Lack of Evidence for Parent-Offspring Resemblance in Social Information Use

Giorgia Bonin

Department of Psychology, University of Amsterdam

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Dr. Lucas Molleman

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Abstract

Individuals acquire knowledge by observing others, a phenomenon known as social learning. Children tend to rely heavily on social information, but there is significant variation in its use at the individual level. In this study, we investigated whether a child's use of social information is correlated to that of their parents. Study one found no discernible relationship between a child's use of social information and that of their parents. In study two, a multiple regression was conducted to assess whether a moderating variable, specifically the matching of gender between parent and offspring, influenced the relationship between parent and child's use of social information. The relationship remained non-significant. These findings indicate that a child's use of social information cannot be predicted by their parent's use, even if they share the same gender.

Introduction

Humans rely heavily on social learning (Henrich, 2016). Social learning is the process by which we use the behaviour of others as a source of information (Bandura & Walters, 1977). By watching others, we not only learn knowledge and skills (Hoppitt & Lala, 2013), but we also use what we see to make socially appropriate decisions and create beliefs about the world (Molleman et al., 2022). Furthermore, a growing body of methodologically diverse evidence shows that some brain areas have evolved and specialised to process social information (Apps & Sallet, 2017). Social cues can have two different types of influence: 'informational influence' and 'normative influence'. The former refers to the use of social cues to gather information about behaviour that is currently adaptive, while the latter refers to adherence to established group norms that reflect general societal expectations in order to foster a sense of belonging and reduce social tensions (Toelch & Dolan, 2015). This paper focuses on the development of informational social learning and, more specifically, on one of its fundamental components, social information use, which is the process of actively focusing on information presented by others and incorporating it into one's existing beliefs (Molleman et al., 2019).

Various experiments show that children, in particular, make extensive use of social information (Price et al., 2017). It has been shown that social information use declines with age, with young children assimilating most social information while adolescents increasingly prioritising their own views over those of others (Molleman et al., 2022). However, at the individual level, there is a high degree of variability in the extent of social information use even within the same age group (Kendal et al., 2018). The quality and quantity of social learning strategies employed by individuals varies depending on a number of factors. Indeed, there is consistent evidence that children prefer to imitate models similar to themselves, engaging in observer-specific model-based biases (Wood et al., 2013). Model characteristics such as social status, prestige, and competence, as well as subjective closeness between the observer and the model (Gradassi et al., 2022; Wood et al., 2012), also increase the likelihood that children will align their beliefs with those of the model. Not only do people use different social learning strategies, but they also flexibly switch between them depending on state, context, development, and prior experience (for reviews, see Kendal et al. (2018) and Mesoudi et al. (2016)). Currently, it is still unclear how all these different learning strategies arise across development. In particular, there has been limited focus on the influence of families on children's social learning, specifically, with regard to the extent to which children resemble their parents in their use of social information.

Empirical evidence shows that children are more likely to acquire information from a model that is most similar to them ('observer-specific model-based bias'; Wood et al., 2013). Copying a familiar model is adaptive because the child and the model share a common environment. In contrast, the history of a stranger is unknown, and the information they provide may not be relevant to the child's specific environment (Wood et al., 2013). During childhood, parents are the most proximal models and the primary source of information for children. For example, if a child sees their parents regularly changing their minds to agree with others, he or she may learn that agreement is important and weigh social information more heavily than children whose parents tend to stick to their opinions.

Although the evidence is not always consistent, parent-offspring similarity has also been found in other behavioural measures. One study found a positive correlation between mothers' and children's prosocial behaviour, as measured by both behavioural experiments and questionnaires (Kosse et al., 2020). Another study using a behavioural task found a positive correlation between parents' and offspring's willingness to compete (Tungodden & Willén, 2019). Similarly, another study found a positive association between parents' and children's self-reported risk attitudes and trust (Dohmen et al., 2012). In contrast, the study by Cipriani et al. (2013) did not find a correlation between parents and their primary school children's cooperation in a public goods game. However, the lack of correlation could be due to either (1) high data variability, which may have obscured significant differences in the absence of sufficient power, or (2) the young age of the children, which may have resulted in a lack of understanding of the task, leading to random answers, as supported by children's extreme contributions in both directions.

The normative influence of social information suggests that children will copy the behaviour of same-sex individuals as they become more aware of gender categories. Preference for same-sex role models over opposite-sex role models has been observed in a number of situations. In particular, children tend to trust more information from a same-sex adult than from an opposite-sex adult when both adults have previously been shown to be equally reliable (Taylor, 2013). Furthermore, an experimental study showed that children would rather eat the food of another same-sex child than the food of an opposite-sex child when they don't know what the food is (Frazier et al., 2012). Finally, when asked to choose between activities or objects endorsed by people of different sexes, children consistently showed a preference for activities endorsed by people of the same sex (Shutts et al., 2010). As modelling the preferences of same-sex individuals is the primary source of gender role development, we expect children to more closely copy the social information strategies used by a same-sex parent compared to an opposite-sex parent.

In summary, through role modelling and adherence to gender norms, offspring are likely to resemble their parents in their use of social information. In addition, the relationship between parent-child social information use is likely to be moderated by whether the parent and child are of the same or opposite sex. Thus, I hypothesize that: 1) the parent's use of social information will be positively related to the child's use of social information; and 2) the parent's and child's use of social information will be more strongly related when the parent is of the same gender as the offspring. Consequently, I predict that scores on behavioural measures of parent and child social information use will be positively correlated, and that the correlation will be higher for matched gender dyads.

Methods

Setting and Subjects

The purpose of the study was to gain insight into children's use of social information, and the study was approved by the Ethics Review Board of the University of Amsterdam (Ethics Reference Code 2021-DP-13852). Data collection took place at the NEMO Museum in Amsterdam, every Saturday and Sunday, from 2 to 17 December 2023. Participants were recruited from visitors to the museum. I first performed a preliminary power analysis with GPower (Erdfelder et al., 1996) using the F-test for multiple linear regression to determine the sample size required to detect a correlation at alpha=.05 and power=.80. To ensure adequate power, I used an effect size estimate of d=0.1, which is the smallest effect size found in psychological studies that can be considered meaningful (Funder & Ozer, 2019). This resulted in an estimated sample size of 114 dyads, for a total of 228 participants.

It should be noted that the data collection and this research paper are part of a larger study with different research questions that has been ongoing since 2021. Therefore, the final sample size may differ from the intended N. Additionally, it is worth mentioning that prior to 2023, parents and offspring faced each other while performing the task, whereas from 2023 onwards, they were seated behind each other. The study included children between the ages of 6 and 17 because practical observation showed that those under the age of 6 did not understand the task correctly, and those over the age of 17 are officially considered adults. Children outside the above age range were excluded from the analysis. There was no age restriction for parents. Participants who were not considered to be part of the same nuclear family (e.g. a child playing with his aunt) were also excluded from the study. Children in the final sample were aged between 6 and 15 years (mean age =10.01, sd=2.01) and 49.04% were male. Parents were aged between 31 and 58 years and 64.42% of them were mothers. Parents and offspring were of the same sex in 51.92% of the dyads.

Study Design and Data Collection

After recruitment, participants were accommodated in a separate room in the museum in groups of 2 to 6 participants and received instructions for the task from an experimenter.

Instructions were given in Dutch or English, depending on the participant's preference. After receiving instructions, participants completed the BEAST task (Molleman et al., 2019), which was programmed using LIONESS Lab (Giamattei et al., 2019). While one of the experimenters remained available to participants for questions about the task (if instructions were not clear and/or children had difficulty understanding), a second experimenter recorded in a logbook (link to the logbook in Appendix D) anything that happened during the task that could have contaminated the results (e.g., parents and children talking during the task). The task was administered on an iPad Pro or a Samsung tablet, and participants' responses to the task were automatically registered in the LIONESS control panel. More detailed information on how the task was administered can be found in the 'NEMO Data Collection Protocol 2023' document in the Appendix A. Upon completion of the task, participants were given feedback on their performance, debriefed on the purpose of the experiment, and given an information letter and informed consent form to sign (the material is available in Appendix B). The same procedure was repeated for each new group of participants.

Measures

Social information: The use of social information was measured using the BEAST task (Molleman et al., 2019; **Figure 1**). During the task, participants viewed a series of images depicting a number between 50 and 100 animals. After a 6-second interval, the image disappeared. Participants were asked to estimate the number of animals shown. Both participants within a parent-child group were then presented with social information consisting of the estimate of a previous unknown participant who was either an adult (treatment A) or a child of the same age as the target child (Treatment B). Participants could then decide whether or not to adjust their estimate. The procedure was repeated for 5 rounds. Note that a parent-child dyad received the same treatment, resulting in different types of transmission. When a child receives information from a peer, it is considered horizontal transmission, while when an adult receives information from a child, it is considered reverse oblique transmission. Similarly, when an adult receives information from another adult, it is categorized as horizontal transmission, while when a child receives information from an adult, it is considered oblique transmission (Acerbi, 2006). Ideally, this study would have compared parent-offspring resemblance on the same type of transmission. However, due to compromises made on data collection to accommodate the various research questions of the overarching study, this was not possible.

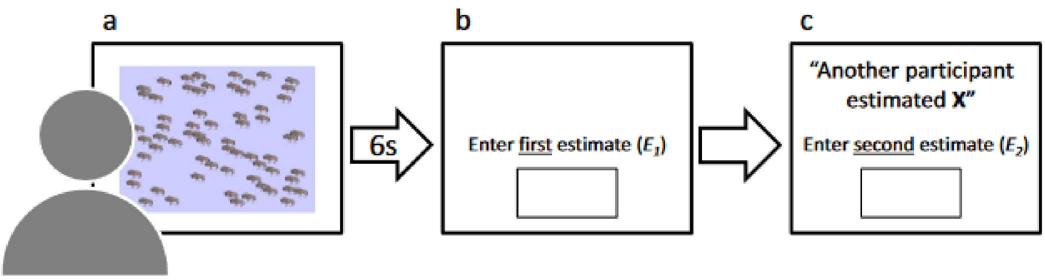
The social information was taken from a pre-recorded database of more than 400 previous participants. We chose an estimate that was halfway between the participant's initial estimate and the correct estimate. The target deviation of X from E1 was 20%. Choosing a prerecorded estimate that closely matched each target allowed us to control for the social information received by participants, enabling a relatively constant margin of adjustment and preventing the social information from being too distant to be completely ignored. In particular, the social information pointed towards the true value (T), i.e. it could be either lower or higher than E1, depending on whether the participant initially underestimated or overestimated the number of animals. The predefined target deviations implied that the social information could be further from the true value if a participant's initial estimate was close to the true value, causing E1 and X to bracket T. Finally, if E1 was exactly correct, it was randomly determined whether the target social information was lower or higher than E1.

To quantify a participant's reliance on social information in a given round, I calculated their social information use (s) as the relative adjustment of their estimate to the social input. $s = (E2 - E1) / (X - E1)$, where E1 is the first estimate, E2 is the second estimate, and X is the social information received by the participant. For each participant, the use of social information was determined using the individual's average adjustments across rounds (S).

The BEAST has significant internal consistency and a good test-retest reliability (Molleman et al., 2019).

Figure 1

Perceptual Judgement Task Measuring Belief Updating after Social Information Use.



Note. From "Unleashing the BEAST: a brief measure of human social information use", by Molleman et al., 2019, *Evolution and Human Behavior* 40 (2019) 492–499, p.493 (https://doi.org/10.1016/j.evolhumbehav.2019.06.005)

Control Variables

I controlled for participants' age and source of social information (unknown adult or unknown child).

