. (2007). Adult age differences in dual information processes: Implications for the role of affective and deliberative processes in older adults' decision making. *Perspectives on Psychological Science*, 2(1), 1-23.
- Reyna, V. F., & Brainerd, C. J. (2011). Dual processes in decision making and developmental neuroscience: A fuzzy-trace model. *Developmental Review*, 31(2), 180-206.
- Shipley, W. C. (1986). *Shipley Institute of Living Scale*. Los Angeles: Western Psychological Services.
- Silvera, D., Martinussen, M., & Dahl, T. I. (2001). The Tromsø Social Intelligence Scale, a self-report measure of social intelligence. *Scandinavian Journal of Psychology*, 42(4), 313-319.
- Sunstein, C. R. (2002). The law of group polarization. *Journal of Political Philosophy*, 10(2), 175-195.
- Suzuki, S., Jensen, E. L., Bossaerts, P., & O'Doherty, J. P. (2016). Behavioral contagion during learning about another agent's risk-preferences acts on the neural representation of decision-risk. *PNAS*, 113(14), 3755-3760.
- Thompson, V. L. S. (2013). Making decisions in a complex information environment: evidential preference and information we trust. *BMC Medical Informatics and Decision Making*, 13(Suppl3), S7.
- Tversky, A., & Kahneman, D. (1981). The framing of decisions and the psychology of choice. *Science*, 211(4481), 453-458.
- Walther, E., Bless, H., Strack, F., Rackstraw, P., Wagner, D., & Werth, L. (2002). Conformity effects in memory as a function of group size, dissenters and uncertainty. *Applied Cognitive Psychology*, 16(7), 793-810.
- Ward, B.W., Schiller, J.S., & Goodman, R.A. (2014). Multiple chronic conditions among US adults: a 2012 update. *Prev Chronic Dis*, 11, 130389. doi:<http://dx.doi.org/10.5888/pcd11.130389>
- Wechsler, D. (1997). *WAIS-III: Administration and scoring manual: Wechsler adult intelligence scale*. Psychological Corporation.
- Weller, J. A., Levin, I. P., & Denburg, N. L. (2011). Trajectory of risky decision making for potential gains and losses from ages 5 to 85. *Journal of Behavioral Decision Making*, 24(4), 331-344.