

Children's judgments of recommendation seeking behaviour

by

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A thesis submitted to the
Faculty of Graduate and Postdoctoral Studies
of the University of Manitoba
in partial fulfilment of the requirements of the degree of

Master of Arts

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Abstract

Recommendations play a central role in guiding our everyday decision-making. My thesis examined how children reason about recommendation seeking behaviours. Specifically, this study focused on the role of information overload in children's predictions of when agents ask a machine for a recommendation. This study employed a within-subjects experimental paradigm where 80 participants aged 5- to 9-years-old were read a story about an agent choosing a sticker across two conditions: information overload and simple decision conditions. The information overload condition included 38 to 40 choices, whereas the simple decision condition included 3 to 5 choices. The number of choices was manipulated to alter the amount of perceived information overload in both conditions. At test, participants were asked whether the agent will rely on a 'recommender' machine or pick a sticker by themselves. Consistent with my hypotheses, a binary logistic regression revealed a significant main effect of condition, age, and an interaction between age and condition, wherein older children were more likely to say that someone wanted a recommendation in the overload condition as compared to the simple condition. While children's selections of a machine increased with age in the overload condition, they still remained at chance, suggesting a need to further examine recommendation seeking behaviours in another context.

Keywords: recommendations, cognitive difficulty, decision-making, information overload, choice

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Acknowledgments

First and foremost, I would like to acknowledge and thank my supervisor, Dr. Shaylene Nancekivell for all her support on this project. Her guidance and advice helped me refine my research idea and write the thesis I have today. I would also like to thank my committee members, Dr. Steven Greening and Dr. Brandon Goulding, for their insightful feedback and thought provoking questions during my proposal and final defence.

A special thanks to the members of the Young Minds Research Lab, for all their help with data collection and feedback during lab meetings. Data collection would not have been possible without their support.

Finally, I would like to thank my family and friends for making me feel like I am not alone in this process. I would especially like to thank the friends I have made over the past two years, for making Winnipeg feel like a second home.

Dedication

I would like to dedicate this thesis to my late grandfather, Sardar Surjit Singh Banipal, who has been the earliest source of inspiration in my life. He always encouraged me to think critically and fostered my desire to keep learning, which inspired me to pursue this degree.

Thank you for everything Daddy Ji.

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Introduction

Imagine you are at a carnival with a friend who goes all the time. Now imagine you win a game of ring toss and get to pick a prize, but the prize booth is filled with dozens of options. What would you do? Ask your friend for help, or try to pick for yourself? Now imagine there are only two options for prizes. Does your answer change? Well, it seems likely that the number of options is going to predict whether you would seek a recommendation from your friend. When there are dozens of options, the choice might feel overwhelming and so you are likely to ask for help, whereas when there are only a few options, you are likely to want to consider the option and choose for yourself. Beyond carnivals, recommendations help us make decisions across many facets of daily life. For example, someone might seek a recommendation for diverse decisions related to which movie to watch, which book to read, which doctor to see, which investment to purchase, or even which career to advance in.

Despite its ubiquity, little is known about how children reason about recommendation seeking behaviours. The present study is the first to my knowledge to study children's beliefs about recommendations. It specifically investigates whether children consider the number of options available to the agent when predicting whether they will seek a recommendation. To this end, in our study, children were asked to predict whether someone will seek a recommendation in a situation where there is a large and small number of similar options.

One possibility is that children indeed view agents as needing a recommendation when there are a lot of options. However, to do this, children likely need to recognize that an agent is experiencing "information overload." Information overload is a general phenomenon that occurs when individuals perceive that the volume of information, in this case options, exceeds their capacity to process all the information effectively (Wilson, 2001). Prior theoretical work suggests

information overload is an important factor that influences when Internet users seek recommendations (Liang et al, 2006). Under an information overload account, recommendations benefit the decision maker by reducing the number of options available to them, thus reducing information overload (Liang et al, 2006). Whether children understand how information overload drives recommendation seeking behaviours is an open-ended question, as they must be able to represent another agent's mind in highly sophisticated ways.