Data Analysis

In the first analysis, I ran a linear regression to predict the child's use of social information (stSChild; i.e., outcome variable) by looking at the parent's use of social information (stSParent; i.e., predictor variable). Previous research has found significant age differences in the use of social information (Molleman et al., 2022), so I controlled for the age of the participants. In addition, the source of social information may play a role. It is more likely that an adult will find the opinion of another adult more trustworthy than that of a child, especially if the child is very young, and thus influence the use of social information. To correct for the effect of age and type of social information, I divided parents and children according to the treatment condition. In treatment A (social source= adult), individuals' *S* was normalised by age. Children's scores were normalized within cohorts of one year, while parents' scores were normalized within a single age group, as social information use tends to stabilize in adulthood (Molleman et al., 2022). In treatment B (social source = child), the same procedure was applied. However, parents' scores were further normalized across age-of-source groups. This is because younger children might be ignored more by adults. Consequently, a regression was run with the normalised data. The above procedure allows the regression analysis to be kept simple and parsimonious while still correcting for potential confounding.

Thus, the analysis to determine whether children's use of social information is correlated with their parents' use of social information is as follows: Y(i)= b0 + b1*stSParent+ e(i), where b0 is the average social information use of the children when stSParent equal zero (which given the normalization of the data should equal 0), and b1 is the main effect of the normalised social information use of the parents on the dependent variable Y (normalised social information use of a child). Based on my hypothesis and previous research, I expect b1 to be positive and significant, meaning that parents' use of social information is correlated with their offspring's use of social information.

In the second analysis, I assessed children's use of social information in relation to parents' use of social information, using gender_match as a moderator variable. This was done by adding to the model described above a variable indicating whether parent and offspring were of the same gender (gender_match; 1=yes and 0=no) and calculating the interaction effect between gender_match and stSParent. The model is as follows: Y(i)= b1*stSParent+ b2*gender_match + b3*stSParent*gender_match + e(i). Based on my hypothesis and previous research, I predict that b3 will be positive and significant, and that b1 will be significantly higher when parents and offspring are gender-matched than when they are not.

Data Exclusion

The following concerns the treatment of outlying data. As the true number of animals was between 50 and 100, we considered errors and did not include in the analysis any value of *E1* and/or

E2 <10, as it is not plausible that someone thought there were so few animals. Furthermore, all trials where the value of *s* was negative (i.e. against the social information) were deleted. The reasons for this are that 1) negative values of s can significantly bias an individual's average; and 2) it's difficult to predict whether individuals actively went against social information (thereby, using social information) or simply thought that their previous estimate was not quite accurate and adjusted it in the second trial without taking into account the social information received (thereby, ignoring social information). Similarly, we also excluded trials in which the value of s was greater than 1 (i.e., overshooting in the direction of social information). The reasons for this decision are that 1) a value above 1 significantly biases the results; and 2) it's hard to predict whether participants overestimated X (herby, indicating high use of social information) or simply changed their mind because they thought their first estimate was incorrect (herby, indicating no use of social information). Given that we used participants' average *s* across five trials for the regression analysis, if two or more values of *s* were excluded for a participant, we completely excluded data from that parent-child dyad. This was done to avoid unrepresentative average estimates. Finally, data was excluded retrospectively if there were indications in the logbook that it may be compromised. These data are highlighted in red and green in Appendix D.

Missing Values

The task was designed to present each new step only after the previous one had been completed. Missing values were not possible unless participants were erroneously terminated from the programme. In such cases, and in the event of any missing values due to system errors, the parent-child dyad was excluded from the analysis.

Results

Data Processing

Data analysis was conducted using R Statistical Software (v.4.3.2; R Core Team 2023). The initial sample size comprised 323 dyads. Thirty-six dyads were excluded based on information from the logbook and another 183 were discarded according to the data exclusion criteria. This led to a final sample size of 104 dyads of parents and children.

Analysis 1

A simple regression analysis was used to test the relationship between children's social information use scores and parents' social information use scores. Assumptions were met and they are available in Appendix C. Contrary to expectations, a child's use of social information was not correlated with his/her parent's use of social information ($F(1, 102) = 0.03$, $p = 0.872$, R^2=0)(See **Figure 2**). As shown in **Table 1,** there was no main effect of parents' *S* in children's *S* ($b1 = -0.02$, $SE = 0.13$, $t = -0.16$, $p = 0.871$).

Table 1

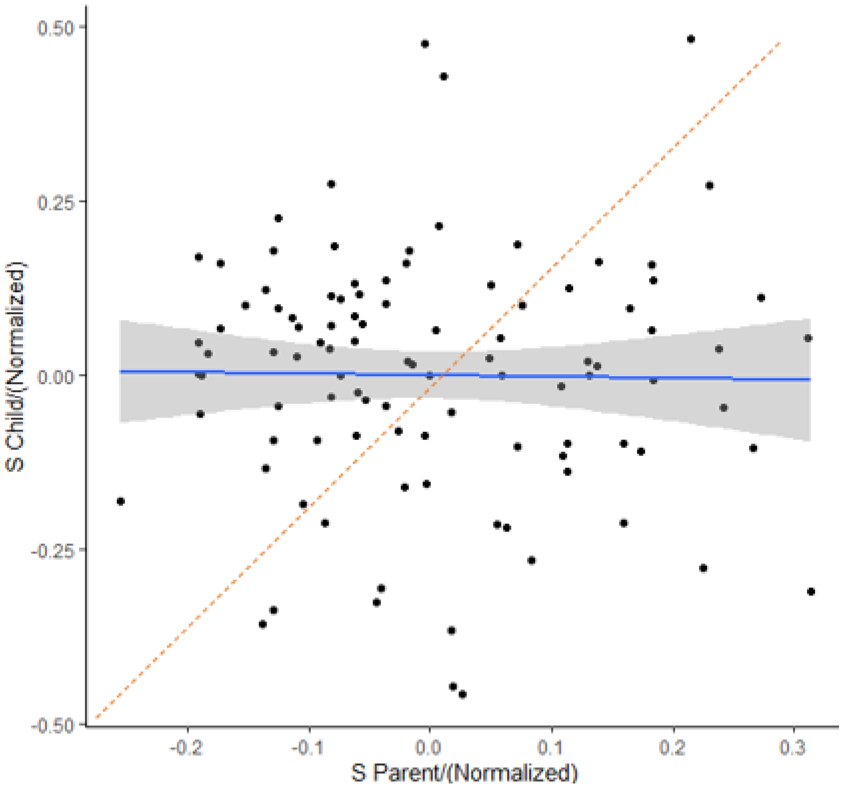
Regression Coefficients for Model 1

	Estimate	SE	t	p
Intercept	0.00	0.02	0.00	1.000
stSParent	-0.02	0.13	-0.16	0.871
R^2	0.00			
Adjusted R^2	-0.01			

This table shows the coefficients of model 1 and the proportion of variation in the dependent variable that is predicted by the independent variable.

Figure 2

Analysis 1



Note. The graph shows the relationship between parents' S and children's S. The dotted line indicates a perfect correlation (r=1), while the blue line shows the correlation found in this study, indicating no association between the variables.

Analysis 2

After the assumptions were met (see Appendix C), a multiple regression was run to test whether a gender match between parent and offspring moderates the relationship between parents' social information use scores and children's social information use scores. No significant moderation was found ($F(3, 100) = 0.04$, $p = 0.989$ $R^2 = 0.00$). Results indicate that the association between children's scores in social information use and parents' score on social information use remain insignificant even when *gender_match* is added as moderator (see **Figure 3**). As shown in **Table 2**, there is no main effect of parents' *S* on children's *S* ($b1 = -0.06$, $SE = 0.18$, $t = -0.31$, p

=0.758) and no main effect of *gender_match* on children's *S* (*b2* = -0.01, *SE* = 0.03, *t* = -0.18, *p* = 0.855). Finally, no interaction effect was found between *gender_match* and parents' *S* (*b3* = 0.07, *se* = 0.27, *t* = 0.25, *p* = 0.802).

Table 2

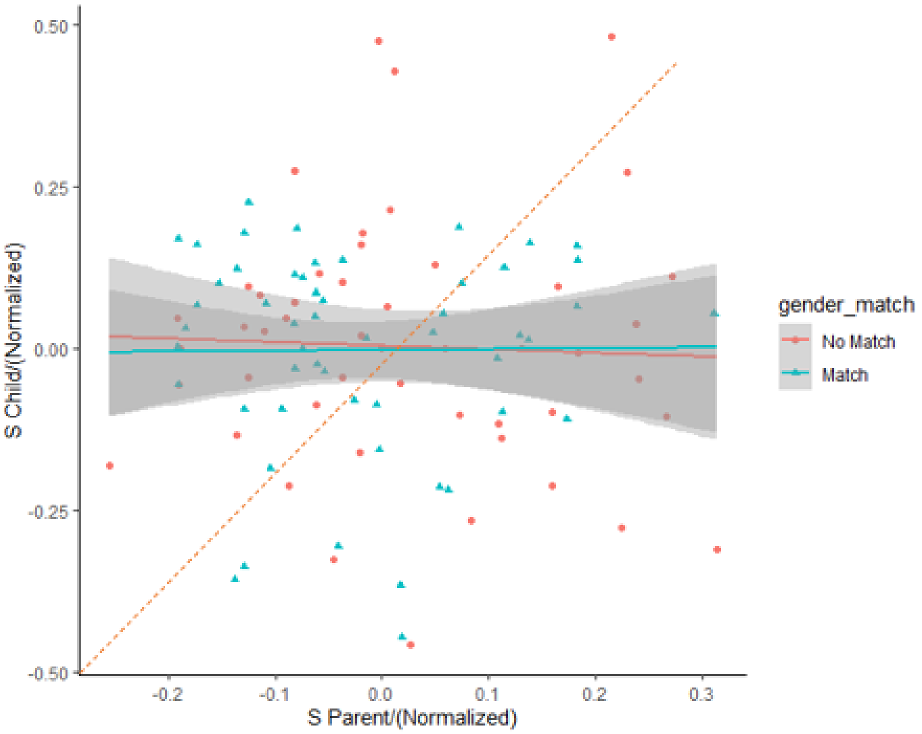
Regression Coefficients for Model 2

	Estimate	SE	t	p
Intercept	0.00	0.03	0.16	0.872
stSParent	-0.06	0.18	-0.31	0.758
gender_match	-0.01	0.03	-0.18	0.855
stSParent * gender_match	0.07	0.27	0.25	0.802
R^2	0.00			
Adjusted R^2	-0.03			

Notes. This table shows the coefficients of model 2 and the proportion of variation in the dependent variable that is predicted by the independent variables.

Figure 3

Analysis 2



Note. The graph shows the relationship between parents' S and children's S when parents and offspring are of the same sex (in green) and when they are of opposite sex (in orange). The dotted line indicates a perfect correlation (r=1), while the green and orange lines represent the associations found in this study, indicating no correlation between the variables.

Since, as mentioned above, a social cue from a child may have a different effect on a child receiver than on an adult receiver, in order to test the robustness of the results, I reconducted the analyses using data from previous years in which parents and children received social information from an unknown source, categorised as oblique transmission for both. The results remained insignificant, confirming the above findings. The assumptions and results of the robustness check can be found in Appendix F.

Conclusion and Discussion

The results of this paper suggest that children's use of social information is not correlated with their parents' use of social information. Furthermore, the correlation remains insignificant when considering whether parents and offspring are of the same gender. The first analysis revealed no correlation between parents' social information use and children's social information use. These findings contradict most previous research and the theoretical proposal that, because children imitate models and parents are the main role models for children during childhood, children's use of social information should resemble that of their parents. The second analysis was also not significant, indicating that there is no relationship between children's use of social information and parents' use of social information, even when the dyad is of the same gender. Once again, the results are in contrast to what might be expected on the basis of modelling and the normative influence of social information.

