IS A GOOD BOT BETTER THAN A MEDIOCRE HUMAN?: CHATBOTS AS ALTERNATIVE SOURCES OF SOCIAL CONNECTION

by

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Abstract

Around the world, hundreds of millions of people have used social chatbots designed to provide companionship to their users. But can people reap genuine feelings of social connection and happiness from interacting with chatbots? Across four pre-registered studies (N = 1201), participants shared good news with an interaction partner whom they believed was either a chatbot or a human. The conversation partner responded in either a highly responsive or less responsive manner. Across the studies, interacting with a highly responsive chatbot was more rewarding than interacting with a less responsive human. Participants who believed they interacted with a highly responsive chatbot felt more rapport, were more socially connected, and were in a better mood than participants who interacted with a less responsive human. Despite their inherent lack of agency, chatbots that are programmed to respond in an optimal manner may deliver greater social benefits than suboptimal human conversation partners.

Lay Summary

Loneliness has been identified as a major public health problem (Cacioppo & Cacioppo, 2018), suggesting there is a pressing need to develop new strategies for helping people satisfy the fundamental human need for social connection. The present research investigated whether social chatbots—text applications designed to provide companionship to their users—have the potential to be meaningful sources of social connection. Participants shared good news with an interaction partner whom they believed was either a chatbot or a human. The conversation partner responded in either a highly responsive or less responsive manner. Across four studies, participants who believed they interacted with a highly responsive chatbot garnered more emotional benefits from the interaction than participants who interacted with a less responsive human. This research points to the optimistic conclusion that meaningful digital companionship with chatbots is a matter of overcoming engineering obstacles as opposed to psychological ones.

Preface

This thesis is largely based on a currently unpublished manuscript for which I was the primary author. I wrote the original drafts of each chapter. My supervisor Elizabeth Dunn then edited the portions of drafts with my assistance as we prepared them for publication. As such, there are sections of each chapter that are solely written by me, as well as portions that were edited into their current form by Elizabeth Dunn with my assistance. All data analyses were conducted by me alone. This project is approved by the Behavioral Research Ethics Board at the University of British Columbia under the certificate number H20-02433.

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Chapter 1: Introduction

1.1 Background

The 2013 Academy Award winning film "Her" follows a man who develops a close bond with his artificially intelligent virtual assistant (Jonze, 2013). Less than a decade later, over 660 million people have subscribed to Microsoft's Xiaoice, a social chatbot designed to offer long-term companionship and emotional connection (Zhou et al, 2020). Meanwhile, Google's Brain Team is developing a chatbot that can "chat about virtually anything a user wants" (Adiwardana & Luong, 2020; Adiwardana et al., 2020). Unlike virtual assistants, social chatbots are designed to provide companionship and social connection to their users. But can people reap genuine feelings of social connection and happiness from interacting with chatbots?

1.2 Chatbots As Social Partners

According to the Computers Are Social Actors Framework (CASA; Nass & Moon, 2000; Nass et al., 1994; Reeves & Nass, 1996), individuals instinctively perceive and interact with computers as if they are people. Our propensity to anthropomorphise (Waytz et al., 2010; Epley et al., 2008) further points to the potential for chatbots to provide social benefits comparable to a human counterpart. In line with this, people with a higher tendency to anthropomorphize (compared to a low tendency to anthropomorphize) rate virtual assistants more favorably (Li & Sun, 2021). Moreover, people prefer female virtual agents over male agents because of the propensity to perceive female agents as more human (Borau et al., 2021). As such, the psychological tendency to "see human" (Epley et al., 2007) may be enough for chatbots to be viable sources of social connection.

However, even a human-like chatbot may still fail to provide meaningful social benefits. Past research has shown that when determining whether something has a mind, people make judgements along two related dimensions. The first dimension consists of perceptions of "experience"—the capacity to be conscious, experience emotions, and have a personality. The second dimension consists of perceptions of "agency"—the capacity to exert self-control, have memory, recognize emotions, and think (Gray et al., 2007). While this research was initially limited to the domain of moral judgement, research has shown mind perception is associated with positive emotional responses to social interactions with digital agents (Fox et al., 2017) and increased customer satisfaction with hotel service robots (Yam et al., 2020). Chatbots lack both experience and agency (for brevity, we refer to the combination as "agency" throughout the paper). As such, chatbots' obvious lack of agency may prevent their human conversation partners from ever feeling like their digital friend truly "gets them" (see Pathway 1, Figure 1). Perceived understanding appears to be a core component of feeling socially connected (Morelli et al., 2014; Reis et al., 2017; Pollman & Finkenauer, 2009). Thus, even the most human-like chatbots may fail to provide the typical benefits of a social interaction between humans.

Despite these potential disadvantages, chatbots offer an important advantage over humans: chatbots can be programmed to respond in a highly supportive manner (see Pathway 2, Figure 1), whereas not all human beings are reliable providers of support. For example, in a study of 59 dating couples (Gable et al., 2004), participants were asked to rate how their partners typically responded when they shared good news (i.e., *capitalization;* Langston, 1994). While some participants endorsed items such as "my partner usually reacts to my good fortune enthusiastically" (reflecting an *active-constructive* style), others endorsed statements such as "he/she points out the potential problems or downsides of the good event" (reflecting an *active-*

destructive style). Having a partner who tended to respond in an active-constructive manner was associated with greater relationship satisfaction (Gable et al., 2004). Likewise, when participants in a lab experiment shared good news with a confederate, participants reported improved mood and felt more positively about their own good news if the confederate responded in an active-constructive manner (versus a less responsive manner; Reis et al., 2010). As such, while chatbots objectively lack agency in the true sense of the word, they can be programmed to interact in a way that gives users a subjective sense of agency. If chatbots can be programmed to respond to good news in an active-constructive (i.e., highly responsive) manner then interacting with a chatbot might actually be more rewarding than interacting with a less responsive human being.

Although developing this type of chatbot remains on the horizon, researchers have overcome current technological constraints using the "Wizard of Oz" methodology: participants are led to believe they are interacting with a digital agent, when in reality the digital agent is controlled behind the scenes by a member of the research team (Dahlback et al., 1993). In a study utilizing this methodology, participants interacted via text with a partner who they believed was either a chatbot or a human (Ho et al., 2018). In reality, their conversation partner was always a research assistant. Participants either disclosed a personal problem and their feelings about it (emotional disclosure) or discussed their schedule for the week (factual disclosure). Regardless of disclosure type, there were no significant differences in the benefits derived from the interactions with the "chatbot" or "human." However, the study had fewer than 25 participants per cell, meaning the null effect can be readily explained by inadequate power. The study did, however, find some evidence that participants acted differently when they thought their partner was a chatbot (vs. a human). This finding aligns with previous research showing that people's beliefs about their interaction partner affect their own behavior (e.g., Lucas et al.,

2014; Hill et al., 2015; Mou & Xu, 2017). Thus, if participants know that their interaction partner is a chatbot, they may behave differently than they usually would (see Pathway 3, Figure 1).

While some past research has investigated the social benefits of interacting with *existing* chatbot technology, these studies have lacked a meaningful comparison group. For example, in one study, participants were led to experience feelings of social exclusion, and then randomly assigned to either interact with an empathic chatbot or merely complete an online questionnaire (de Gennaro et al., 2020). The results revealed that participants who talked to the chatbot were in a more positive mood than those in the control condition. However, because the control condition only consisted of completing an online survey, the study only showed that interacting with a chatbot is more socially connecting than completing a solitary questionnaire. Other research with existing chatbot technology has similarly lacked a comparison condition in which participants had a social interaction with a real human being (e.g., Kramer et al., 2017; Fitzpatrick et al., 2017). As a result, we do not know how interacting with a chatbot compares to interacting with a real person.