Children have rich theories of how others' minds operate by the end of their preschool years (Saracho, 2014). Very briefly, children can represent a diversity of mental states, such as goals, beliefs, and desires and how they predict behaviour (Saracho, 2014). Infants expect others to act in ways compatible with their goals (Brandone & Wellman, 2009; Meltzoff, 1995). By age 3- to 4-years-old, children can successfully complete a false belief task, which suggests they understand others can have mental states different from their own (Perner & Wimmer, 1985; Gopnik & Astington, 1988; Rakoczy et al., 2015). At around this age, preschoolers can also predict emotional states in others, such as being happy when given an ice cream cone or being scared when having a nightmare (Borke, 1971; Denham, 1986). In general, during the preschool years, children expect people to act in ways compatible with their desires (Cassidy et al., 2005; Cassidy, 1998). For example, they predict that an agent who likes broccoli and hates M&M's will want to eat broccoli instead of the M&M's (Cassidy, 1998). However, during later preschool and middle childhood their understanding of desires becomes more complex. By the end of their preschool years, they also expect others to act in ways compatible with their desires which can be incompatible with their own. For example, in Atance and colleagues' (2010) study, children were asked whether their mother would prefer a magazine or a small frog as a gift. By the age of 5-years-old, children could successfully identify that they would want the small toy, but their

mother would want the magazine instead (Atance et al., 2010). During middle childhood, they also recognize that desires are not deterministic (Wente et al., 2016; Kushnir et al., 2015). For example, they know that someone may not eat their favourite dessert despite wanting to because actions can be restricted, due to reasons such as being full, and do not solely depend on immediate gratification of desires (Kushnir et al., 2015). There is also growth in children's thinking about other mental states and their links to behaviour. During middle childhood, children develop second-order beliefs where they can represent the ways in which people also think about other people (Astington et al., 2002; Miller, 2009; Perner & Wimmer, 1985). For example, in Perner & Wimmer (1985)'s study, they assessed children's second-order beliefs wherein two characters named John and Mary were individually informed that an ice cream van had changed its location. By age 6- to 7-years-old, children began correctly identifying that the character John will think Mary thinks (i.e., a second order belief) John thinks that the ice cream van is still at its old location (Perner & Wimmer, 1985). Together, the literature on mental states suggests that children's theory of mind becomes more sophisticated with age, but by the end of early childhood, children can use diverse mental states to predict and understand others' behaviour.

To identify information overload, children must not only be capable of representing the link between an agent's mental state (e.g., goal to pick a prize) and behaviour (e.g., picking a prize), but also differences in cognitive processing that make tasks easier or more cognitively demanding. Although children's awareness of information overload has never been studied, prior work shows that children can reason about diverse cognitive processes that are likely similar in nature, as they also require understanding what is cognitively demanding. By 4- to 6-years-old, children can infer what an agent would find difficult to learn based on their own experiences

with cognitive difficulty (Ronfard et al., 2016). For instance, they think it will be more difficult for an agent to solve a puzzle box if they found it difficult to solve previously (Ronfard et al., 2016). Further, by 6-years-old, children can reflect on memory processes and are capable of differentiating between items that would be easier or more difficult to recall for *themselves* (Paulus et al., 2014). But this ability shows improvement with age as only adolescents aged 14- to- 15-years-old could accurately predict an agent's ability to recall items based on the amount of time an agent was exposed to the item (Paulus et al., 2014). Similarly, the metacognitive monitoring and confidence literature shows that children during early to middle childhood consider difficulty when representing their own confidence in an answer (Baer et al., 2021). For example, children know that easier decisions usually result in more confidence in accuracy for the decision maker (Baer & Friedman, 2018). Finally, diverse papers across educational and cognitive psychology show growth in children's ability to apply diverse cognitive strategies to make learning or executing cognitive tasks easier during early to middle childhood (Byrnes, 2002; Pressley & Harris, 2009). For example, they can engage in metamemory and employ cognitive strategies, such as rehearsal, anticipation, and naming to make recall easier (Flavell et al., 1970). They can also deploy strategies to improve their own self-control in difficult situations (Carlson & Beck, 2009; Mischel & Mischel, 1983). For example, in Mischel & Mischel's seminal (1983) delay of gratification study, they found that by 6-years-old, children employed strategies such as covering the marshmallow with a plate to make waiting easier. Together, this diverse literature suggests that children are likely able to represent a cognitive state like information overload by middle childhood, because children are attuned to cognitive processes that may make a task cognitively easier or difficult.