Overall, this paper’s findings are consistent with Cipriani et al. (2013) but contradict most previous research on parent-offspring correlations on behavioural measures. The conflicting results may be due to different methodological choices. Kosse et al. (2020) measured prosociality as a combination of prosocial motivation (altruism), beliefs about the prosociality of others (trust), and prosocial actions (other-regarding behaviour), using both choice experiment and survey measures. The use of different collection methods, coupled with the analysis of different facets of the construct, allows for more comprehensive and robust results. It's worth noting that the effect size they found was very small (*R2*= 0.067), close to zero. Dohmen et al. (2012), on the other hand, found effect sizes ranging from 0.116 to 0.261. However, although they measured different components of trust and risk attitudes, they used a survey whose responses are not objective by nature. Tungodden and Willén (2019) was the only paper that used only a behavioural task to assess risk preferences. Interestingly, adding two measures of risk preference and two measures of ability to the analysis reduced the intergenerational correlation in competitiveness to zero, suggesting that the initial correlation may be explained by similarities in risk preferences and ability. Finally, it should be pointed out that psychological publications are biased towards positive findings (Marks-

Anglin & Chen, 2020). This means that many negative findings go unpublished, leaving us with the idea that there are mostly positive parent-offspring behavioural correlations.

It's important to note that the study has some methodological problems. First, due to the high number of excluded cases, some age x treatment subgroups that we obtained through the normalisation process had less than 4 participants. Small numbers of data points are subject to high variability, which makes it difficult to detect significant effects. We also found that people didn't read the instructions fully, as evidenced by the fact that they often didn't know who the source of information was (i.e. adult or child). As previous research has shown, the source of social information is important when it comes to using social information. If the parent read the information but the child didn't (or vice versa), they may have given different weight to the social information, leading to biased results. Another limitation is that when looking at the distribution of parents' S before normalisation, all data points are between 0 and 0.5, with most data being 0, whereas the distribution of children's S is between 0 and 1, and the data were better spread along the distribution. This is true for both treatment conditions. The above is consistent with findings that social information use declines with age (Molleman et al., 2022), but the limited variance in parents' social information use may have masked a correlation between the variables. Finally, it is also possible that the BEAST task does not properly capture an individual's use of social information. This possibility is supported by the high number of excluded cases, which was more than half of the original sample. Indeed, many participants had 2 or more estimates of s greater than 1 and/or less than 0. This, combined with the fact that it's difficult to predict the meaning of negative values of *s* and *s* values greater than 1 from the task, points to 2 possible flaws in the BEAST: either the task does not measure social information use as intended, producing many ambiguous cases, or, if social information use is elicited and measured as intended, the task does not provide a clear interpretation for a significant and meaningful proportion of the observations.

Beyond methodological issues, another limitation could explain the lack of significant findings even after including the moderating variable. As known from previous research, a constellation of different factors influences the use of social information (Kendal et al., 2018). In this paper, only the type of social source and age were controlled for. It may be that other more influential intrapersonal variables, for which we did not correct, have masked the correlation. For example, there is already some evidence on the influence of IQ on social learning (Muthukrishna et al., 2016). Other interesting variables to test would be SES, parental education level, or personal values (i.e., Schwartz's basic values; Schwartz, 2012).However, if we had to control for too many factors to find a correlation between parents' and offspring's use of social information, the correlation would have no practical significance and low ecological validity, because in real life individuals cannot be separated from their personal characteristics.

In future studies, it is advisable to investigate the issue using a task other than the BEAST to see whether null results are due to task flow or whether they reflect the true state of affairs. An example of a task that could be used is the adapted version of the bandit task (Glowacki & Molleman, 2017). A different task that is better able to detect variance in the data would also compensate for the variability problem of the distributions mentioned above. Furthermore, manipulation checks should be carried out before the actual experiment to check that participants have correctly and fully understood the task. One way of doing this would be to run a pre-test in which participants are asked to complete a questionnaire at the end about their understanding of the task and the thought process behind their responses.

An advantage of this study is that the BEAST is a behavioural measure and as such is less subject to personal bias than questionnaires or third-party observation. In addition, this study has high power. This was possible because the study is part of a larger study that includes different research questions and has been running since 2021. Despite the large number of excluded participants, the final sample size was very close to the sample size needed to obtain a power of 0.8, thanks to the amount of data collected over the past few years.

In conclusion, this paper suggests that parental differences in social information use do not account for the variability in children's social information use. These findings call for a possible reevaluation of theories concerning intergenerational transmission of behaviours, and they emphasise the necessity for further research on factors that contribute to variability in social information use among peers. Finally, comprehending the possible shortcomings of the BEAST task encourage the creation of more sophisticated techniques for assessing social information use.

Reference

Acerbi, A., & Parisi, D. Cultural Transmission Between and Within Generations. *Journal of Artificial Societies and Social Simulation*, *9*(1). http://bura.brunel.ac.uk/handle/2438/20175

Apps, M. A. J., & Sallet, J. (2017). Social Learning in the Medial Prefrontal Cortex. *Trends in Cognitive Sciences*, *21*(3), 151–152. https://doi.org/10.1016/j.tics.2017.01.008

Bandura, A., & Walters, R. H. (1977). *Social learning theory* (Vol. 1). Prentice Hall: Englewood cliffs.

Cipriani, M., Giuliano, P., & Jeanne, O. (2013). Like mother like son? Experimental evidence on the transmission of values from parents to children. *Journal of Economic Behavior & Organization*, *90*, 100–111. https://doi.org/10.1016/j.jebo.2013.03.002

Dohmen, T., Falk, A., Huffman, D., & Sunde, U. (2012). The Intergenerational Transmission of Risk and Trust Attitudes. *The Review of Economic Studies*, *79*(2), 645–677. https://doi.org/10.1093/restud/rdr027

Erdfelder, E., Faul, F., & Buchner, A. (1996). GPOWER: A general power analysis program. *Behavior Research Methods, Instruments & Computers*, *28*(1), 1–11. https://doi.org/10.3758/BF03203630

Frazier, B. N., Gelman, S. A., Kaciroti, N., Russell, J. W., & Lumeng, J. C. (2012). I'll have what she's having: The impact of model characteristics on children's food choices. *Developmental Science*, *15*(1), 87–98. https://doi.org/10.1111/j.1467-7687.2011.01106.x

Funder, D. C., & Ozer, D. J. (2019). Evaluating effect size in psychological research: Sense and nonsense. *Advances in Methods and Practices in Psychological Science*, *2*(2), 156-168. https://doi.org/10.1177/2515245919847202

Giamattei, M., Yahosseini, K. S., Gächter, S., & Molleman, L. (2020). LIONESS Lab: a free web-based platform for conducting interactive experiments online. *Journal of the Economic Science Association*, *6*, 95-111. https://doi.org/10.1007/s40881-020-00087-0

Glowacki, L., & Molleman, L. (2017). Subsistence styles shape human social learning strategies. *Nature Human Behaviour*, *1*(5), 0098. https://www.nature.com/articles/s41562-017-0098

Gradassi, A., Slagter, S., Pinho, A., Molleman, L., & van den Bos, W. (2022). Network distance and centrality shape social learning in the classroom. *School Psychology*, *38*. https://doi.org/10.1037/spq0000490

Henrich, J. (2016). *The secret of our success: How culture is driving human evolution, domesticating our species, and making us smarter*. Princeton University Press.

Hoppitt, W., & Lala, K. N. (2013). Social Learning: An Introduction to Mechanisms, Methods, and Models. In *Social Learning*. Princeton University Press. https://doi.org/10.1515/9781400846504

Kendal, R. L., Boogert, N. J., Rendell, L., Laland, K. N., Webster, M., & Jones, P. L. (2018). Social Learning Strategies: Bridge-Building between Fields. *Trends in Cognitive Sciences*, *22*(7), 651–665. https://doi.org/10.1016/j.tics.2018.04.003

Kosse, F., Deckers, T., Pinger, P., Schildberg-Hörisch, H., & Falk, A. (2020). The Formation of Prosociality: Causal Evidence on the Role of Social Environment. *Journal of Political Economy*, *128*(2), 434–467. https://doi.org/10.1086/704386

Marks-Anglin, A., & Chen, Y. (2020). A historical review of publication bias. *Research Synthesis Methods*, *11*(6), 725-742. https://doi.org/10.1002/jrsm.1452

Mesoudi, A., Chang, L., Dall, S. R. X., & Thornton, A. (2016). The Evolution of Individual and Cultural Variation in Social Learning. *Trends in Ecology & Evolution*, *31*(3), 215–225. https://doi.org/10.1016/j.tree.2015.12.012

Molleman, L., Ciranka, S., & van den Bos, W. (2022). Social influence in adolescence as a double-edged sword. *Proceedings of the Royal Society B: Biological Sciences*, *289*(1977), 20220045. https://doi.org/10.1098/rspb.2022.0045

Molleman, L., Kurvers, R. H. J. M., & van den Bos, W. (2019). Unleashing the BEAST: A brief measure of human social information use. *Evolution and Human Behavior*, *40*(5), 492–499. https://doi.org/10.1016/j.evolhumbehav.2019.06.005

Muthukrishna, M., Morgan, T. J. H., & Henrich, J. (2016). The when and who of social learning and conformist transmission. *Evolution and Human Behavior*, *37*(1), 10–20. https://doi.org/10.1016/j.evolhumbehav.2015.05.004

Price, E. E., Wood, L. A., & Whiten, A. (2017). Adaptive cultural transmission biases in children and nonhuman primates. *Infant Behavior and Development*, *48*, 45–53. https://doi.org/10.1016/j.infbeh.2016.11.003

R Core Team (2023). _R: A Language and Environment for Statistical Computing_. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/

Schwartz, S. H. (2012). An Overview of the Schwartz Theory of Basic Values. *Online Readings in Psychology and Culture*, *2*(1). https://doi.org/10.9707/2307-0919.1116

Shutts, K., Banaji, M. R., & Spelke, E. S. (2010). Social categories guide young children's preferences for novel objects. *Developmental Science*, *13*(4), 599–610. https://doi.org/10.1111/j.1467-7687.2009.00913.x

Taylor, M. G. (2013). Gender influences on children's selective trust of adult testimony. *Journal of Experimental Child Psychology*, *115*(4), 672–690. https://doi.org/10.1016/j.jecp.2013.04.003

Toelch, U., & Dolan, R. J. (2015). Informational and Normative Influences in Conformity from a Neurocomputational Perspective. *Trends in Cognitive Sciences*, *19*(10), 579–589. https://doi.org/10.1016/j.tics.2015.07.007

Tungodden, J., & Willén, A. (2023). When Parents Decide: Gender Differences in Competitiveness. *Journal of Political Economy*, *131*(3), 751–801. https://doi.org/10.1086/721801

Wood, L. A., Kendal, R. L., & Flynn, E. G. (2012). Context-dependent model-based biases in cultural transmission: Children's imitation is affected by model age over model knowledge state. *Evolution and Human Behavior*, *33*(4), 387–394. https://doi.org/10.1016/j.evolhumbehav.2011.11.010

Wood, L. A., Kendal, R. L., & Flynn, E. G. (2013). Whom do children copy? Model-based biases in social learning. *Developmental Review*, *33*(4), 341–356. https://doi.org/10.1016/j.dr.2013.08.002

Note: *Some Appendix were removed from this document due to privacy reasons.*

APPENDIX B

Informed Consents and Information Letters

Toestemmingsverklaring ouder

Ik verklaar hierbij op voor mij duidelijke manier te zijn ingelicht over de aard en methoden van het onderzoek, zoals in de informatiebrief uiteengezet. Mijn eventuele vragen zijn naar tevredenheid beantwoord.

- Ik stem geheel vrijwillig in met de deelname van mijzelf en mijn kind aan dit onderzoek.
- Ik heb het recht deze instemming weer intrekken, zonder opgaaf van reden.
- Ik heb het recht om de deelname van mij en/of mijn kind(eren) op elk moment in te stoppen, zonder reden.
- Ik stem in met het delen van volledig geanonimiseerde onderzoeksresultaten in wetenschappelijke publicaties, of het op een andere manier openbaar maken van volledig geanonimiseerde onderzoeksresultaten.