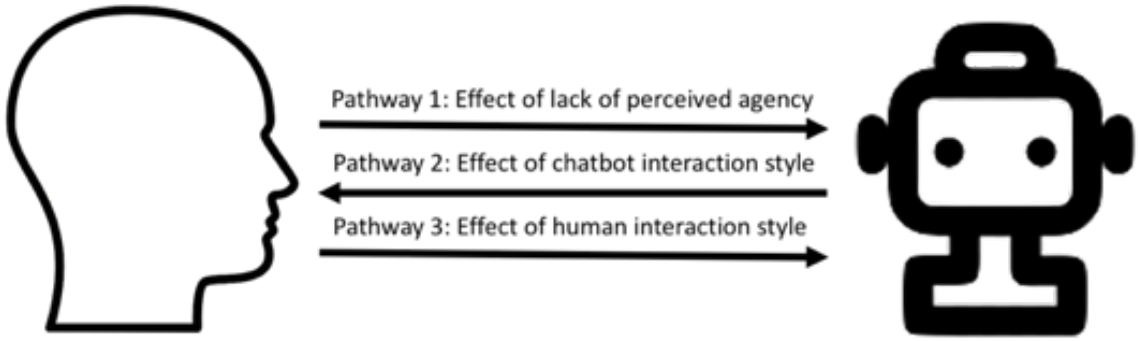


Figure 1: *Potential factors influencing benefits of interacting with chatbot*

1.3 The Present Research

We were interested in whether an optimally responding chatbot can provide a more rewarding social interaction than a sub-optimally responding human. In other words, do the benefits of interacting with a highly responsive partner (Pathway 2, Figure 1) outweigh any costs of knowing your partner is just a computer, rather than a human (Pathway 1, Figure 1)? Currently, testing this question is difficult because people might act strangely with a chatbot (Pathway 3, Figure 1), due to their novelty (e.g., people might try to "trip up" the chatbot). Thus, we examined the benefits of interacting with a chatbot when people only found out they were interacting with a bot after the conversation (Studies 1 and 2), as well as when they were told before the interaction (Studies 3 and 4). If a conversation partner's objective level of agency is an essential ingredient for feeling socially connected, then thinking that the partner was a chatbot should significantly reduce the social and emotional benefits of a positive social interaction. We propose, however, that people can derive genuine feelings of connection and happiness from engaging with a supportive partner—even if that partner is a computer.

Chapter 2: Study 1

2.1 Pre-registration

The detailed pre-registration for Study 1 is available on the Open Science Framework (OSF) at https://tinyurl.com/y58v4hcn.

2.2 Experimental Design

The study had a 2 (Response style) X 2 (Perceived conversation partner) design; participants shared positive news with either a more responsive or less responsive conversation partner and then were led to believe they interacted with either a human or a chatbot. When discussing the chatbot and human conditions, we take the point of view of the participant and describe the conditions as either "interacting with a chatbot" or "interacting with a human".

2.3 Procedure

To maximize the size and diversity of our sample, we recruited participants from both our university human subjects pool (in exchange for bonus course credit) and adults living in the United States or Canada from Prolific Academic (in exchange for $2.17 USD). The procedure was approved by our institution's review board. All participants first completed a consent form and answered a set of demographics questions. Next, participants described a positive event from the past three months that they would be comfortable sharing with a stranger. Participants were then informed they would interact with another participant in the study via text for 8 minutes. In reality, participants' conversation partner was *always* a trained research assistant. Participants were instructed to spend the entire interaction discussing their positive experience with the other "participant". The research assistants were trained to respond to the positive event disclosure in

either a highly responsive or less responsive manner[1]. See Appendix A for examples of these response styles.

Immediately after the interaction, the participants were informed that they had actually interacted with either a research assistant (human condition) or a chatbot (chatbot condition), rather than a fellow participant (research assistants were blind to condition assignment). After learning the "true" identity of their conversation partner, the participants completed measures of our dependent variables of interest.

2.4 Exclusion Criteria

As pre-registered, we excluded participants who did not send any messages during the text interaction (n = 30; typically due to technical difficulties with the chat platform), thereby failing to share any positive news. We also asked participants to report whether their interaction partner was a chatbot, research assistant, or another participant; as pre-registered, we excluded participants whose answer did not correspond to their assigned condition (n = 17 in the chatbot condition and n = 9 in the human condition). Participants also answered three yes-or-no questions assessing whether they perceived their conversation partner as highly responsive (e.g., "Did your interaction partner share your excitement about the positive experience you shared?"); participants in the highly responsive condition who answered "no" to all three questions were excluded (n = 1). Likewise, participants answered three questions assessing whether they perceived their conversation partner as low in responsiveness (e.g., "Did your interaction partner minimize the significance of the positive experience you shared?"); participants in the low responsiveness condition who answered "no" to all three questions were excluded (n = 26). This

[1] To minimize jargon, we use "highly responsive" and "less responsive" as short-hand for "active-constructive" and "active-destructive," respectively.

level of differential attrition suggests that the less responsive partner was not perceived as particularly negative by many participants. As a result of this differential attrition, we conducted supplementary "intent-to-treat" analyses including participants who failed the responsiveness manipulation check, which had no substantive effect on our results (see Appendix A).

2.5 Sample

In accordance with our pre-registered target, our final sample consisted of 400 participants after exclusions (age: $M = 24.47$, $SD = 8.86$; 68% women). Because of the novelty of this research, it was difficult to estimate an expected effect size, but this sample size gave us 80% power to detect main effects of approximately *Cohen's d* = .28 or greater and differences between individual conditions of $d = .35$ or greater (which is smaller than the typical effect size observed in social psychology; Richard et al., 2003).

2.6 Measures

To assess the benefits participants derived from the interaction, we measured their feelings of rapport with their conversation partner, as well as their overall feelings of social connection. We also assessed participants' positive feelings about the experience they shared, as well as their overall positive mood (see Table 1 for the measures used in the present analyses). We created composite scores for each of the measures by averaging participants' responses to the items in each measure, unless they answered less than 80% of the items (as pre-registered).

Table 1. *Measures used in Studies 1, 2, 3, and 4.*

Measure	α (Study 1)	α (Study 2)	α (Study 3)	α (Study 4)	# of items	Sample item	Source
Rapport (pre-registered)	.96	.97	.97	.97	15	I felt _____ toward my partner.[a]	Dwyer & Dunn, in prep
Social connection (pre-registered)	.94	.92	.95	.94	11	I had a sense of belonging.[b]	Lok & Dunn, in prep
Positive affect: PANAS (pre-registered)	.90	Not included	Not included	Not included	10	Enthusiastic.[c]	Watson et al., 1988
Positive affect: SPANE (pre-registered)	Not included	.94	.95	.95	6	Joyful.[c]	Diener et al., 2009
Feelings about experience (pre-registered)	.89	.91	.90	.90	5	How excited are you about the experience you identified? [d]	Created for present study
Positive affect: single item (exploratory)					1	Compared to how you normally feel, how do you feel right now? [e]	Adapted from Kumar & Epley, 2018
Perceived Agency (pre-registered)	Not included	Not included	.78	.79	4	During the interaction, to what extent Did you feel like your conversation partner had a mind of their own?[f]	Epley et al., 2008

Note: [a] = "very negative" (1) to "very positive" (5); [b]= "strongly disagree" (1) to "strongly agree" (7); [c] = "not at all" (1) to "extremely" (5); [d] = "not at all excited" (1) to "extremely excited" (10); [e] = "much more negative than normal" (-5) to "much more positive than normal" (5);[f]= "Strongly disagree" (1) to "Strongly agree" (6).

2.7 Results

To test our pre-registered research questions, we conducted 2 (Response style) X 2 (Perceived conversation partner) ANOVA's on our pre-registered dependent variables[2]. For each of our ANOVA models, we also conducted a planned contrast comparing the means between the highly responsive chatbot condition and the less responsive human condition (as pre-registered).

2.7.1 Pre-registered Analyses

2.7.1.1 Main effect of response style

Participants who engaged with a highly responsive conversation partner felt significantly higher levels of rapport (p <.001) and social connection (p <.001) and felt better about their positive experience (p =.029) than participants who engaged with a less responsive conversation partner. However, participants who interacted with the more responsive partner did not report higher levels of positive mood on the PANAS than those who interacted with a less responsive conversation partner (p = .248; see Table 2).