In the present study, I compared children's thinking about other agents' choices in a context where information overload is a likely factor, to a context where an agent has to make a simple decision among a few choices. Here, I expect when there are only a few choices that children's self-agency preferences will lead them to expect that others will seek answers for themselves. In their own behaviour, children show a self-agency preference across diverse contexts (see Kushnir et al., 2009). Specifically, a recent review outlines how when children face uncertain or ambiguous situations, they prefer to seek out relevant information on their own (Kushnir et al., 2009). For example, when trying to figure out how a music box works, children as young as 3- to- 4-years-old prefer to rely on their own direct observation of how the music box was solved by the experimenter over an adult that has conflicting claims (Hermansen et al., 2021). Further, when trying to find a hidden toy, 4- to- 5-year-old children prefer to rely on their own observations of where someone hid a toy over an adults' conflicting testimony, and will label the conflicting testimony as a lie or a trick (Ma & Ganea, 2010). A more recent study applied self-agency preference to an information seeking context online, in which children were asked to either seek information from an adult or from a website by themselves (Tong et al., 2023). Here, children as young as 4-years-old were more trusting of information they obtained themselves from a computer, when compared to information relayed to them by adults (Tong et al., 2023). Therefore, children should predict the agent will make their own choice, if they are aware that others, at baseline, also prefer to seek information and make decisions on their own, especially when there is no cost or limit to the agent's behaviour.

The Present Study

In the present study, I investigated children's reasoning about recommendations using a within-subjects experiment. The age range of the participants in this study is 5- to- 9 years old,

considering children's developed theory of mind by the age of 4-years-old and advances in representing diverse cognitive processes and strategies across different contexts over early to middle childhood. In this study, participants were read a story in which an agent must choose a sticker using a machine or independently. Participants consider decisions across two conditions with multiple trials. In the information overload condition, participants were told the agent has to decide among 38 to 40 stickers, whereas in the simple decision condition, participants were told the agent must decide between 3 to 5 stickers. At test, participants' predictions of whether an agent will seek the machine's recommendation or choose independently were measured. Using a machine in this experimental paradigm allowed us to avoid the potential confounds related to social properties of the recommender. For example, it allowed us to avoid issues related to participants thinking that a girl might give better recommendations to a girl. Additionally, using a machine allowed us to replicate digital recommendations, which are increasingly prevalent in everyday decision-making.

The hypothesis is as follows: If children think an agent will consider information overload when making predictions about recommendations, then they will predict that the agent will rely on the machine for a recommendation more in the overload condition than in the simple condition.

Methods

Participants

Participants included 80 children aged 5- to 9-years-old with 16 children at each age in years. Parental consent and child assent was obtained prior to participation. All testing was completed at the Manitoba Museum's Living Lab.

To determine the sample size, a power analysis was conducted using the *simr* package in R (Green, 2016). I simulated a dataset for a binary mixed regression with age in months, condition, and age by condition interaction as predictors. Fixed random effect was modelled as 1|participant. To generate my age variable, age was modelled as age in months and was mean centered. I generated the ages in months by converting the age in years to their respective months. For example, all 5-year-olds in the power analysis were modelled as 60 months old. As per my design, condition has two levels (simple, overload) and three trials or repetitions per level. For effect sizes, I chose the following parameters:

- Intercept with a beta of -0.4 indicating a base rate (40%) of selecting recommendation, which is slightly below chance
- Small main effect of condition with a beta of 0.22 or odds-ratio of 1.25
- Small increasing effect of age with a beta of 0.10 or odds-ratio 1.1 indicating they select the machine more with age
- Interaction among age and condition with a beta of 0.22 or odds-ratio of 1.25
- A moderate amount of variance at the participant level with an SD set to 0.5 (Browne & Draper, 2000)

I chose an effect size of an odds-ratio of 1.25 for both the condition and interaction predictors after visualizing three simulated datasets (see Figure 1c for bar chart). I started with an effect size of 1.68 (see Figure 1a), which is a cited threshold for a small effect size (Chen et al., 2010) but this led to too large an effect at the older ages. I next decreased the odds ratio to 1.5 (see Figure 1b) but ultimately chose 1.25 because it best fit my predictions for my dataset, where older children should select the machine most of the time (i.e., around 75%), but not all of the

time in the overload condition. The effect of age is modelled as a very small effect with an odds ratio of 1.1, as I expect a very small overall increase of selecting the machine with age as children's self-agency preference decreases. As shown in the power curve (Figure 2), at 80 participants I have adequate power to test my hypothesis. This sample size also allowed for adequate power for follow-up analyses, divided up by age.