□ **Ik verklaar dat ik het onderzoek met mijn kind heb besproken**

De ouder(s)/verzorger(s) van

Naam kind/kinderen:

……………………………..……………………………..

……………………………..……………………………..

Ik geef hierbij **toestemming** voor deelname aan het onderzoek van de Universiteit van Amsterdam

……………………… ………………………. ……………………..

Naam ouder/verzorger Handtekening * Datum

*De handtekening impliceert ook toestemming van een mogelijke andere ouder/verzorger van uw kind.

[ONDERZOEKER]

- Ik heb de ouder(s)/verzorger(s) geïnformeerd over het onderzoek.
- Ik ben bereid nog opkomende vragen over het onderzoek naar vermogen te beantwoorden.

.... ……………………

Naam onderzoeker Handtekening onderzoeker Datum

Consent Form parents

I am clearly informed about the core and methods of this study, as explained in the information letter. Any of my questions about the study are answered by the researcher.

- I voluntarily gave permission for participation for myself and my child in this study.
- I reserve the right to withdraw my permission, without providing any reason.
- I reserve the right to withdraw my and/or my child's participation from the study at any moment without providing any reason.
- I agree that fully anonymized research data can be shared in scientific publications or can be made publicly available.

□ **I declare that I have discussed the study with my child**

The parent(s)/guardian(s) of

Name child(ren):

……………………………..…………………………..

……………………………..…………………………..

I hereby give **permission** to participate in this study of the University of Amsterdam

……………………… ………………………. ……………………..

Name parent/guardian Signature * Date

*The signature implicates also the permission of a possible other parent/guardian of your child.

[RESEARCHER]

- I have informed the parent(s)/guardian(s) about the study.
- I am willing to answer any upcoming questions about the research to the best of my ability.

.... ……………………

Name researcher Signature researcher Date

Toestemmingsverklaring kind (12 jaar of ouder)

Ik verklaar hierbij dat het onderzoek duidelijk is uitgelegd, zoals het in de informatiebrief beschreven is. Al mijn vragen zijn goed beantwoord door de onderzoeker.

- Ik stem geheel vrijwillig in met mijn deelname aan dit onderzoek.
- Ik heb het recht deze instemming weer intrekken, zonder opgaaf van reden.
- Ik heb het recht om mijn deelname op elk moment in te stoppen, zonder reden.
- Ik stem in met het delen van volledig geanonimiseerde onderzoeksresultaten in wetenschappelijke publicaties, of het op een andere manier openbaar maken van volledig geanonimiseerde onderzoeksresultaten.

□ **Ik verklaar dat ik het onderzoek met mijn ouder(s)/verzorger(s) heb besproken**

Ik geef hierbij **toestemming** voor deelname aan het onderzoek van de Universiteit van Amsterdam

……………………… ………………………. ……………………..

Naam Handtekening Datum

[ONDERZOEKER]

- Ik heb de deelnemer geïnformeerd over het onderzoek.
- Ik ben bereid nog opkomende vragen over het onderzoek naar vermogen te beantwoorden.

.... ………………………

Naam onderzoeker Handtekening onderzoeker Datum

Consent Form child (12 years or older)

I am clearly informed about the core and methods of this study, as explained in the information letter. Any of my questions about the study are answered by the researcher.

- I voluntarily gave permission to participate in this study.

- I reserve the right to withdraw my permission, without providing any reason.
- I reserve the right to withdraw my participation from the study at any moment without providing any reason.
- I agree that fully anonymized research data can be shared in scientific publications or can be made publicly available.

□ **I declare that I have discussed the study with my parent(s)/guardian(s)** I hereby give **permission** to participate in this study of the University of Amsterdam

……………………… ………………………. ……………………..

Name Signature Date

[RESEARCHER]

- I have informed the participant about the study.
- I am willing to answer any upcoming questions about the research to the best of my ability.

.... ……………………

Name researcher Signature researcher Date

Informatiebrief ouders en kinderen

Samen oordelen vormen

In dit experiment onderzoeken we op een speelse en leerzame manier **hoe mensen oordelen vormen** en hoe zij de oordelen van anderen gebruiken. Ook bekijken we of het gebruik van de oordelen van anderen tot verbetering of verslechtering leidt. Bezoekers van NEMO dragen op deze manier bij aan een lopende studie en leren op een leuke en toegankelijke manier over onderzoek naar besluitvorming bij mensen.
In het experiment kijken bezoekers (ouders, kinderen en andere bezoekers) naar plaatjes waarop een aantal dieren staan. Ze **schatten vervolgens hoeveel dieren er te zien zijn**. Tenslotte zien ze de schatting van voorgaande bezoekers en maken een tweede schatting. Aan het einde vragen we ouders een paar vragen over hoe zij tegen kinderen aankijken.
Voor het experiment wordt alleen **anonieme** data verzameld. Deze anonieme data wordt gebruikt voor onderzoek en kan gedeeld worden met andere onderzoekers (nooit met commerciële partijen). De studie is deel van een onderzoeksproject geleid door Dr. Lucas Molleman (UvA). Voor meer informatie kan je contact opnemen met Dr, Molleman (l.s.molleman@uva.nl).
Er zijn geen negatieve effecten aan dit onderzoek verbonden. **Deelname is geheel vrijwillig.** Je kan zonder gevolgen je deelname aan dit onderzoek terugtrekken door binnen 2 weken na deelname een mailtje te sturen naar bovenstaand mailadres.
Na afloop van het experiment zal de testleider je meer vertellen over het doel van dit onderzoek.

Lucas Molleman
Developmental Psychology
University of Amsterdam
(UvA) tel. 020-5256830

Voor klachten en commentaar kan contact worden opgenomen met de ethiekcommissie van de UvA via:
Helle Larsen
h.larsen@uva.nl

Information letter parents and children

Making judgments together

This experiment investigates in a playful and informative way **how people make judgments** and how they incorporate the judgments of others – and whether and when incorporating the judgment of others is beneficial or detrimental. In doing so, visitors of NEMO contribute to an ongoing research project and become informed on research on human decision making in an engaging manner.

The setup invites visitors (parents, children and other visitors) to observe pictures of animal groups and **estimate the number of animals in these groups**. Next, visitors will observe the judgments of previous visitors and then make a second estimate. At the end, we ask parents a couple of questions about how they perceive children.
For the experiment, only **anonymous** data is collected. The anonymous data will be used for research purposes and may be shared with cooperation partners (never commercial parties). This study is a research project within a project led by Dr. Lucas Molleman. For more information, please contact Dr. Molleman (l.s.molleman@uva.nl).
Participation in this research does not have any known adverse effects. **Participation is fully voluntary**. Without any consequences, you can pull out of this research by sending an email to the above address, within 2 weeks of participation.
After you have completed the experiment, the test leader will explain you more about the aims of this research.

Lucas Molleman
Developmental Psychology
University of Amsterdam
(UvA) tel. 020-5256830

For any other complaints, concerns or comments, please contact the UvA Ethics committee:
Helle Larsen
h.larsen@uva.nl

APPENDIX C
Assumptions Check

Analysis 1

Linearity. Figure C1 shows that the residuals follow a linear pattern, so linearity between the dependent and independent variables can be assumed.

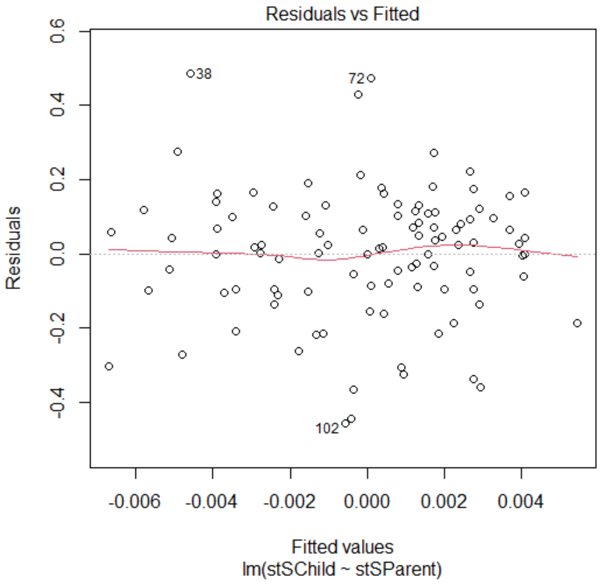


Figure C1. Residual vs Fitted plot for Analysis 1

Independence of Residuals. The Durbin-Watson test (D-W=2.07, p=0.742) is not significant, indicating independence or residuals. In the quantile-quantile plot (Figure C2), the residuals approximate a straight line, also indicating independence.

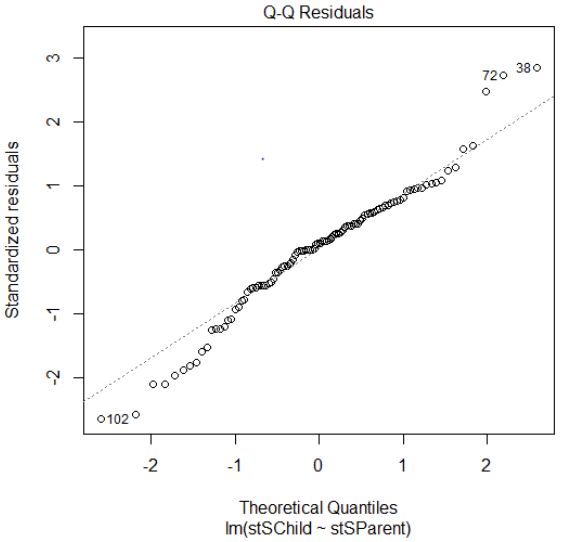


Figure C2. Quantile-Quantile plot for Analysis 1

Normality of residuals. The Shapiro-Wilk test for normality is significant (W=0.97, p=0.021), indicating a non-normal distribution of the residuals, but when looking at the QQ plot (Figure C2), the residuals approximate a straight line. The Shapiro-Wilk test is a frequentist test and as such is subject to power issues. Since our analysis has high power, the Q-Q plot is a better indicator of the presence or absence of normality. Therefore, looking at the plot, it is reasonable to assume a normal distribution of the residuals.

Homoschedasticity. The Spread-Location plot (Figure C3) approximates a straight line, showing that the residuals are evenly distributed along the ranges of the predictors.

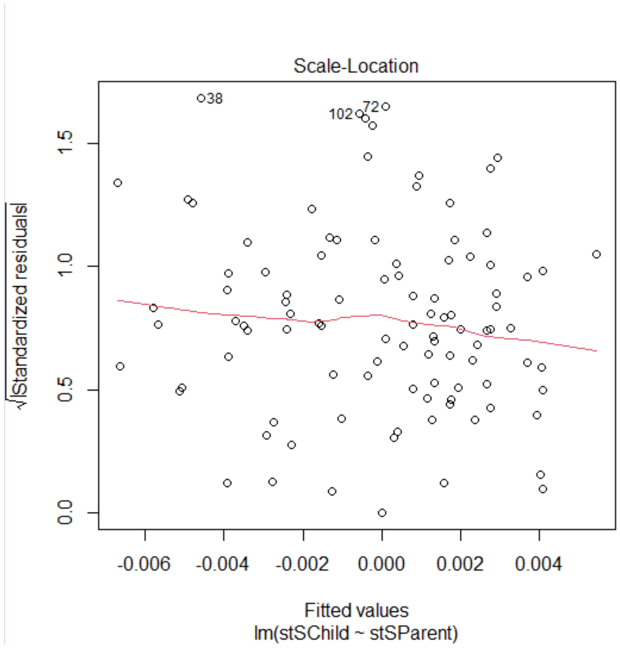


Figure C3. Spread-Location plot for Analysis 1

Influential Outliers. The Cook's distance plot (Figure C4) shows the presence of 2 clear outliers (85, 38). As some subgroups of age X condition have few data points and there are no systematic similarities between the outliers, they were retained in the analysis.