2.7.1.2 Main effect of perceived conversation partner

Participants who interacted with a chatbot did not significantly differ in rapport (p =.116), social connection (p =.454), feelings about the positive experience (p =.598), or positive mood (p =.875) compared to those who interacted with a human (see Table 3).

2.7.1.3 Interaction between perceived conversation partner and response style

The beneficial effects of interacting with a highly responsive partner did not depend on whether the partner was a human or chatbot; there was no significant Partner X Response Style interaction for rapport $F(1,396) = 0.002$, p =.967, social connection, $F(1,396) = 0.000$, p =.987,

[2] Due to unequal group sizes and homogeneity of variance (HOV) violations, we conducted robust ANOVA's on our rapport and social connection variables (the two variables that violated HOV assumptions). Results of these analyses were consistent with the non-robust analyses, aside from a significant main effect of conversation partner for our rapport variable. The analyses can be found in Appendix A.

feelings about the experience, $F(1,396) = 0.010$, $p = .752$, or positive mood $F(1,396) = 0.277$, $p = .599$.

2.7.1.4 More responsive chatbot vs. less responsive human

Participants who interacted with a more responsive chatbot reported significantly higher levels of rapport ($p < .001$) and social connection ($p < .001$) than those who interacted with a less responsive human. There were no significant differences in feelings about the positive experience ($p = .253$) or positive mood overall ($p = .366$; see Table 4).

2.7.2 Exploratory Analyses

Given that our pre-registered measure of positive mood did not seem sensitive to our response style manipulation, we conducted an exploratory analysis with our single-item measure of positive mood. Consistent with our other findings, there was a significant main effect of response style ($p < .001$; see Table 2), no main effect of perceived conversation partner ($p = .390$; see Table 3) and no significant interaction, $F(1,396) = 0.129$, $p = .72$. Likewise, participants who interacted with a highly responsive chatbot reported feeling better "right now" than those who interacted with a less responsive human ($p = .028$; see Table 4).

Table 2. *Main effect of response style (Study 1).*

	Mean (SD)					
	More responsive condition ($n = 211$)	Less responsive condition ($n = 189$)	*F*	*p*	*Cohen's d*	95% CI
Rapport	4.67 (0.86)	3.91 (1.03)	$F(1,396) = 64.056$	< .001	0.81	[0.60, 1.02]
Social connection	5.19 (1.00)	4.67 (1.25)	$F(1,396) = 21.646$	< .001	0.46	[0.26, 0.66]
Feelings about positive experience	6.47 (2.03)	6.02 (2.06)	$F(1,396) = 4.813$	.029	0.22	[0.03, 0.42]
Positive affect: PANAS	2.96 (0.91)	2.85 (0.89)	$F(1,396) = 1.339$	.248	0.12	[-0.08 0.31]
Positive Affect: single item	1.42 (1.93)	0.62 (1.92)	$F(1,396) = 16.614$	< .001	0.41	[0.21, 0.61]

Table 3. *Main effect of perceived conversation partner (Study 1).*

	Mean (SD) Chatbot condition (n = 198)	Human Condition (n = 202)	F	p	*Cohen's d*	95% CI
Rapport	4.22 (1.07)	4.41 (0.94)	$F(1,396) = 2.486$	.116	0.19	[-0.01, 0.38]
Social connection	4.97 (1.19)	4.92(1.12)	$F(1,396) = 0.563$	.454	0.05	[-0.15, 0.24]
Feelings about positive experience	6.19 (2.01)	6.32 (2.10)	$F(1,396) = 0.278$	.598	0.06	[-0.13, 0.26]
Positive affect: PANAS	2.91 (0.91)	2.90 (0.89)	$F(1,396) = 0.025$	.875	0.01	[-0.19, 0.21]
Positive Affect: single item	0.93 (1.94)	1.14 (1.99)	$F(1,396) = 0.740$	.390	0.11	[-0.09, 0.30]

Table 4. Contrast comparing more responsive chatbot to less responsive human (Study 1).

	Mean (SD) More responsive chatbot condition (n = 99)	Less responsive human condition (n = 90)	F	p	*Cohen's d*	95% CI
Rapport	4.60 (0.84)	3.99 (0.87)	$F(1,396) = 19.540$	< .001	0.71	[0.41, 1.01]
Social connection	5.24 (0.99)	4.62 (1.18)	$F(1,396) = 13.823$	< .001	0.56	[0.27, 0.86]
Feelings about positive experience	6.38 (1.94)	6.04 (2.05)	$F(1,396) = 1.313$	.253	0.17	[-0.11, 0.46]
Positive affect: PANAS	2.94 (0.93)	2.82 (0.89)	$F(1,396) = 0.818$	.366	0.13	[-0.15, 0.42]
Positive Affect: single item	1.36 (1.85)	0.74 (1.90)	$F(1,396) = 4.891$	.028	0.33	[0.04, 0.62]

2.8 Study 1 Discussion

In Study 1, participants who interacted with a highly responsive chatbot felt more rapport with their conversation partner and felt more socially connected overall than those who interacted with a less responsive human. We also replicated previous work showing the benefits of sharing a positive experience with a highly responsive conversation partner (Reis et al. 2010; Gable & Reis, 2010), and extended this work by demonstrating that response style mattered more

than whether the partner was a human or a computer. In Study 2, we sought to replicate our key finding that people are better off interacting with a more responsive chatbot than a less responsive human.

Chapter 3: Study 2

3.1 Pre-registration

The pre-registered sample size target, analysis plan, and exclusion criteria for Study 2 are available on the OSF at https://tinyurl.com/y3eupnzj.

3.2 Experimental Design

The procedure for Study 2 was identical to Study 1 aside from two changes: we only ran our two critical conditions (more responsive chatbot & less responsive human), and we replaced the PANAS with an alternate measure of mood. Specifically, we asked participants to report the intensity of emotions they experienced using positive and negative affect words from the Scale of Positive and Negative Experience (SPANE; Diener et al., 2009; see Table 1).

3.3 Exclusion Criteria

As in Study 1, we excluded participants who failed to share a positive experience (n = 13), failed the perceived conversation partner manipulation check (n = 26), or failed the response style manipulation check (n = 12)[3]. After exclusions, 96 participants were in the less responsive human condition and 104 participants were in the highly responsive chatbot condition.

3.4 Sample

Participants currently living in the United States and Canada were recruited from Prolific Academic in return for $2.17 USD. Because Study 2 had only two experimental conditions, we pre-registered a target sample size half that of Study 1 (N = 200). Our final sample size consisted

[3] Intent-to-treat analyses that includes these participants can be found in Appendix B. Results were consistent with our primary analyses.

of 200 participants (Age: $M = 33.00$, $SD = 11.44$; 47% women). As such, we had 80% power to detect effect sizes of *Cohen's d* = .35 or greater.

3.5 Pre-registered Hypotheses

In line with Study 1, we predicted that participants who interacted with a more responsive chatbot (vs. less responsive human) would feel more rapport with their conversation partner and more socially connected overall, as well as feel better about their positive experience and more positive overall.

3.6 Results

3.6.1 Pre-registered Analyses

To test our directional predictions, we conducted four one-tailed independent samples t-tests, as pre-registered. Participants who interacted with a highly responsive chatbot felt significantly higher levels of rapport ($p < .001$), social connection ($p < .001$), and positive mood ($p = .012$), than participants who interacted with a less responsive human. Participants who interacted with the highly responsive chatbot also felt slightly better about the positive experience they shared, but this difference was marginally significant ($p = .062$; see Table 5 for detailed t-test results for each of the four comparisons).