Materials

Participants were read a story consisting of agents trying to make decisions. In the story, there was a “machine” that provided a good recommendation from a set of visually represented options (e.g., images of stickers; see Figure 3 for more detail). In the Information Overload Condition, participants viewed 38-40 different options, whereas in the Simple Decision Condition, they viewed between 3-5 different options. These different options were generated by AI on Canva. Participants were asked whether the agent in the story will rely on the “machine” to pick options for them or decide themselves from all the stickers.

Procedure

This study implemented a within-subjects experimental design, with each participant completing the task across 6 trials broken into three trials per condition: three trials in the Information Overload Condition and three trials in the Simple Decision Condition. To control for order effects, two pseudorandom orders were created. The pseudorandom orders for the conditions are (see Figure 3 for study flow):

- Order 1: overload, simple, simple, overload, simple, overload
- Order 2: simple, overload, overload, simple, overload, simple

Further, the options were visually represented, wherein a machine was represented using a figure of a loader machine and the self option was represented by a hand (see Figure 3 for these

images). To control for order effects, the side of the screen with the self and machine option and test questions were counterbalanced. For example, there are two versions with order 1 (mentioned above). In the first version, the machine is mentioned second at test and displayed on the right side of the screen, whereas in the second version, the machine is mentioned first at test and is displayed on the left side of the screen. The same is done with order 2, hence there are four different versions of this experiment.

The flow of the experiment is as follows. At the start of the experiment, participants view a character named ‘Sally’ who is trying to make a decision about selecting a gumball. In order to make a decision, “Sally asks the machine for help picking one out.” Then, participants were introduced to a “machine” that displays one option that it identifies as “good” (i.e., “The machine picks out this gumball. The machine always picks one good thing.”). Then, participants were told that, “Sally could also just look in the bag and pick a gumball by herself” and that she also picks out a “good” object. By doing so, participants are made aware that there are two options: the machine or choosing by self, with the same quality of decision.

Following this introduction, participants began the test trials, where they were told their “job will be to guess who used the machine and who picked all by themselves.” During the test trials, participants viewed six different agents making decisions about stickers across the two conditions: (1) the Information Overload condition with 38 to 40 options and (2) the Simple Decision condition with 3 to 5 options (see Figure 3 for study flow). The number of options in the simple condition was determined by extant work on memory that indicates that more than 5 items would be difficult for children’s visual working memory to process and thus might find overwhelming (Simmering, 2012). To increase perceptions of cognitive demand, I chose 38 to 40 options for the information overload condition. For each trial, participants answered a question

about whether the agent will choose an item (1) themselves or (2) ask the machine for help (i.e., “Will she ask the machine for help or pick all by herself?”: see Figure 3).

Results

The dependent variable was coded so that when participants picked the machine, it was coded as 1 and if they chose self, it was coded as 0. Age was calculated as age in months and then centered. Condition was entered as a predictor with two levels (overload, simple) and was contrast coded (1,-1). It used an intercept of 1|participant. Thus, the binary logistic regression included the predictors of age (centered), condition, age by condition interaction, and the random intercept. For all age calculations, if the month of birth was unknown, age in months was based on age in years (e.g., 7-years = 84 months).

The binary logistic regression was conducted to examine participants’ selections of machine versus self across conditions, age, and their interaction (Table 1). There was a significant main effect of condition, $b = 0.39$, $SE = 0.096$, $z = 4.06$, $p < .001$, and a main effect of age, $b = -0.01$, $SE = 0.006$, $z = -1.77$, $p = .077$. However, these main effects were qualified by an interaction between age and condition, $b = 0.02$, $SE = 0.006$, $z = 2.83$, $p = .005$ (see Figure 4).

Follow-up regressions were next conducted to decompose the interaction by conducting one binary regression per age with the predictor of condition and the intercept of 1|participant. Five and 6-year-olds’ responses did not differ by condition, $ps > .55$. However, 7-year-olds’ ($p = .033$), 8-year-olds’ ($p = .036$) and 9-year-olds’ ($p < .001$) responses were sensitive to condition as they selected the machine more in the overload than in the simple condition.

General Discussion

The present study examined children's beliefs about recommendations, by investigating whether children consider the number of options available to the agent, or information load, when predicting whether they will seek a recommendation. It was found that older children were more likely to think that others would seek a recommendation when they were overloaded with information, than when there were only a few options to choose from. In contrast, younger children were insensitive to the overload versus simple condition manipulation, as their selections of machine and self did not differ by condition and, as per Figure 4, were around chance rates in both conditions.