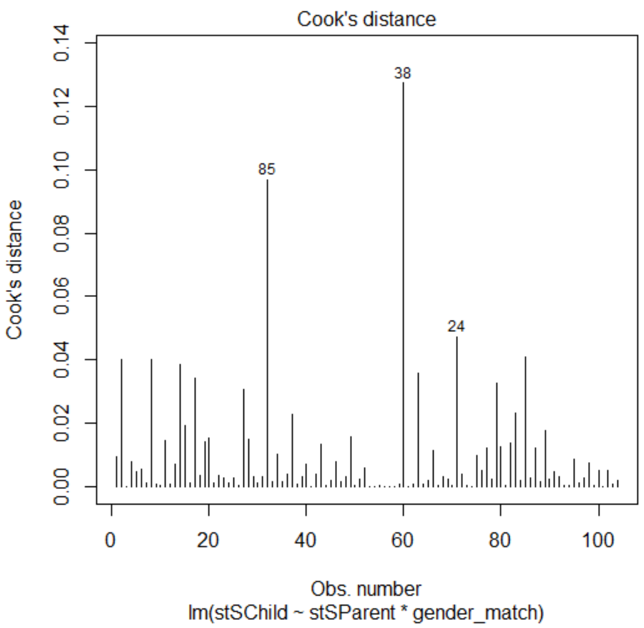


Figure C4. Cook’s Distance plot for Analysis 1

Analysis 2

Linearity. The plot (Figure C5) shows that the residuals follow an approximately linear pattern. The tails appear to deviate slightly from the straight line, but this should be interpreted in the light of the fact that the tails have very few data points, which can distort the residual plot somewhat. Overall, the residual plot shows an approximately linear relationship between the dependent and independent variables.

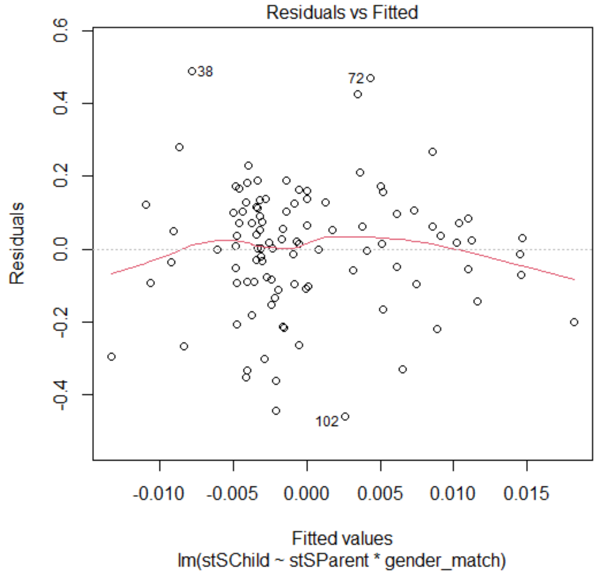


Figure C5. Residual vs Fitted plot for Analysis 2

Independence of Residuals. The Durbin-Watson test (D-W=2.07, p=0.662) is not significant, indicating independence or residuals. In the quantile-quantile plot (Figure C6), the residuals approximate a straight line, also indicating independence.

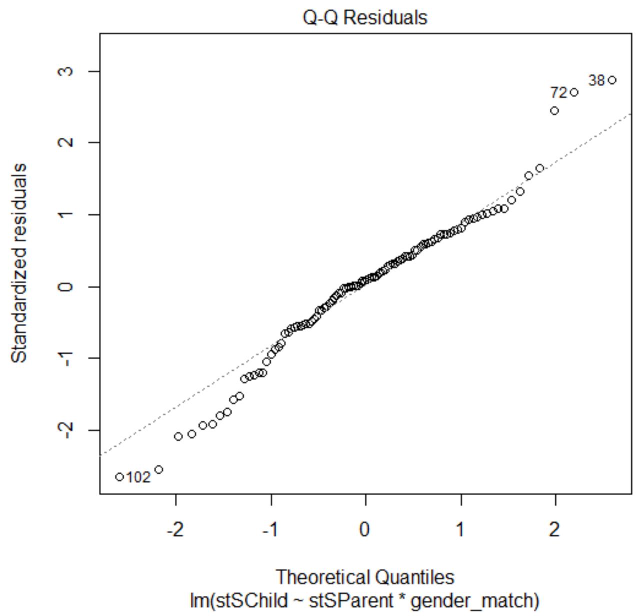


Figure C6. Quantile-Quantile plot for Analysis 2

Normality of residuals. As with the first analysis, the Shapiro-Wilk test for normality is significant (W=0.97, p=0.031), indicating a non-normal distribution of the residuals, but when looking at the QQ plot (Figure C6), the residuals approximate a straight line. The reasoning above applies.

Homoscedasticity. The Spread-Location plot (Figure C7) approximates a straight line, showing that the residuals are randomly distributed.

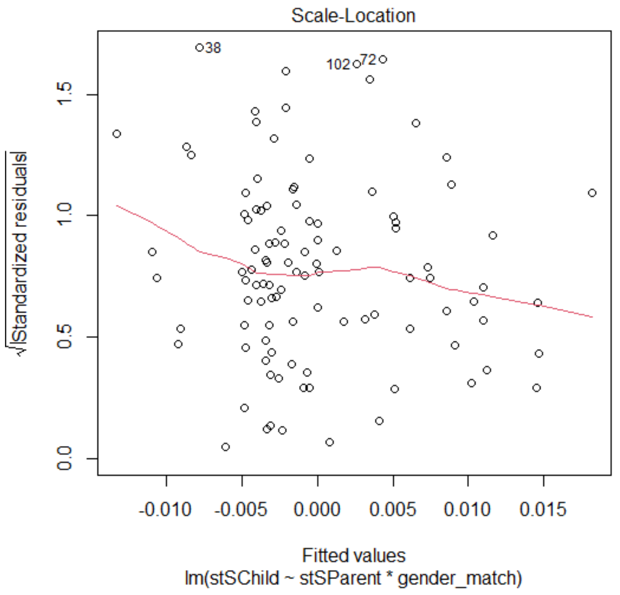
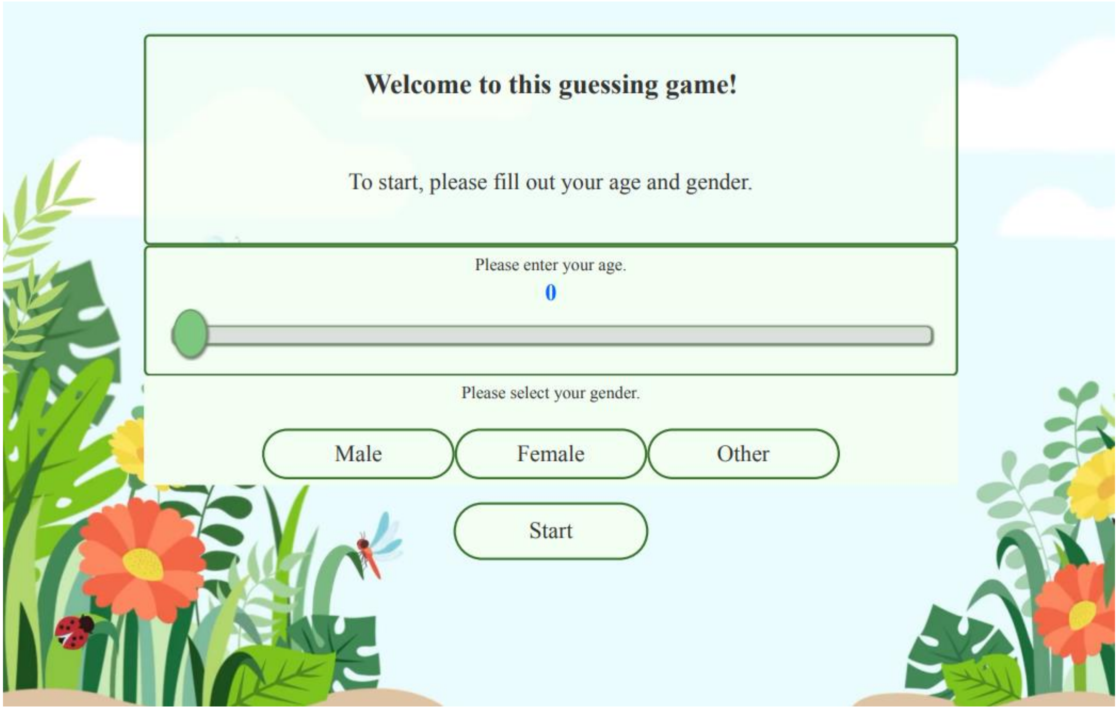


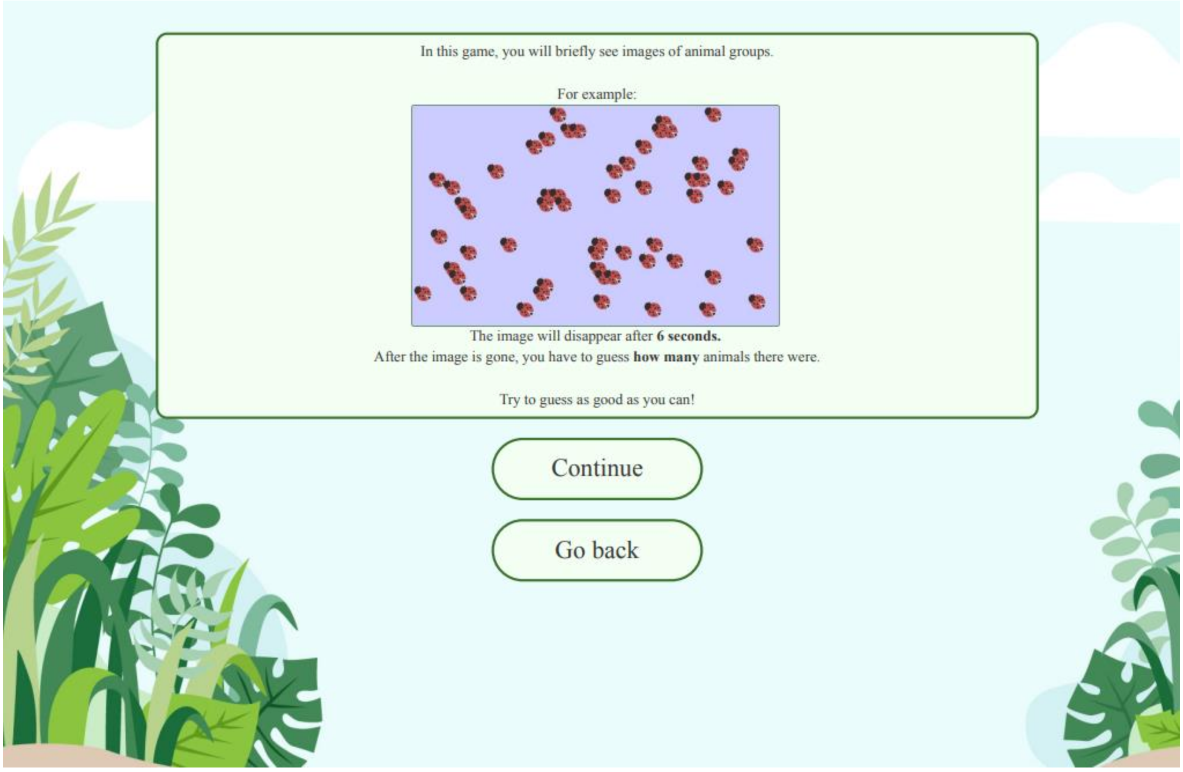
Figure C7. Spread-Location plot for Analysis 2