Table 5. *Means and t-test results (Study 2)*

Outcome Variable	Mean (SD)						
	More responsive chatbot ($n = 104$)	Less responsive human ($n = 96$)	*t*	*df*	*p*	*Cohen's D*	*95% CI*
Rapport	4.86 (0.76)	4.04 (1.13)	5.97	164.6	<.001	0.86	[0.56, 1.16]
Social connection	5.19 (0.99)	4.61 (1.19)	3.68	185.52	<.001	0.52	[0.24, 0.81]
Positive affect: SPANE	3.48 (0.95)	3.14 (1.13)	2.28	186.16	.012	0.32	[0.04, 0.60]
Feelings about positive experience	6.43 (2.13)	5.95 (2.20)	1.54	195.51	.062	0.22	[-0.06, 0.50]

3.7 Study 2 Discussion

Study 2 replicated our key findings that people who interacted with a more responsive chatbot felt higher levels of social connection and rapport than those who interacted with a less responsive human. In addition, people who interacted with a more responsive chatbot (vs. less responsive human) reported somewhat more positive feelings about their experience and significantly more positive moods overall.

Why do people derive such benefits from interacting with a chatbot that inherently lacks agency? It is possible that people's capacity for anthropomorphism enabled them to feel as though the chatbot had agency, given that the chatbot responded to them in a humanlike manner. We propose, however, that people perceive chatbots (vs. humans) as much lower in agency, but that this effect only partially suppresses the substantial pleasure of interacting with a highly responsive conversation partner. In Studies 3 and 4, we measured perceived agency to investigate these competing explanations.

An important limitation of Studies 1 and 2 was that participants were not told the "true" identity of their conversation partner until after the interaction. We did this to ensure participants in the chatbot condition did not behave differently than those in the human condition. However, it is possible participants failed to update their thoughts about the conversation based on the new information about the identity of their conversation partner. In Studies 3 and 4, we addressed this limitation by telling participants they would be interacting with a chatbot (or a fellow participant) prior to the interaction.

Chapter 4: Study 3

4.1 Pre-registration

The pre-registered sample size target, analysis plan, and exclusion criteria for Study 3 are available on the OSF at https://tinyurl.com/mn7v9njd.

4.2 Experimental Design

The procedure for Study 3 was identical to Study 2 except participants were told that they would be interacting with either a chatbot or a fellow participant prior to the conversation (they were not told that they had actually interacted with a research assistant until the post-experimental debriefing). In addition, as pre-registered, we included a measure of perceived agency (see Table 1) that has been used in previous research on anthropomorphism (Epley et al., 2008). While all participants presumably know that a chatbot objectively lacks agency, this measure captured how participants felt about their partner during the interaction. For example, participants indicated the extent to which they felt their partner "had a mind of their own" and "experienced emotions".

4.3 Exclusion Criteria

As in Studies 1 and 2, participants who failed to share a positive experience (n = 15), failed the perceived conversation partner manipulation check (n = 27), or failed the response style manipulation check (n = 20)[4] were excluded. After exclusions, 88 participants were in the less responsive human condition and 112 participants were in the highly responsive chatbot condition.

[4] Intent-to-treat analyses that include these participants can be found in Appendix C. Results were consistent with our primary analyses.

4.4 Sample

Similar to Study 1, we recruited participants from Prolific Academic (for $2.17 USD) and our university's Human Subject Pool (for course credit). As Study 3 was a conceptual replication of Study 2, we pre-registered the same sample size target (N = 200). Our final sample size consisted of 200 participants (Age: M = 30.26, SD = 11.26; 57% women). Thus, we had 80% power to detect effect sizes of *Cohen's d* = .35 or greater.

4.5 Pre-registered Hypotheses

As in Studies 1 and 2, we predicted that participants who interacted with a more responsive chatbot (vs. less responsive human) would feel more rapport and more social connection, as well as feel better about their positive experience and more positive overall. Additionally, we predicted that participants would perceive less agency in the highly responsive chatbot (compared to the less responsive human) condition, and that this would partially suppress the benefits of interacting with the chatbot.

4.6 Results

4.6.1 Pre-registered Analyses

We again conducted 4 one-tailed independent samples t-tests to assess whether participants who interacted with the highly responsive chatbot derived more emotional benefits than those who interacted with the less responsive human. Participants who interacted with a highly responsive chatbot felt significantly higher levels of rapport ($p < .001$), social connection ($p = .009$), positive mood ($p < .001$), and felt better about their positive experience ($p = .025$) compared to participants who interacted with a less responsive human (see Table 6 for detailed results).

Table 6. *Means and t-test results (Study 3)*

Outcome Variable	Mean (SD)						
	More responsive chatbot (n = 112)	Less responsive human (n = 88)	*t*	*df*	*p*	*Cohen's D*	*95% CI*
Rapport	4.91 (0.83)	3.81 (1.14)	7.57	153.07	< .001	1.12	[0.80, 1.43]
Social connection	5.14 (1.18)	4.75 (1.13)	2.37	190.25	.009	0.34	[0.05, 0.62]
Positive affect: SPANE	3.78 (0.84)	3.23 (1.14)	3.77	152.24	< .001	0.56	[0.27, 0.84]
Feelings about positive experience	6.84 (1.89)	6.24 (2.34)	1.97	165.41	.025	0.29	[0.01, 0.57]

As pre-registered, we also investigated whether perceived agency suppressed any of the benefits of interacting with the highly responsive chatbot compared to a less responsive human. Perceived agency did not significantly suppress the relationship between perceived conversation partner and any of our four outcome variables (p's > .17; see Table 7 for detailed results). Contrary to our pre-registered prediction, the mediation estimates for perceived agency were positive for each of our outcome variables; as expected, perceived agency was positively correlated with most of our dependent measures (see Table 8), but if anything, people tended to perceive slightly more agency in the highly responsive chatbot (M = 4.46, SD = 0.98) than the less responsive human (M = 4.27, SD = 0.94), t(190.58) = 1.43, p = .153.

Table 7. *Perceived agency mediating the effects of interacting with a highly responsive chatbot compared to less responsive human*

	Estimate	95% CI	*p*
Mediation 1: Rapport as outcome variable			
Indirect effect (Partner is chatbot →Perceived agency→ Rapport)	0.08	[-0.03, 0.20]	.17
Direct effect (Partner is chatbot → Rapport)	1.02	[0.74, 1.27]	< .001
Total effect	1.09	[0.79, 1.37]	< .001
Mediation 2: Social connection as the outcome variable			
Indirect effect (Partner is chatbot →Perceived agency→ Social connection)	0.07	[-0.03, 0.20]	.172
Direct effect (Partner is chatbot → Social connection)	0.31	[0.00, 0.62]	.050
Total effect	0.39	[0.05, 0.70]	.028
Mediation 3: Positive affect as the outcome variable			
Indirect effect (Partner is chatbot →Perceived agency→ Positive affect)	0.06	[-0.03, 0.16]	.220
Direct effect (Partner is chatbot → Positive affect)	0.49	[0.21, 0.76]	<.001
Total effect	0.55	[0.25, 0.83]	< .001
Mediation 4: Feelings about positive experience as the outcome variable			
Indirect effect (Partner is chatbot →Perceived agency→ Feelings about experience)	0.05	[-0.03, 0.17]	.282
Direct effect (Partner is chatbot → Feelings about experience)	0.56	[-0.06, 1.14]	.088
Total effect	0.60	[-0.03, 1.19]	.062

Note: estimates obtained using 1000 bootstrapped samples

Table 8. Correlations (Study 3)

	1	2	3	4	5
1. Perceived agency	1				
2. Rapport	.38[a]	1			
3. Social connection	.32[a]	.51[a]	1		
4. Positive affect: SPANE	.32[a]	.57[a]	.60[a]	1	
5. Feelings about positive experience	.12[b]	.35[a]	.42[a]	.54[a]	1

Note: [a]= p <.001; [b] = p < .10

4.8 Study 3 Discussion

Study 3 replicated our key finding that people derive greater emotional benefits from a highly responsive chatbot compared to a less responsive human. Importantly, this effect remained even though participants were made aware of the identity of their conversation partner (chatbot or fellow participant) prior to the conversation. The results of the mediation with

perceived agency suggested that response style played a larger role in perceptions of agency than the identity of the conversation partner. In Study 4, we sought to both replicate our key findings and address the problem of the unbalanced design by using the full study design used in Study 1.