Older children were less likely to choose the machine in the simple condition, suggesting they considered task difficulty when making predictions of when an agent will do something on their own versus when seeking a recommendation. Specifically, at approximately 7-years-old, children began selecting 'machine' less often in the simple condition, which suggests that they may appreciate two key facts. First, they likely appreciate that the number of options might be linked to task difficulty. They likely appreciate that when there are less options, there is less difficulty. Second, they appear to link recommendations with difficulty to some degree because they selected 'self' less often when there were a lot of choices; but, whether they are certain that recommendations can reduce choice difficulty *per se* is not conclusive from this thesis. It's worth noting, again, that the developmental changes appear to be driven by an increasing appreciation that the simple choice had fewer options, and likely to be done independently as opposed to the difficult choice being difficult and requiring a recommendation. These findings contribute to the literature in a few ways.

Most critically these findings highlight young children have beliefs about an understudied domain of reasoning: recommendations. Future work might follow-up on these findings by

studying the diverse ways recommendations intersect with social life, such as how children make social inferences about a recommendee. However, one open question is how recommendations fit into diverse social-cognitive processes that the field has already studied. One possibility is that recommendations are a type of helping behaviour. Previous work on helping behaviour largely focuses on instrumental helping behaviours, which highlights children's ability to assist someone in completing a task or achieving a, usually physical, goal (Warneken & Tomasello, 2006; Warneken & Tomasello, 2007; Svetlova et al., 2010; Dunfield & Kuhlmeier, 2013).

Recommendations are similar, wherein they provide someone with assistance, but differ in the sense that they do not provide assistance in achieving a goal that might fail otherwise, but rather helping someone make a decision that they would likely make anyways. For example, imagine someone is making a block tower. One might provide instrumental help by picking up a fallen block. In contrast, if someone was overwhelmed with the decision of which block to use next, one might provide decisional help by recommending a block to put on next. If someone needs decisional help, simply handing them a block, which might help them achieve their goal of building the tower, would not be perceived as helpful and might even be confusing. This example highlights what I call 'decisional help'. This might be a related but different kind of help, worthy of further study. Overall, these findings suggest that recommendations likely play a role in helping someone make a decision, and highlight the need to potentially study a new domain of helping behaviours in the form of 'decisional help'.

Prior work shows children can represent and reflect on cognitive processes like confidence and uncertainty to guide their own behaviours and predict others' behaviours. By the ages of 4- to 7-years-old, children often consider difficulty when representing their own and others' confidence in an answer (Baer et al., 2021). Additionally, children can predict when an

agent will find it more difficult to solve a puzzle box by reflecting on their own prior experience (Ronfard et al., 2016). These findings reveal another way children around this age use beliefs about cognitive processes, in this case the simplicity of the decision, to make social cognitive inferences about others' behaviour. Specifically, in the present findings, children around 7-years-old began integrating information about cognitive difficulty, especially in the simple condition, by considering the number of options on the screen. Then, they integrated this information into their social cognitive decisions of when an agent will *not* seek a recommendation. Of note, they remained uncertain of when a recommendation *was needed*, but they still made reliable inferences about when they were *not needed*.

Indeed, older children consistently predicted that the agent would choose 'self' in the simple condition. The assumption that someone will rely on oneself unless evidence is provided otherwise, is consistent with self agency preferences in childhood (Kushnir et al., 2009; also see Hermansen et al., 2021; Ma & Ganea, 2010; Tong et al., 2023), as older children predicted that the agent would choose for themselves when there was no competing influence. Namely, when there was no cost or limit to the agent's behaviour, children predicted the agent would make their own choice, showing an awareness that others likely prefer to seek information and make decisions on their own. If they were unaware that others prefer to seek information and make decisions by themselves, then their selections would have remained at chance in the simple condition.

In contrast, younger children's responses were around chance rates in both the simple and overload condition with no meaningful condition differences, but why this is the case is not clear. Unlike the older children, younger children under 7-years-old may not have the ability to identify differences in cognitive demand between the two conditions, and thus could not infer increasing

the number of options increased task difficulty. Although prior work on 4- to- 6-year-olds shows that children can reason about other cognitive processes like confidence and memory (Ronfard et al., 2016; Paulus et al., 2014), the present findings suggest that younger (and older to some degree) children may find it difficult to infer task difficulty as it pertains to information overload. Another possibility is that younger children (and older children to some degree) may have represented the differences in difficulty, but did not understand the function of recommendations. Namely, that recommendations function to reduce the number of choices, but did not link the number of choices to recommendation seeking behaviours.