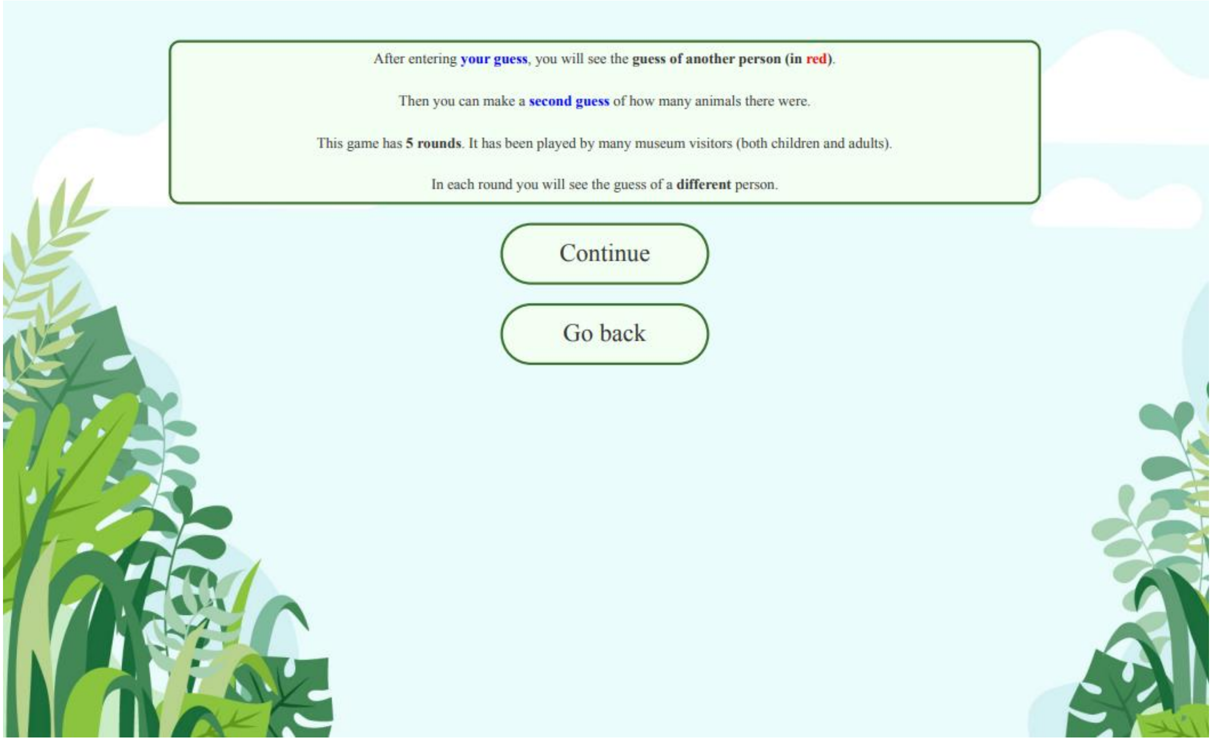
Multicollinearity. A test for multicollinearity shows that there is no linear relationship between the independent variables (stSParent, VIF = 1.82; gender_match, VIF = 1.03; stSParent:gender_match, VIF = 1.80)

Influential Outliers. See evaluation for analysis 1.