Chapter 5: Study 4

5.1 Pre-registration

The pre-registration for Study 4 is available on the OSF at https://tinyurl.com/tfkhk3cs.

5.2 Experimental Design

Study 4 was identical to Study 3 but used the full 2 (Response Style) x 2 (Conversation partner) design of Study 1. Information on the outcome measures is available in Table 1.

5.3 Exclusion Criteria

As pre-registered, participants who did not share a positive experience (n = 47), failed the perceived conversation partner (n = 39) or the response style (n = 24 in less responsive condition; n = 2 in highly responsive condition)[5] manipulation check were excluded (see Tables 9-11 for information on the number of participants per condition).

5.4 Sample

Participants were recruited from Prolific Academic in return for $2.17 USD. As Study 4 was a replication of Study 1, we pre-registered the same sample size (N = 400). Our final sample consisted of 401 participants (Age: M = 32.67, SD = 11.25; 48% women). As such, we had 80% power to detect effect sizes of *Cohen's d* = .35 or greater between the individual conditions, and main effects of approximately *Cohen's d* = .28 or greater.

[5] Intent-to-treat analyses that include these participants can be found in Appendix D, the results are consistent with the main analyses.

5.5 Pre-registered Research Questions and Hypotheses

We had the same pre-registered hypotheses and research questions as in Study 1. Additionally, we pre-registered mediation/suppression analyses to investigate whether agency mediated/suppressed any of the effects of interacting with a chatbot compared to a human.

5.5 Results

We conducted 2 (Response style) X 2 (Conversation partner) ANOVA's on our pre-registered dependent variables[6]. For each variable, we also conducted one-tailed t-tests to assess whether people derived greater benefits from the highly responsive chatbot compared to the less responsive human (as pre-registered). We also investigated the role of perceived agency as a mediator.

5.5.1 Pre-registered Analyses

5.5.1.1 Main effect of response style

Participants who interacted with a highly responsive conversation partner felt significantly higher levels of rapport (p <.001) and social connection (p <.001) and were in a more positive mood (p <.001) than those who engaged with a less responsive conversation partner (see Table 8). In contrast, participant's feelings about their positive experience did not significantly differ based on the response style of their conversation partner (p = .156; see Table 9).

[6] Due to unequal group sizes and homogeneity of variance (HOV) violations, we conducted robust ANOVA's on our rapport and social connection variables (the two variables that violated HOV assumptions). Results of these analyses were consistent with the non-robust analyses and can be found in Appendix D.

5.5.1.2 Main effect of perceived conversation partner

Compared to those who interacted with a human, participants who interacted with a chatbot did not significantly differ in rapport (p =.419), social connection (p =.573), feelings about their positive experience (p =.870), or positive mood (p =.281; see Table 10).

5.5.1.3 Interaction between perceived conversation partner and response style

There was no significant interaction for feelings of rapport $F(1,397) = 1.85$, p =.174 or positive mood $F(1,397) = 1.76$, p =.185. However, there was a significant Response Style X Partner interaction for thoughts about the positive experience $F(1,397) = 8.65$, p =.003 and social connection, $F(1,396) = 4.95$, p =.027. To illuminate the nature of the two significant interaction effects, we conducted simple effects analyses comparing the chatbot and human partners within the highly responsive and less responsive conditions. Participants who interacted with a highly responsive human (vs. highly responsive chatbot) felt somewhat better about their positive experience (p = .056, d = .26) and felt marginally higher levels of social connection (p = .052, d = .27; see Table 11). Participants who interacted with a less responsive human (vs. less responsive bot) felt significantly worse about their positive experience (p = .026, d = 0.32), but not significantly less socially connected (p = .22, d = 0.17; see Table 12). Thus, a positive interaction was marginally more rewarding when it came from a human (compared to a bot), but a less responsive style was also somewhat more detrimental coming from a human; these results suggest that people's feelings may be influenced more strongly—both for better and for worse—by a human than by a bot.

5.5.1.4 More responsive chatbot vs. less responsive human

Participants who interacted with a highly responsive chatbot reported significantly higher levels of rapport (p < .001), social connection (p =.025) and more positive mood (p = .005) than

those who interacted with a less responsive human. There were no significant differences for participants' feelings about their positive experience (p = .11; see Table 13).

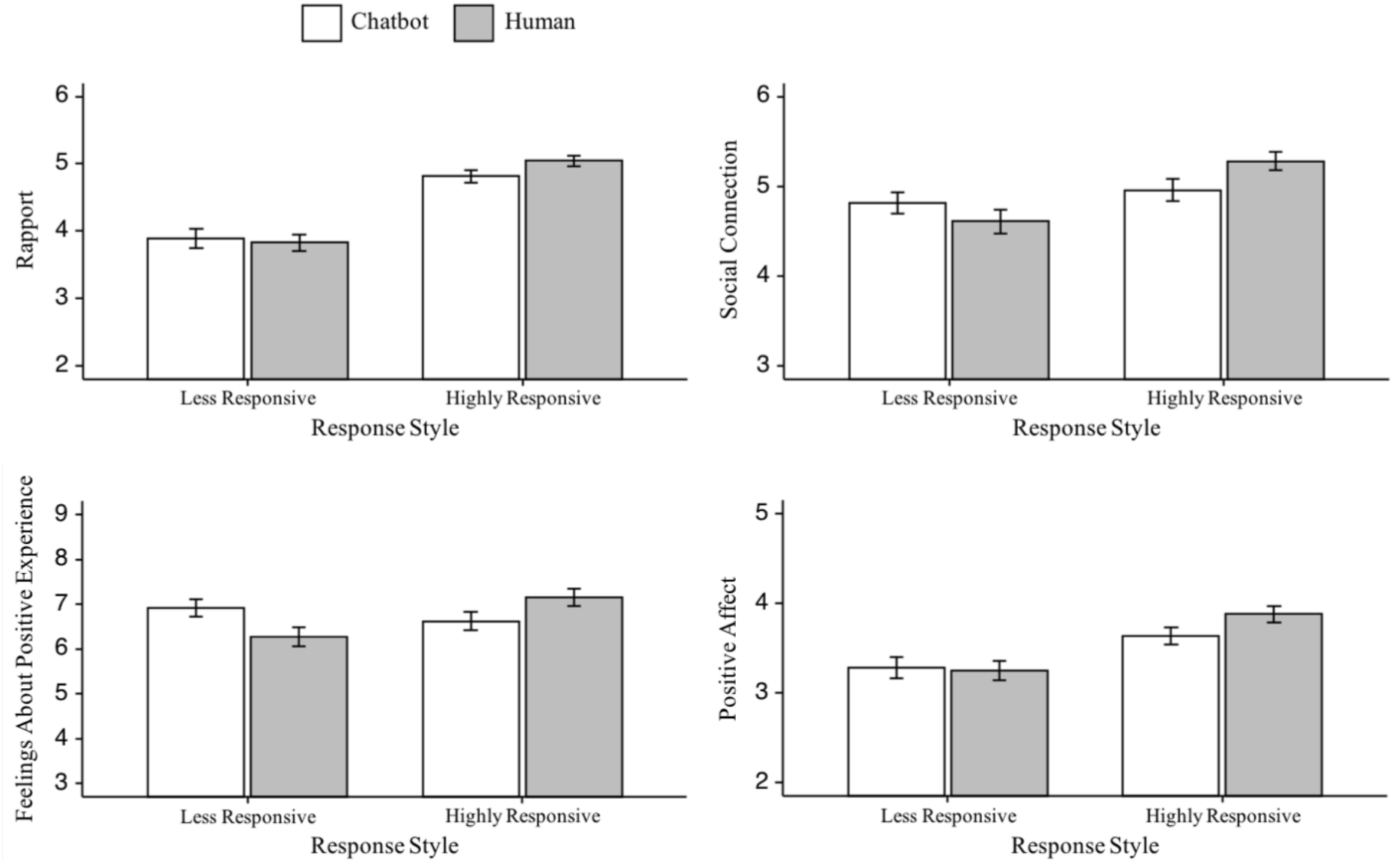
Table 9. *Main effect of response style (Study 4).*