Another open question is whether younger children fully understood the role of the machine as a recommender in this task. Although children were told the machine always picks a good option, children may not have interpreted the machine as a high quality source of recommendations. For instance, children may have perceived the machine as unfamiliar, irrelevant to the decision, or even unrealistic compared to real-life recommenders, like people they interact with everyday. If children did not view the machine as a high quality source of recommendations, reducing cognitive effort, then children may be less likely to predict it will be used across both conditions. It is also important to note that although older children were more likely to choose the machine in the overload condition, Figure 4 suggests that their selections were still around chance. Older children may have also considered the quality of the decision itself. For example, children might be around chance in the overload condition, if they also believed that the machine did not produce a high quality recommendation (despite thinking that they may be more likely to be wanted). A future study can look into using more real-life examples of recommenders that children may come across everyday, like a friend.

Conclusion

Together, this thesis provides foundational understanding of how children reason about recommendation seeking behaviours. Specifically, this research provides insight on whether children consider information overload when predicting recommendation seeking behaviours in agents. Across a wide age range, this study also captures the developmental trajectory of children's considerations of information overload when reasoning about recommendation seeking behaviours.

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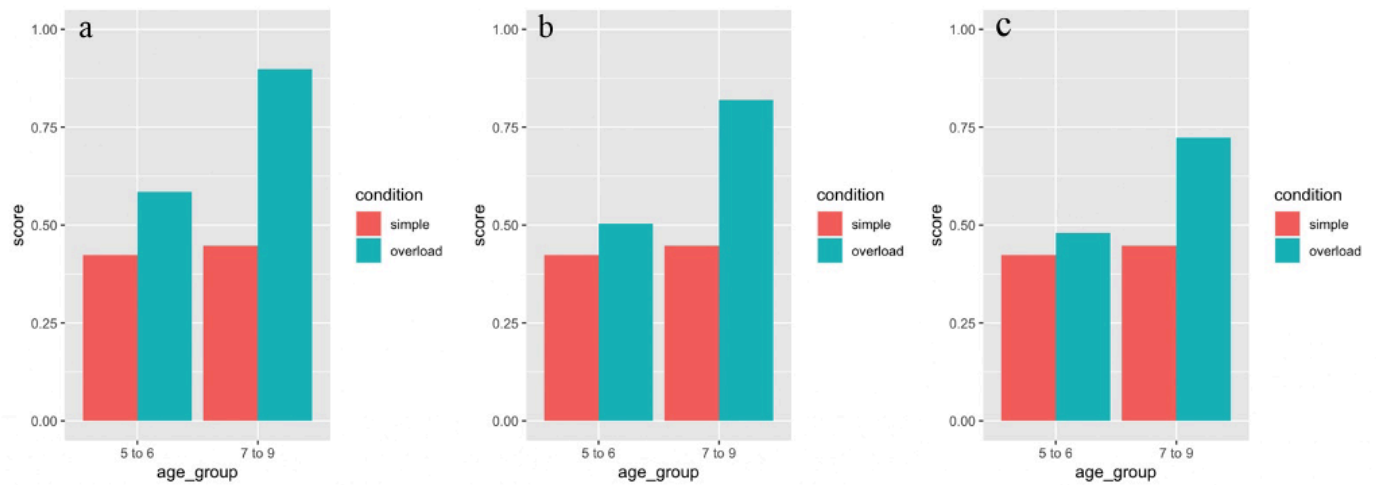
Table 1*Binary Logistic Regression Results for Recommender Choice (Machine vs. Self)*

	Estimate	<i>SE</i>	<i>z</i>	<i>p</i>
Intercept	-0.356041	0.095993	-3.709	0.000208
Condition	0.389467	0.095993	4.057	4.97e-05
Age (Centred)	-0.010061	0.005689	-1.769	0.076959
Age*Condition	0.016079	0.005689	2.827	0.004705

Note. Table showing estimate, standard error, standard score, and p-value of the predictors intercept, condition, age (centred), and an age by condition interaction.