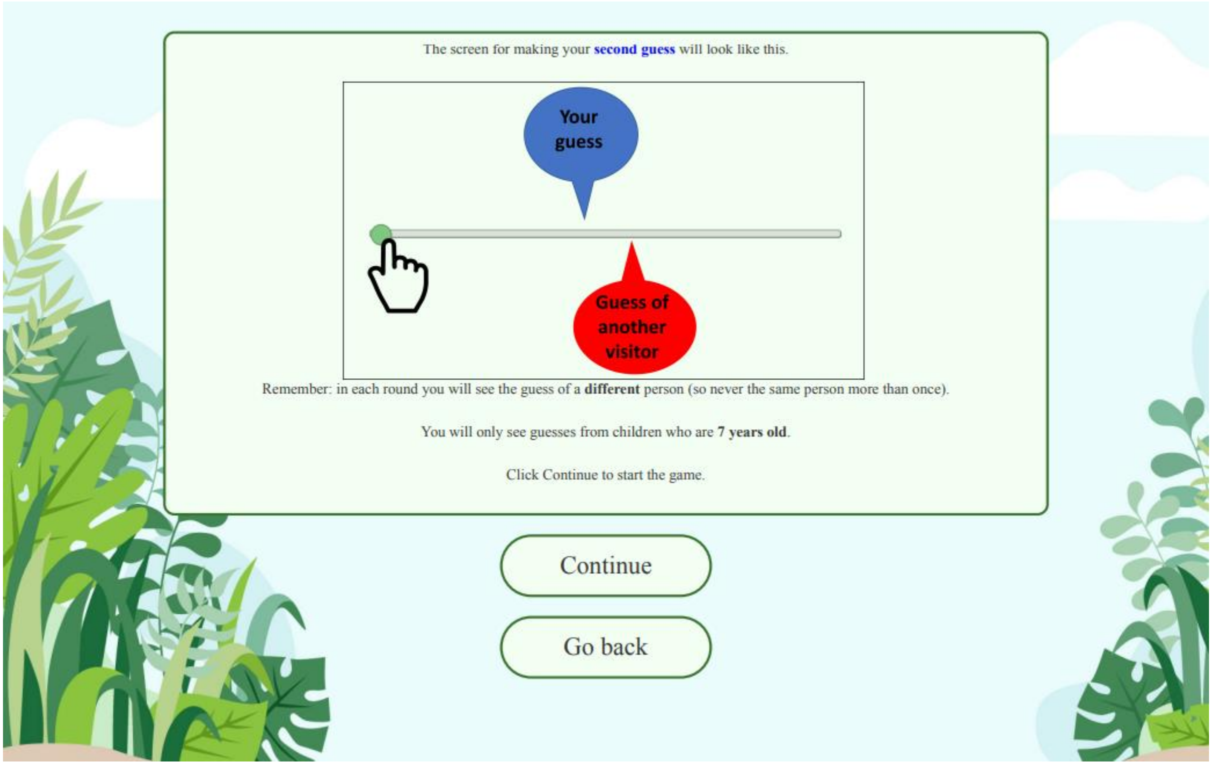
APPENDIX E
BEAST Task

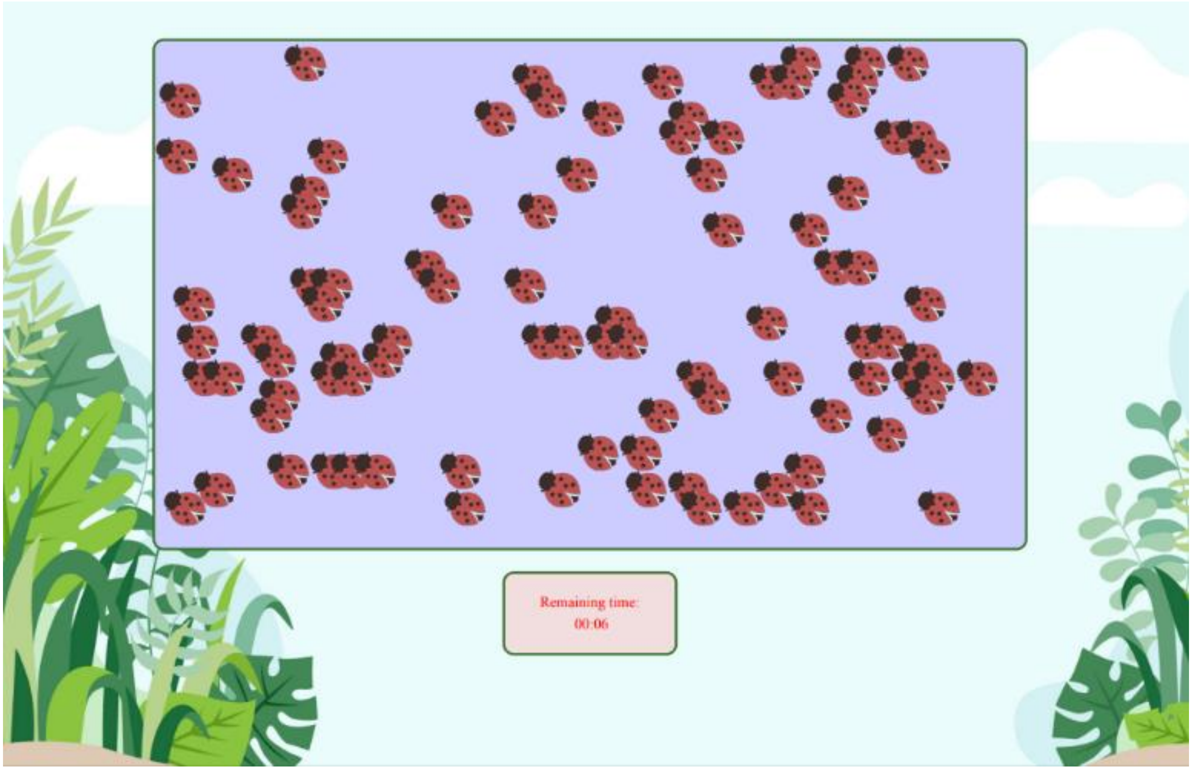


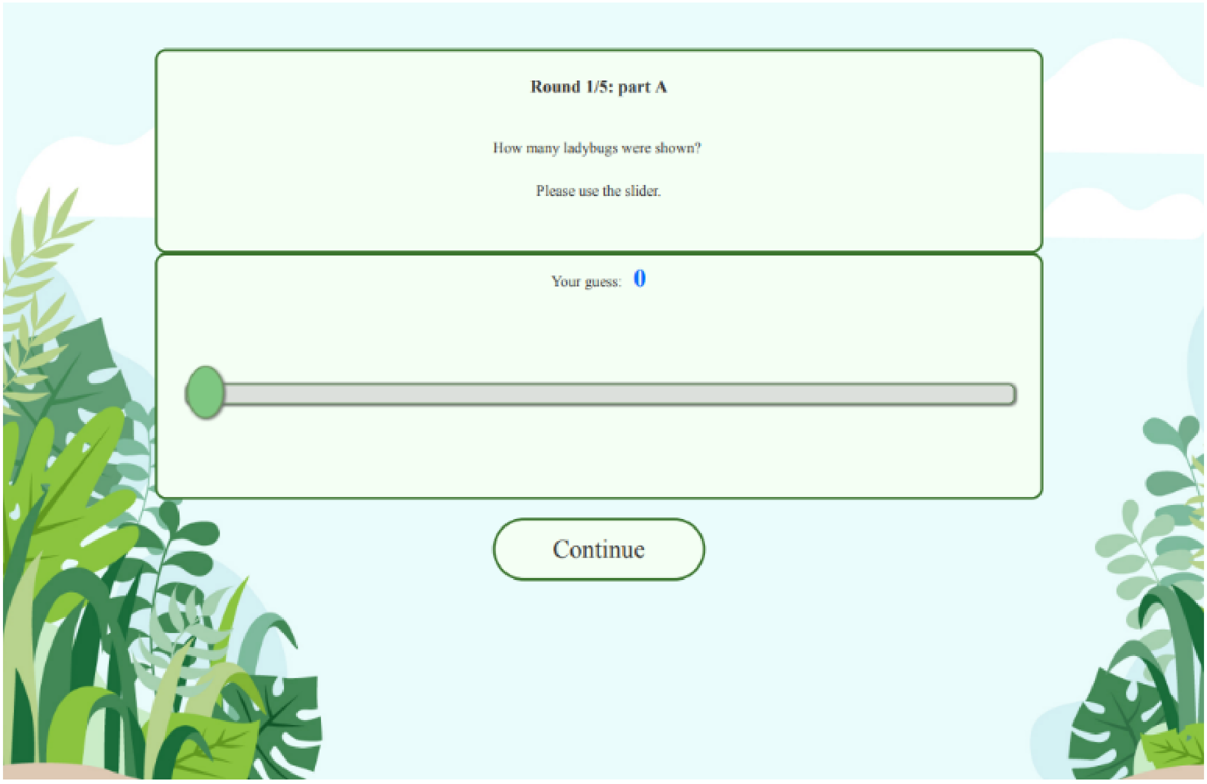


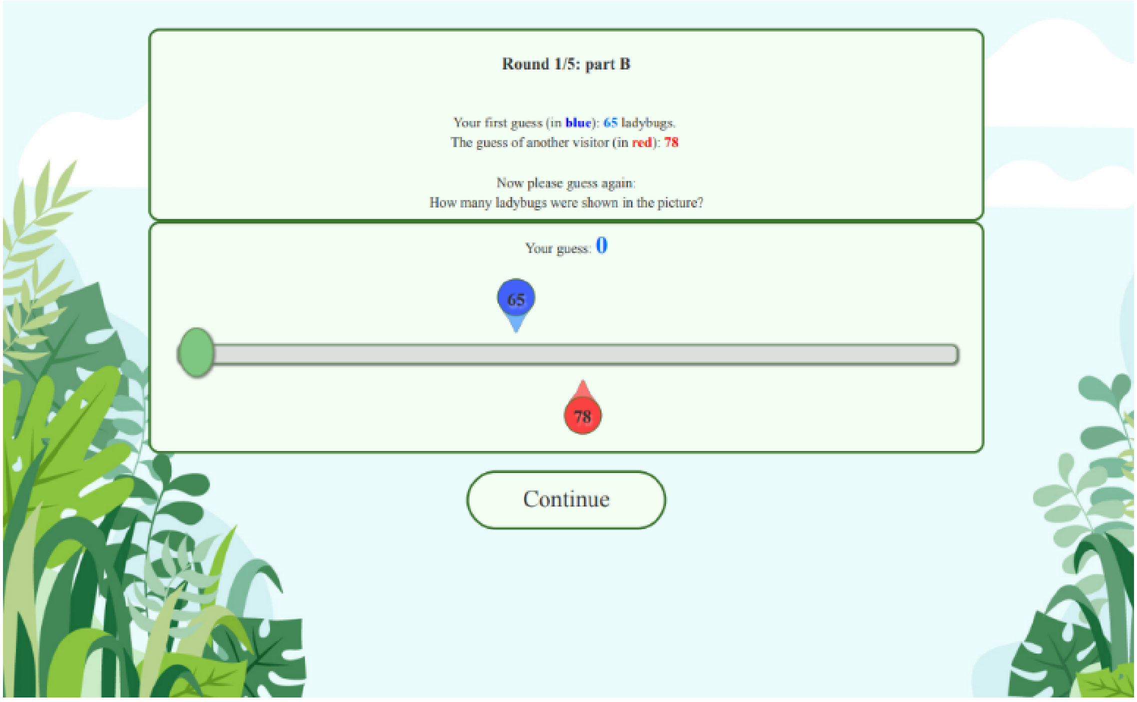


**Note*. Where now it says ‘different’ (in black) participants would instead read ‘adult’ (if they where in treatment A), or ‘Child of (age of the target child) yo’(if they where in tratment B)

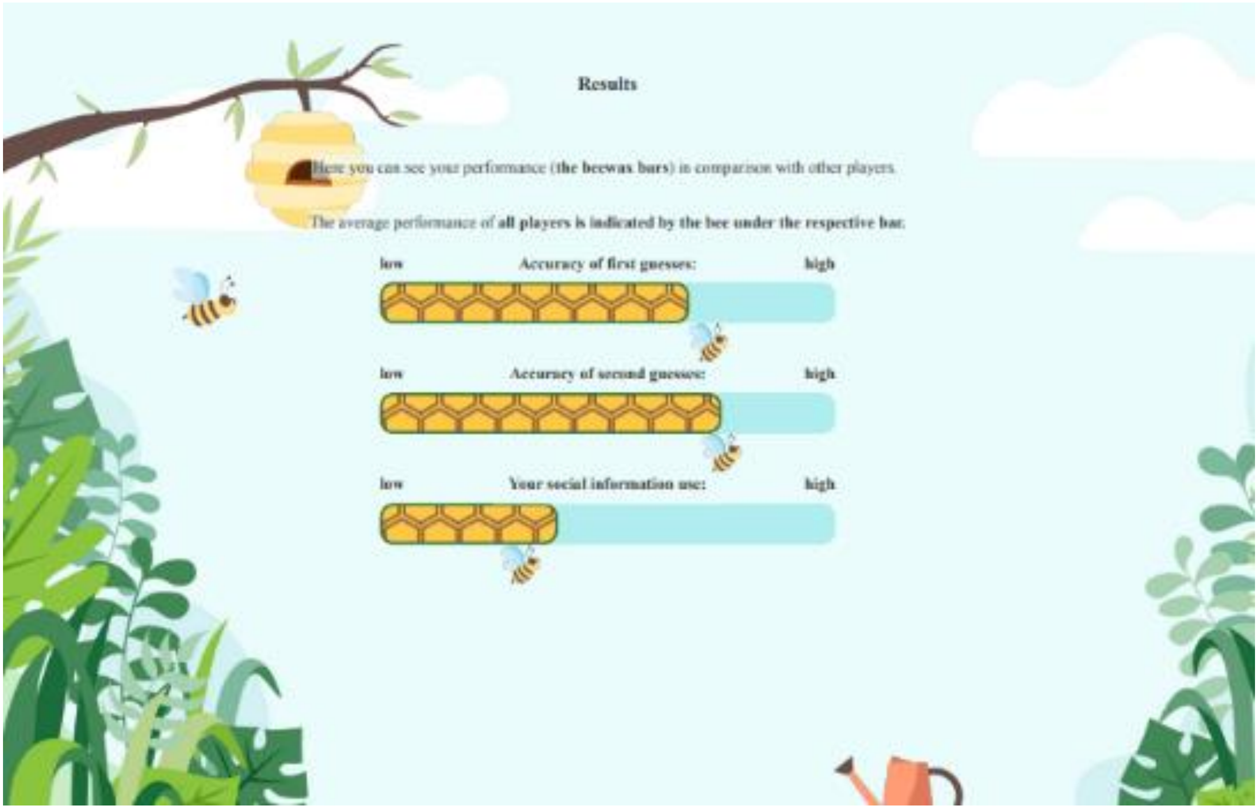



Remaining time:
00:06


Round 1/5: part A
How many ladybugs were shown?
Please use the slider.
Your guess: 0
Continue



Note. Here it is only shown round 1. Participant repeted the excercise for 5 rounds



APPENDIX F

Robustness Check

This was done using data from previous years in which both parents and children received the social information from an unknown source.

Analysis 1.2

Assumptions.

Linearity. The Residual vs Fitted plot (Figure F1) shows almost perfect linearity. The assumption is therefore met.

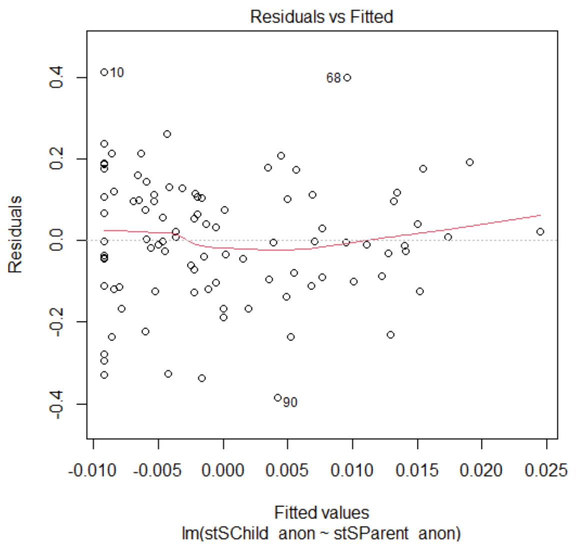


Figure F1. Residual vs Fitted plot for Analysis 1.2

Independence of Residuals and Normality of Residuals. In the quantile-quantile plot (Figure F2), the residuals approximate a straight line, indicating independence and normality of residuals. The Shapiro-Wilk test also shows normality (W=0.99, p=0.50).

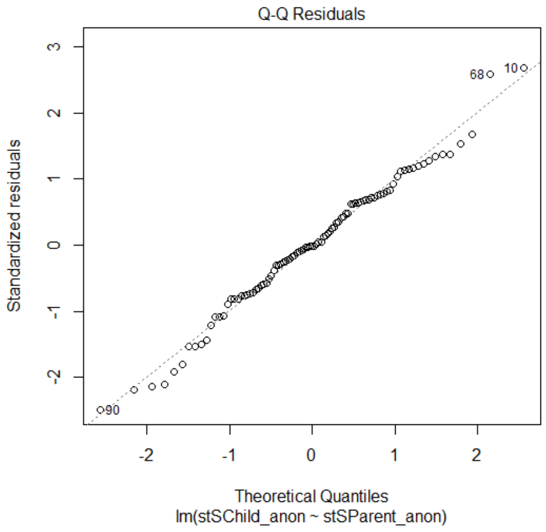


Figure F2. Quantile-Quantile plot for Analysis 1.2

Homoscedasticity. The Spread-Location plot (Figure F3) approximates a straight line, showing that the residuals are evenly distributed along the ranges of the predictors.

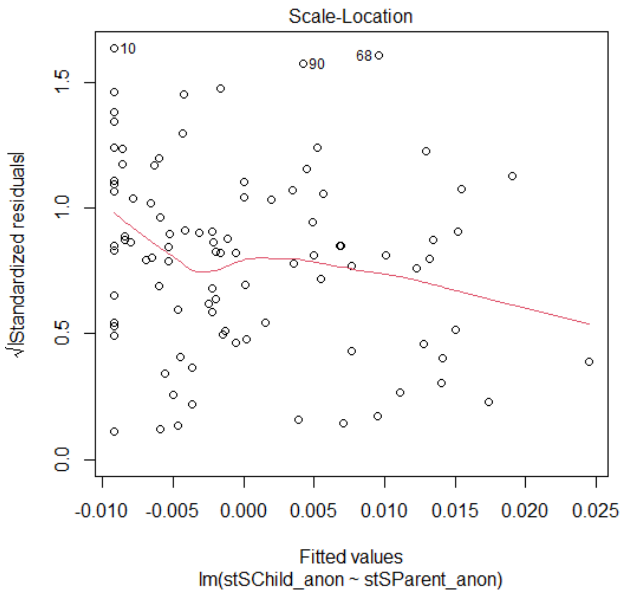


Figure F3. Spread-Location plot for Analysis 1.2

Influential Outliers. The Cook's distance plot (Figure F4) shows the presence of 2 clear outliers (68, 10). As there are no systematic similarities between the outliers, they were retained in the analysis.

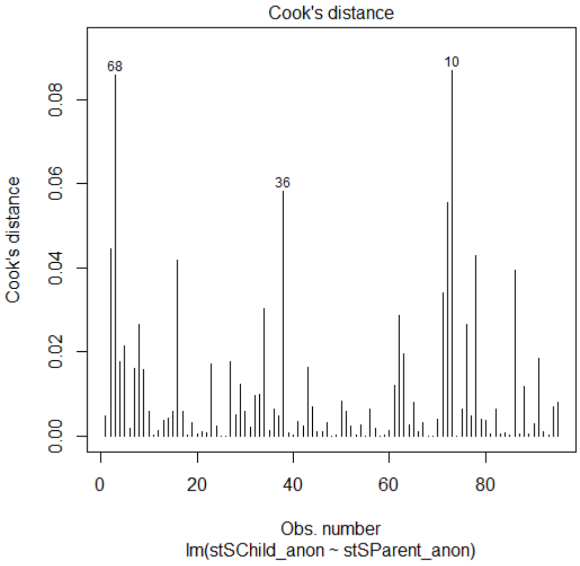


Figure F4. Cook’s Distance plot for Analysis 1.2

Analysis results. No significant correlation was found between parents' *S* and children's *S* in the unknown condition (F (1, 93) = 0.26, p = 0.609 R^2 = 0.00; see Figure F5). Table F1 shows the coefficients of the regression model.