	Mean (SD) More responsive condition (n = 210)	Mean (SD) Less responsive condition (n =191)	*F*	*p*	*Cohen's d*	95% CI
Rapport	4.92 (0.90)	3.85 (1.27)	95.98	<.001	0.98	[0.76, 1.20]
Social connection	5.11 (1.22)	4.71 (1.22)	11.35	<.001	0.34	[0.13, 0.53]
Feelings about positive experience	6.88 (1.99)	6.60 (2.00)	2.01	.156	0.14	[-0.06, 0.34]
Positive affect: SPANE	3.75 (0.98)	3.27 (1.10)	22.38	<.001	0.47	[0.27, 0.67]

Table 10. *Main effect of perceived conversation partner (Study 4).*

	Mean (SD) Chatbot condition (n = 205)	Mean (SD) Human Condition (n = 196)	*F*	*p*	*Cohen's d*	95% CI
Rapport	4.38 (1.26)	4.45 (1.16)	0.65	.419	0.06	[-0.14, 0.25]
Social connection	4.89 (1.22)	4.95 (1.21)	0.32	.573	0.05	[-0.15, 0.25]
Feelings about positive experience	6.76 (1.97)	6.72 (2.02)	0.03	.870	0.02	[-0.18, 0.21]
Positive affect: SPANE	3.47 (1.10)	3.57 (1.03)	1.17	.281	0.10	[-.10, 0.29]

Figure 2: *Breakdown of conversation benefits by condition and pre-registered outcome variable (Study 4)*



Note: Error bars = standard error of the mean.

Table 11. *Means and results of simple effects analysis comparing the highly responsive chatbot condition to the highly responsive human condition (Study 4).*

Outcome Variable	Mean (SD)					
	Highly responsive chatbot (n = 109)	Highly responsive human (n = 101)	*t*	*p*	*Cohen's D*	*95% CI*
Social connection	4.96 (1.28)	5.28 (1.05)	1.95	.052	0.27	[-0.00, 0.55]
Feelings about positive experience	6.63 (2.05)	7.15 (1.89)	1.91	.056	0.26	[-0.01, 0.54]

Note: all t-tests are two-tailed.

Table 12. *Means and results of simple effects analysis comparing the less responsive chatbot condition to the less responsive human condition (Study 4).*

Outcome Variable	Mean (SD)					
	Less responsive chatbot (n = 96)	Less responsive human (n = 95)	*t*	*p*	*Cohen's D*	*95% CI*
Social connection	4.81 (1.16)	4.60 (1.27)	-1.22	.22	0.17	[-0.11, 0.46]
Feelings about positive experience	6.91(1.90)	6.27 (2.07)	-2.24	.0257	0.32	[0.04, 0.061]

Note: all t-tests are two-tailed.

Table 13. *Means and t-test results (Study 4).*

Outcome Variable	Mean (SD)						
	More responsive chatbot (n = 109)	Less responsive human (n = 95)	*t*	*df*	*p*	*Cohen's D*	*95% CI*
Rapport	4.81 (0.96)	3.82 (1.16)	6.59	183.51	<.001	0.94	[0.63, 1.24]
Social connection	4.96 (1.28)	4.60 (1.27)	1.97	198.01	.025	0.28	[-0.01, 0.56][a]
Positive affect: SPANE	3.64 (1.05)	3.25 (1.07)	2.62	197.31	.005	0.37	[0.08, 0.65]
Feelings about positive experience	6.63 (2.05)	6.27 (2.06)	1.22	197.62	.110	0.17	[-0.11, 0.45]

Note: [a]= t-test is one-tailed; as such, the 95% CI includes 0, even though the t-test is significant

5.5.1.5 The role of perceived agency as a mediator

Notably, participants did not perceive significantly lower levels of agency in a chatbot (M = 4.46; SD = 1.23) compared to a human conversation partner (M = 4.58; SD = 1.16), $t(398.93) = 0.99$, $p = .322$ (two-tailed). It appears the human capacity for anthropomorphism

enabled them to perceive agency in a chatbot who responded in a humanlike manner. Because there was no difference between conditions in perceived agency, this variable did not mediate the effects of conversation partner (chatbot vs human) for any of our pre-registered outcome variables (*p*'s > .34), even though perceived agency was positively correlated with all of our outcome variables (see Table 14). However, participants interacting with a highly responsive partner did perceive marginally higher levels of agency (*M* = 4.62 ; *SD* = 1.26) in their conversation partner than those who interacted with a less responsive partner (*M* = 4.40, *SD* = 1.11), *t*(398.55) =1.82, *p* = .069 (two-tailed). As such, perceptions of agency appear to be influenced more by response style than by the humanity of one's partner.

Table 14. *Correlations (Study 4).*

	1	2	3	4	5
1. Perceived agency	1				
2. Rapport	.45[a]	1			
3. Social connection	.34[a]	.61[a]	1		
4. Positive affect: SPANE	.26[a]	.59[a]	.62[a]	1	
5. Feelings about positive experience	.27[a]	.32[a]	.43[a]	.52[a]	1

Note: [a] = $p < .001$

5.6 Study 4 Discussion

Study 4 replicated our key finding that interacting with a highly responsive chatbot yielded greater emotional benefits than interacting with a less responsive human. We again found no differences in the overall benefits of interacting with a human compared to a chatbot. However, this finding should be interpreted with caution given that we found some evidence that the effects of interacting with a human compared to a chatbot depended on the response style of the conversation partner (see Figure 2). Lastly, exploratory analyses suggested that participants

were anthropomorphising their chatbot conversation partners, as there were no significant differences in perceptions of agency between the human and chatbot conditions.

Chapter 6: Internal Meta-Analyses

6.1 Analyses

To obtain an overall estimate of the emotional benefits of interacting with a highly responsive chatbot compared to a less responsive human, we conducted an internal random effects meta-analyses of each of our four pre-registered variables across Studies 1-4 using the procedure described in Goh et al., 2016. Estimates for the effect size of each outcome variable were obtained by averaging the Cohen's *d*'s from each study. Each study was equally weighted when calculating the mean, and the *p*-value for the overall effect size was obtained using a one-sample t-test.

6.2 Results

The results of the meta-analyses for the comparison between the highly responsive chatbot and less responsive human conditions can be found in Table 15. Across our four studies, participants who interacted with a highly responsive chatbot (compared to a less responsive human) felt significantly higher levels of rapport ($d = 0.91$, $p = .002$), social connection ($d = 0.43$, $p = .008$), positive mood ($d = 0.35$, $p = 0.03$) and felt better about their positive experience ($d = 0.21$, $p = .005$).

Table 15. *Internal meta-analyses for comparison between highly responsive chatbot and less responsive human.*

Outcome Variable	Cohen's *d*					*p* (overall estimate)
	Study 1	Study 2	Study 3	Study 4	Overall estimate	
Rapport	0.71	0.86	1.12	0.94	0.91	.002
Social connection	0.56	0.52	0.34	0.28	0.43	.008
Positive affect[a]	0.13	0.32	0.56	0.37	0.35	.030
Feelings about positive experience	0.17	0.22	0.29	0.17	0.21	.005

Note: [a] = Study 1 estimate obtained using PANAS; studies 2-4 estimates obtained using SPANE.

Chapter 7: General Discussion

Across four studies, participants who believed they interacted with a highly responsive chatbot felt more rapport, were more socially connected, were in a better mood, and felt better about their positive experience than participants who interacted with a less responsive human. Moreover, the benefits of interacting with a highly responsive chatbot were similar regardless of whether participants were told their conversation partner was a chatbot after the interaction (Studies 1-2) or beforehand (Studies 3-4). Despite their inherent lack of agency, chatbots that are programmed to respond in an optimal manner may deliver greater social benefits than suboptimal human conversation partners.