Figure 1

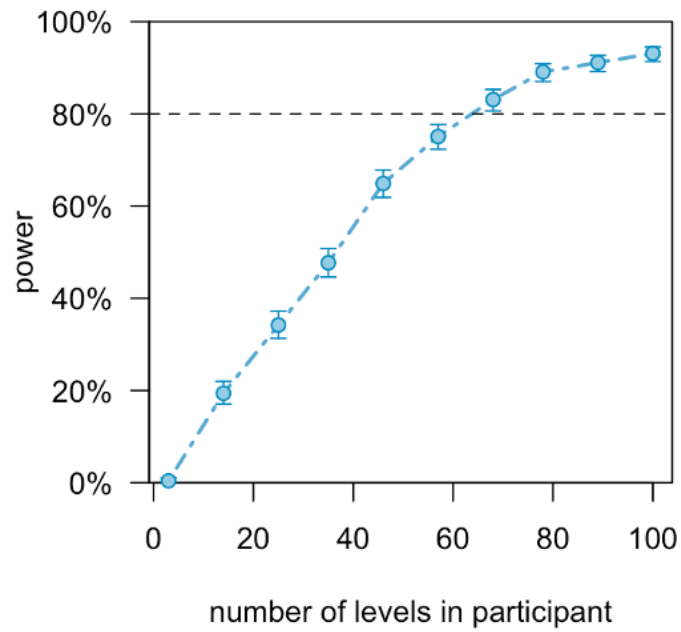
Simulated Effects of Condition and Age on Recommender Choice



Note. Bar charts showing simulated datasets with varying effect sizes or odds ratios for the condition and interaction predictors. Figure 1a shows ORs of 1.68. Figure 1b shows ORs of 1.5. Figure 1c shows the selected ORs of 1.25.

Figure 2

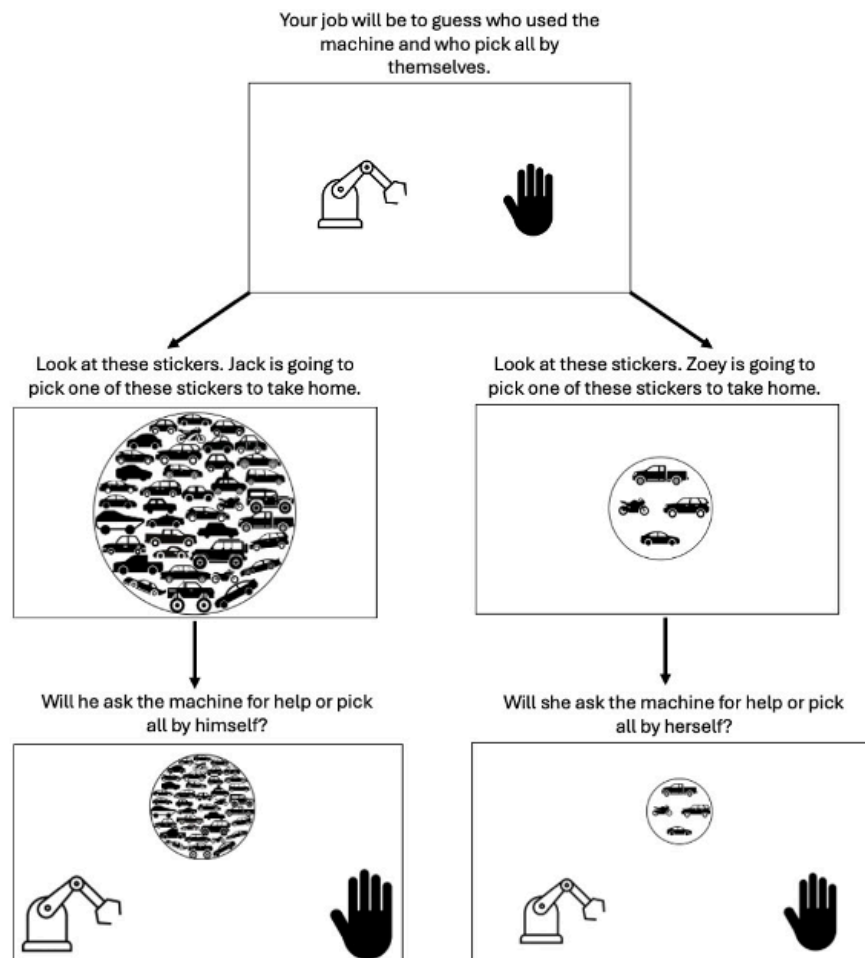
Simulated Power Curve for Detecting Age by Condition Interaction