Table F1

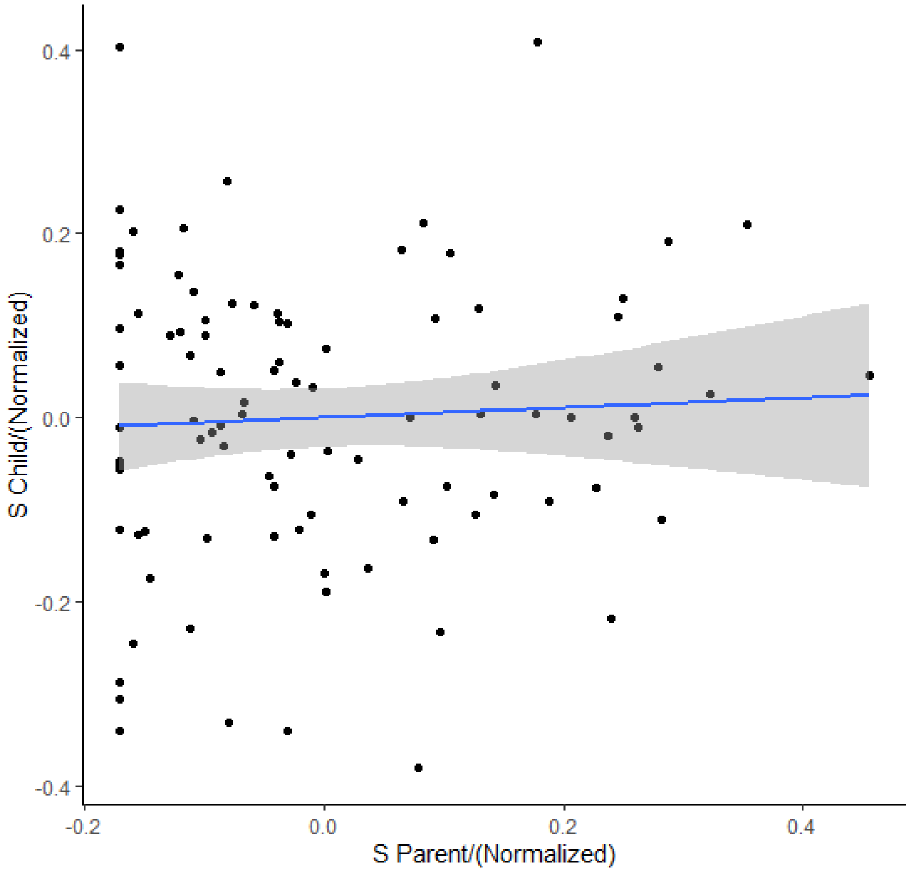
Regression Coefficients for Model 1.2 with Unknown Social Information

	Estimate	SE	t	p
Intercept	0.00	0.02	0.00	1.000
stSParent_anon	-0.05	0.10	0.51	0.609
R^2	0.00			
Adjusted R^2	-0.01			

Note. This table shows the coefficients of model 2.2 and the proportion of variation in the dependent variable that is predicted by the independent variable.

Figure F5

Analysis 1.2



Note. The graph shows the relationship between parents' S and children's S in the unknown condition. The blue line shows the correlation found in this study, indicating no association between the variables.

Analysis 2.2

Assumptions.

Linearity. The Residual vs Fitted plot (Figure F6) doesn't show a particular pattern other than approximately linear, thus linearity can be considered as met.

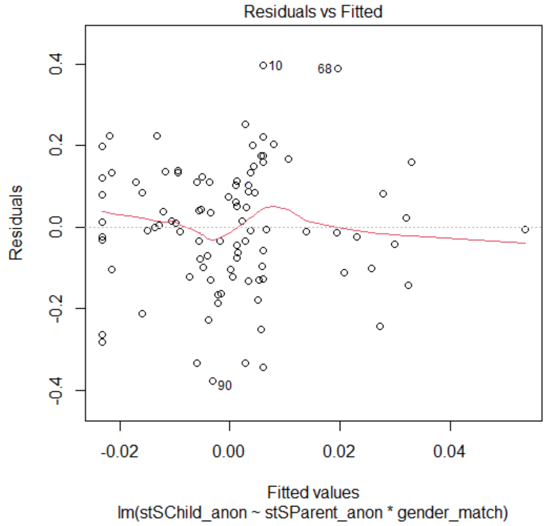


Figure F6. Residual vs Fitted plot for Analysis 2.2

Independence of Residuals and Normality of Residuals. In the QQ-plot (Figure F7), the residuals approximate a straight line, indicating independence and normality of residuals. The Shapiro-Wilk test also indicates normality (W=0.99, p=0.54).

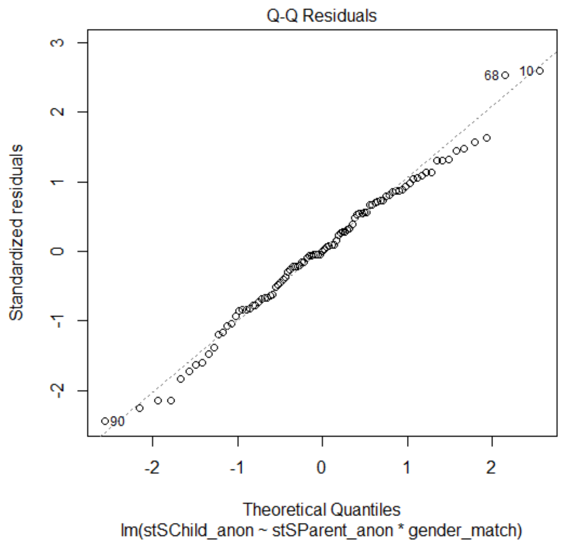


Figure F7. Quantile-Quantile plot for Analysis 2.2

Homoschedasticity. The Spread-Location plot (Figure F8) shows a steeper slope towards *x*=0.03, however that is due to the singular outlier in the right bottom corner. The rest of the residuals appear equally spread along the ranges of predictors.

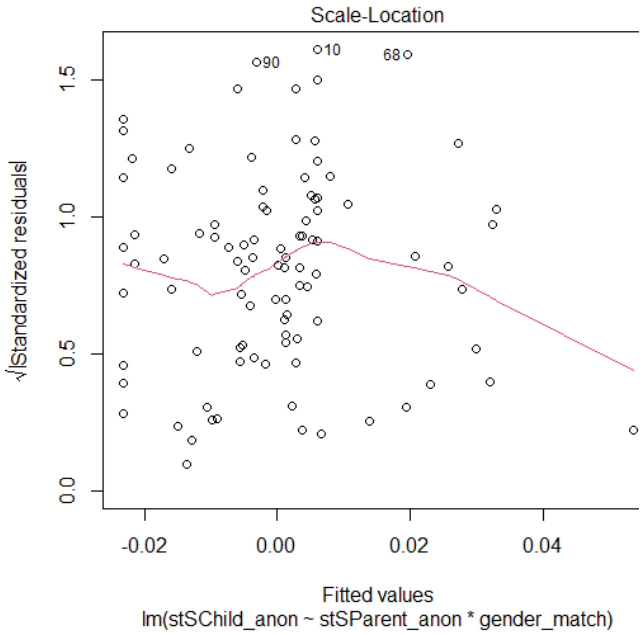


Figure F8. Spread-Location plot for Analysis 2.2

Multicollinearity. A test for multicollinearity shows the absence of a linear relationship between the independent variables (stSParent_anon, VIF = 1.76; gender_match, VIF = 1.01; stSParent_anon:gender_match, VIF = 1.75)

Influential Outliers. See evaluation for analysis 1.2.

Analysis results. No significant correlation was found between parents' *S* and children's *S* in the unknown condition when accounting for gender_match (F (3, 91) = 0.27, p = 0.845 R^2 = 0.01: see Figure F9). The model's coefficients can be found in Table F2.

Table F2

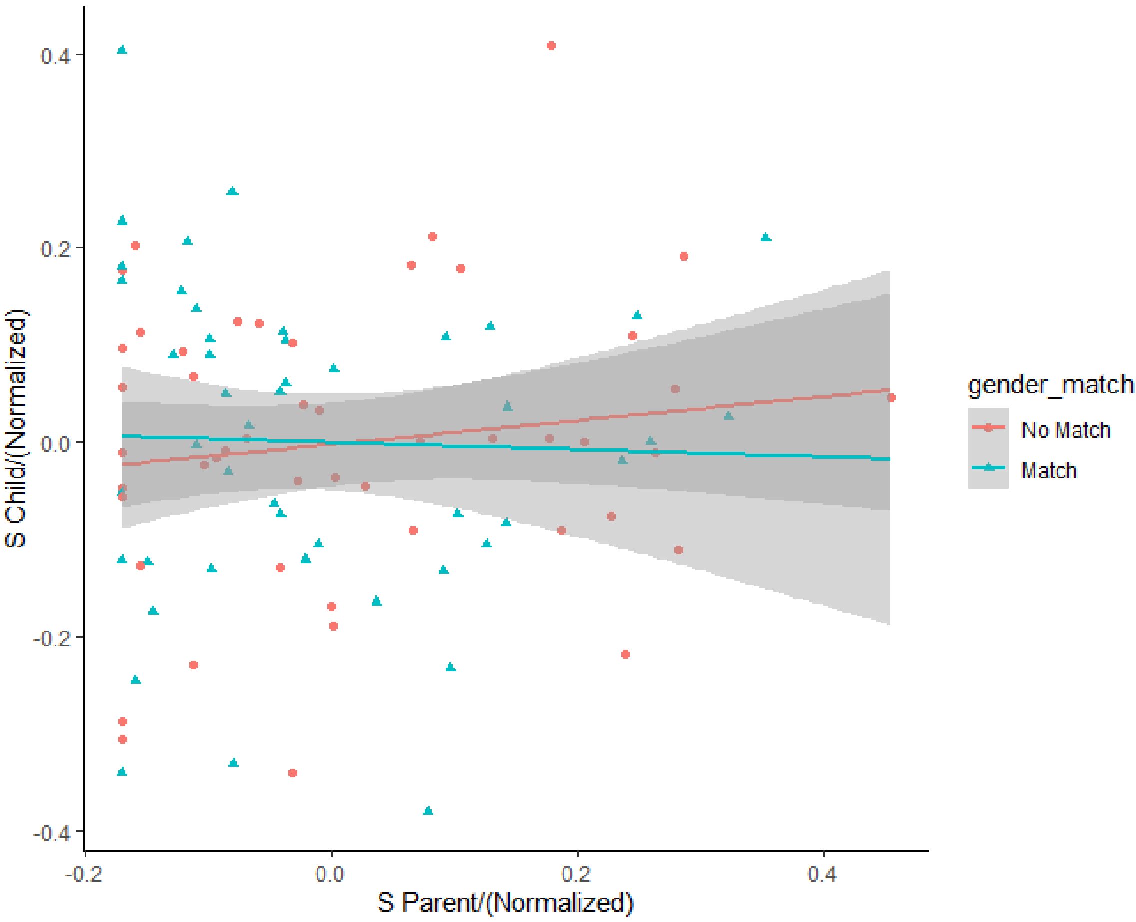
Regression Coefficients for Model 2.2 with Unknown Social Information

	Estimate	SE	t	p
Intercept	0.00	0.02	-0.10	0.922
stSParent_anon	0.12	0.14	0.88	0.384
gender_match	0.00	0.03	0.06	0.951
stSParent_anon * gender_match	-0.16	0.21	-0.74	0.459
R^2	0.01			
Adjusted R^2	-0.02			

Note. This table shows the coefficients of Model 2.2 and the proportion of variation in the dependent variable that is predicted from the independent variables.

Figure F9

Analysis 2.2



Note. The graph shows the relationship between parents' S and children's S when parents and offspring are of the same sex (in green) and when they are of the opposite sex (in orange). The graph shows no correlation between parents' and children's S, even after taking into account whether parents and offspring were of the same sex.