Remarkably, in our studies using the full 2X2 design (Studies 1 & 4), we found no significant main effect of partner (human vs. chatbot) on any of our measures. Both studies were powered to detect small-to-medium effects (d = 0.28), suggesting that any benefit of interacting with a human (vs. chatbot) may be relatively small—and may be easily outweighed by the benefit of an optimal response style. It is also worth noting, however, that in Study 4 people derived marginally greater benefits talking to a highly responsive human compared to a highly responsive chatbot, suggesting participants were not insensitive to the identity of their conversation partner. Of course, it is also possible that participants in the chatbot condition did not believe they actually interacted with a chatbot, eliminating any effect of our manipulation. Across all studies, however, only about 4% of participants expressed strong disbelief that they interacted with a chatbot when asked if there was anything suspicious about the study. Indeed, some participants in Studies 1 and 2 actually indicated they had known it was a chatbot all along (e.g., “I immediately identified that I was chatting with a chatbot”). Even when participants were told they would be interacting with the bot prior to the conversation (Studies 3 & 4), only 21% of

participants indicated having any doubts or feelings of surprise about the identity of their chatbot conversation partner, and 68% of participants had no suspicions at all.

A separate explanation for why participants derived similar benefits in our chatbot and human conditions involves differential responding based on the identity of participant's conversation partners. It is conceivable that when answering questions that referred to their conversation partner specifically (e.g., "I felt in harmony with my interaction partner") participants in the chatbot condition were more likely to respond positively because their partner was relatively good for a chatbot. This does not explain our results, however, as three of our four outcome variables did not refer to participant's conversation partner directly. Instead, these measures (e.g., social connection) asked participants to respond to items about their feelings in general (e.g., "I felt l like I belonged").

Instead, a more likely explanation for the apparent lack of difference between chatbot and human conversation partners is that participants tended to anthropomorphize the chatbot. Our findings provide support for the CASA framework (e.g., Nass & Moon, 2000; Nass et al., 1994), which posits that people instinctively perceive computers as human. In Studies 3 and 4, participants perceived the chatbot as possessing similar levels of agency as a human. While we assume that participants objectively recognized that chatbots lack conscious experience, they apparently still felt *as though* the chatbot had a mind. This finding dovetails with classic research showing that people readily anthropomorphize objects, by for example, perceiving a larger triangle as "bullying" a smaller one (see video here: https://tinyurl.com/y8rc6ntt; Heider & Simmel, 1944). Perhaps then, it is not so surprising that human beings readily perceive agency in a chatbot who responds to their good news with interest and personalized engagement. Indeed,

participants' perceptions of agency were influenced more by their partner's response style than by their partner's identity as a human or computer.

Because our studies lacked a control group in which participants did not share their good news, we cannot determine whether interacting with a responsive partner made people feel better or interacting with a less responsive partner made people feel worse. However, past research has shown that people feel better after sharing positive experiences with a responsive partner than after simply writing about them (Reis et al., 2010). In our studies, we found that participants reported feeling more positive than usual even after interacting with the less responsive partner, perhaps because the "active-destructive" style employed in the less responsive condition could be interpreted as a form of caring (e.g., "Are you worried your new puppy will be too much work?").

We chose to focus on sharing good news because this represents a common and enjoyable form of social interaction. Using daily diaries, Gable and colleagues (2004) found that people share the best news of the day on 70% of days and sharing news from one's day appears to be common among chatbot users (Metz, 2020). Nevertheless, our methodology could be readily adapted to study other forms of social interaction, from sharing bad news to discussing politics or the weather.

Our methods could also be used to study whether older or younger people benefit more from interacting with supportive chatbots. The average age of participants in the present set of studies was 29, although ages ranged from 17 to 79 years old. Technological companions such as social robots have been gaining traction as antidotes to loneliness in the elderly (e.g., Engelhardt, 2021), suggesting that chatbots could also be helpful for that demographic, as well as any group of people prone to feelings of loneliness. Future research should also investigate the benefits of

chatbot use over time. We only explored the benefits of interacting with a chatbot (vs. human) in a single interaction. Thus, it is possible that the benefits of interacting with a chatbot could decline over time as the novelty of using such technology declines. However, perceptions of agency seem unlikely to decline as novelty decreases, suggesting people may be able to reap benefits from continued interaction with a chatbot.

It is worth underscoring that our findings do not suggest people should opt for a supportive chatbot over a supportive human. Rather, if a supportive human partner is not an option, people could benefit from opting for a positive chatbot. Given that nearly 25% of a nationally representative sample of American adults reported having no one in their lives to discuss important matters with (Mcpherson et al., 2006), the population of people who could benefit from chatbots appears to be large. On the whole, much research is needed to better understand when and for whom chatbots can offer viable alternative sources of social connection. That said, our research offers initial evidence that meaningful digital companionship with chatbots is a matter of overcoming engineering obstacles as opposed to psychological ones.

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Appendices

Appendix A: Supplemental Materials, Chapter 2

Other Participant	Hello!
Me	Hi
Other Participant	So what's the positive news or experience you're sharing with me?
Me	I am an academic and I have published one of my work in a very good academic journal
Other Participant	Congratulations! That's great news
Me	It made me so happy because I worked on the piece for more than a year
Other Participant	Yes, that sounds like a lot of hard work.
Me	Thanks, indeed it was
Other Participant	Did you do anything to celebrate?
Me	Nothing very special but yeah
Me	I shared the news on my social media accounts

Figure. Excerpt from conversation in high responsiveness condition (viewed from perspective of the study participant, such that "Other Participant" is the research assistant).

Me	I got a puppy!
Other Participant	Interesting
Other Participant	That sounds like a lot of responsibility having to take care of it though
Other Participant	If I were you, I'd be most nervous about juggling school, having to work, and then making sure I care for it and give it the attention it deserves and needs.
Me	it is, it's been really hectic
Me	but he's the best thing that's ever happened to me
Me	my cousins and I take care of him together
Me	so it hasn't been that tad
Other Participant	Aren't you worried it'll be a little too overwhelming?
Me	Yeah, we were but it has been over a month now so I got used to it

Figure. Excerpt from conversation in low responsiveness condition (viewed from perspective of the study participant, such that "Other Participant" is the research assistant).

Robust Analyses

As a result of unequal group sizes, our 2x2 ANOVA's were susceptible to homogeneity of variance (HOV) violations. Brown-Forsythe tests revealed that HOV was not violated for our measures of feelings about the positive experience, F (3,396) = 0.374, p = .772 or positive mood, F (3,396) = 0.082, p = .970. However, Brown-Forsythe tests did reveal that HOV was violated for our measures of rapport, F (3,396) = 5.313, p = .001 and social connection, F (3,396) = 4.527, p = .004. Therefore, we conducted two separate ANOVA's that were robust to HOV violations. First, we conducted A 20% trimmed means ANOVA using the "WRS2" package in R (Field et al., 2012). As a second robust analysis, we randomly dropped participants from each condition to reach an equal sample size of 90 participants per condition (and thus escaping the effects HOV violations). Lastly, in place of the planned contrasts comparing the more responsive chatbot condition to the less responsive human condition, we conducted Welch's independent samples t-tests, which are robust to HOV violations. The results of these analyses with our rapport and social connection variables are presented below.

Main effect of Response Style. Consistent with the pre-registered analyses, the 20% trimmed means analysis resulted in a significant main effect of response partner for both social connection F = 15.588, p < .001 and rapport, F = 51.689, p < .001. Likewise, the equal group size analyses resulted in similarly consistent findings for social connection F(1,356) = 19.239, p < .001 and rapport F(1,356) = 59.153, p < .001 (see Table A1).