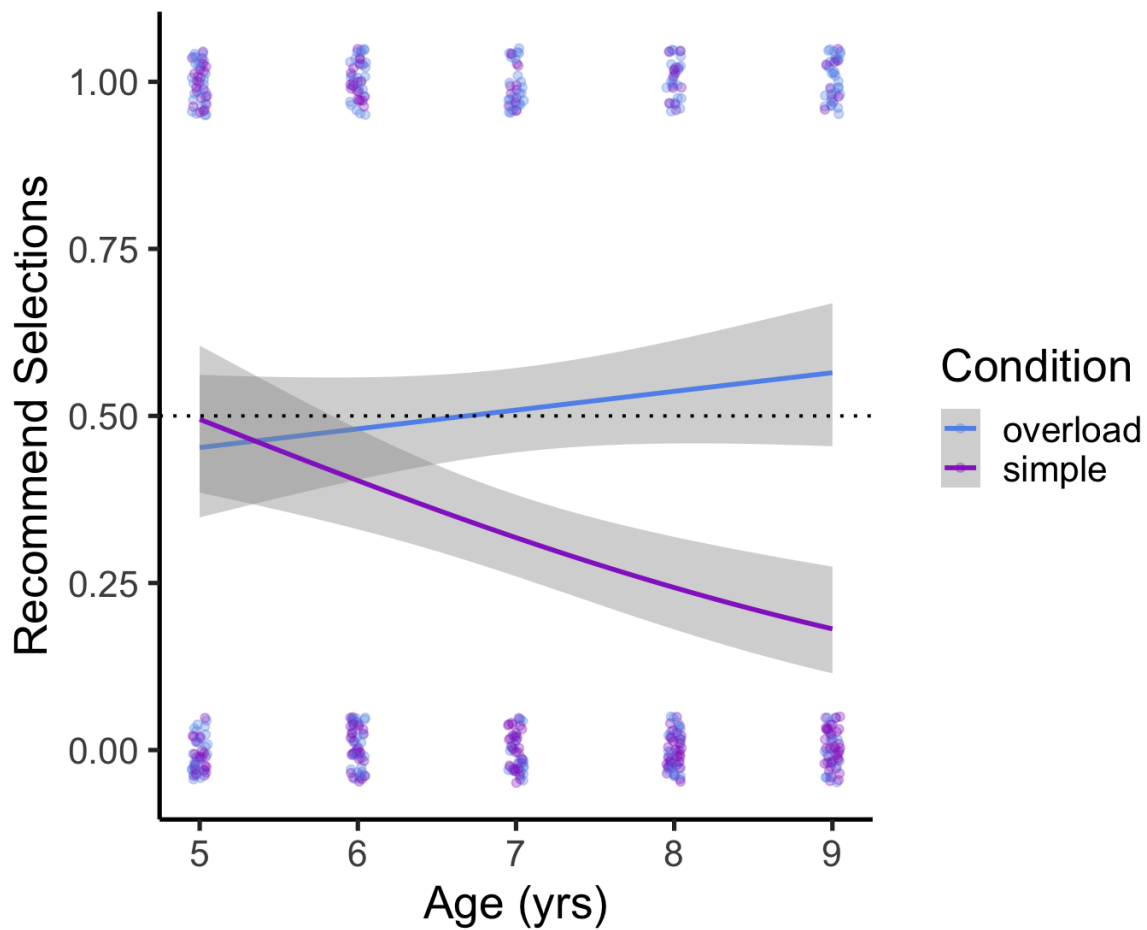
Note. Power curve plotting the sample size required to detect an interaction among age and condition with a small effect ($OR = 1.25$) using 1000 simulations.

Figure 3

Study Flow Chart Across Information Overload and Simple Conditions



Note. Study flow chart showing both conditions: information overload (on the left) and simple decision (on the right). The bottom slides show what participants saw at test.

Figure 4*Age by Condition Interaction of Selecting Machine vs. Self*

Note. Line graph displaying the age by condition interaction generated using ggplot. The shaded areas (blue and purple) represent 95% CI. The dotted line represents selections at chance. 1 represents selections of 'machine' and 0 represents selections of 'self'.