Main effect of perceived conversation partner. The results of the trimmed means analyses for social connection, F = 0.292, p = .590 and rapport, F= 2.532, p = .114 were consistent with the pre-registered analyses. While the equalized group sizes analysis was

similarly non-significant for social connection, $F(1,356) = 0.002$, $p = .966$, the rapport analysis was significant, $F(1,356) = 5.416$, $p = .021$ (see Table A2).

Interaction between perceived conversation partner and response style. Consistent with the pre-registered analyses, the trimmed means ANOVA resulted in a non-significant interaction for both rapport, $F= 0.107$, $p = .744$ and social connection, $F= 0.118$, $p = .732$. The results of the equal-group size ANOVA's were similarly non-significant for social connection $F(1,356) = 0.208$, $p = .648$ and rapport, $F(1,356) = 0.066$, $p = .797$.

More responsive chatbot compared to a less responsive human. The results of the Welch's independent samples t-tests were consistent with the pre-registered analyses for both social connection, $t(173.87) = 3.838$, $p < .001$ and rapport, $t(184.11)= 4.861$, $p < .001$ (see Table A3).

Intent to treat analyses

To ensure that removing participants based on their response style manipulation check responses was not biasing our results, we conducted our primary analyses on a dataset that included the 27 participants that we removed for failing the response style manipulation check. As such, the dataset consisted of 427 participants as opposed to the 400 participants included in the original analyses. The results were consistent with the primary analyses.

Main effect of Response Style. See Table A1 for detailed results regarding the main effect of response style.

Main effect of perceived conversation partner. See Table A2 for detailed results regarding the main effect of perceived conversation partner.

Interaction between perceived conversation partner and response style. In line with the pre-registered analyses, the Perceived Conversation Partner*Response Style interaction for

our rapport (p = .91), social connection (p = .88), feelings about the positive experience (p = .89), and mood (PANAS: p = .69; single-item: p =.67) variables were non-significant.

More responsive chatbot compared to a less responsive human. See Table A3 for detailed results regarding the planned contrast comparing the more responsive chatbot to the less responsive human conditions.

Table A1. *Intent-to-treat analysis: Main effect of response style (Study 1)*

	More responsive condition (n = 212)	Less responsive condition (n = 215)	*F*	*p*	*Cohen's d*	95% CI
Rapport	4.67 (0.86)	3.98 (1.02)	56.45	< .001	0.74	[0.54, 0.94]
Social connection	5.18 (1.00)	4.74 (1.23)	16.29	< .001	0.39	[0.20, 0.58]
Feelings about positive experience	6.47 (2.03)	5.95 (2.15)	6.45	.01	0.25	[0.06, 0.44]
Positive affect: PANAS	2.95 (0.92)	2.83 (0.91)	1.73	.19	0.13	[-0.06, 0.32]
Positive Affect: single item	1.39 (1.98)	0.73 (1.96)	11.10	< .001	0.33	[0.14, 0.52]

Table A2. *Intent-to-treat analysis: Main effect of perceived conversation partner (Study 1)*

	Chatbot condition (n = 215)	Human Condition (n = 212)	*F*	*p*	*Cohen's d*	95% CI
Rapport	4.23 (1.06)	4.42 (0.94)	2.73	.10	0.19	[0.00, 0.38]
Social connection	4.97 (1.18)	4.95 (1.12)	0.23	.63	0.02	[-0.17, 0.21]
Feelings about positive experience	6.09 (2.10)	6.32 (2.11)	0.95	.33	0.11	[-0.08, 0.30]
Positive affect: PANAS	2.88 (0.92)	2.90 (0.91)	0.02	.88	0.02	[-0.17, 0.21]
Positive Affect: single item	0.92 (1.99)	1.20 (1.99)	1.66	.20	0.14	[-0.05, 0.33]

Table A3. *Intent-to-treat analysis: planned contrast comparing more responsive chatbot condition to less responsive human condition (Study 1)*

	More responsive chatbot condition (n = 100)	Less responsive human condition (n = 100)	*F*	*p*	*Cohen's d*	95% CI
Rapport	4.60 (0.84)	4.06 (0.89)	16.16	< .001	0.62	[0.33, 0.91]
Social connection	5.22 (1.00)	4.72 (1.18)	9.59	.002	0.45	[0.17, 0.73]
Feelings about positive experience	6.38 (1.93)	6.07 (2.08)	1.15	.28	0.16	[-0.12, 0.44]
Positive affect: PANAS	2.92 (0.95)	2.82 (0.93)	0.64	.43	0.11	[-0.17, 0.39]
Positive Affect: single item	1.30 (1.95)	0.91 (1.95)	1.96	.16	0.20	[-0.08, 0.48]

Appendix B: Supplemental Materials, Chapter 3

Intent to treat analyses

We conducted intent-to-treat analyses on our Study 2 data. Participants (n = 12) who were removed from the primary analyses for failing the response style manipulation check were included in the intent-to-treat analyses. As such, the dataset consisted of 212 participants as opposed to the 200 that were included in the primary analyses in the main text. The results were consistent with the primary analyses (see Table B1).

Table B1. *Intent to treat analyses (Study 2)*

Outcome Variable	Mean (SD)						
	More responsive chatbot (n = 106)	Less responsive human (n = 106)	*t*	*df*	*p*	*Cohen's D*	*95% CI*
Rapport	4.83 (0.82)	4.12 (1.13)	5.23	191.55	<.001	0.72	[0.43, 1.00]
Social connection	5.15 (1.01)	4.70 (1.20)	3.00	204.08	.002	0.41	[0.14, 0.69]
Feelings about positive experience	6.38 (2.15)	6.01 (2.23)	1.25	209.74	.107	0.17	[-0.10, 0.44]
Positive affect: SPANE	3.46 (0.96)	3.19 (1.12)	1.90	205.50	.030	0.26	[-0.01, 0.53][a]

Note. [a]= The t-tests conducted were one-tailed. This is why the 95% CI includes 0, while the t-test itself was significant.

Appendix C: Supplemental Materials, Chapter 4

Intent to treat analyses

As in Study 2, we conducted intent-treat-analyses on the Study 3 dataset. Participants (n = 20) who were removed from the primary analyses for failing the response style manipulation check were included in the intent-to-treat analyses. As such, the dataset consisted of 220 participants as opposed to the 200 that were originally included. The results were consistent with the primary analyses (see Table C1).

Table C1. *Intent to treat analyses (Study 3)*

Outcome Variable	Mean (SD)						
	More responsive chatbot (n = 113)	Less responsive human (n = 107)	*t*	*df*	*p*	*Cohen's D*	*95% CI*
Rapport	4.87 (0.90)	3.85 (1.20)	7.14	193.76	<.001	0.97	[0.68, 1.27]
Social connection	5.13 (1.17)	4.76 (1.20)	2.32	215.43	.011	0.31	[0.05, 0.58]
Feelings about positive experience	6.83 (1.89)	6.21 (2.26)	2.18	205.41	.015	0.30	[0.03, 0.56]
Positive affect: SPANE	3.76 (0.85)	3.31 (1.13)	3.35	192.44	<.001	0.46	[0.19, 0.73]

Appendix D: Supplemental Materials, Chapter 5

Brown-Forsythe tests revealed that HOV was not violated for our measures of positive mood, F (3,397) = 2.44, p = .064, feelings about the positive experience, F (3,397) = 0.13, p = .940, and social connection, F (3,396) = 1.48, p = .220. However, the HOV assumption was violated for our measure of rapport, F(3,397) = 10.714, p <.001. Therefore, we conducted the same robust analyses as in Study 1 for our rapport variable.

Main effect of Response Style. Consistent with the pre-registered analyses, the 20% trimmed means analysis resulted in a significant main effect for rapport, F = 72.40, p < .00. The equal group size analyses resulted in similarly consistent findings, F(1,376) = 92.93, p < .001.

Main effect of perceived conversation partner. The results of the trimmed means analysis for rapport was non-significant, F= .0259, p = .873. The equal group size analysis was also non-significant, F(1,376) = 0.37, p =.544

Interaction between perceived conversation partner and response style. There was no significant interaction for the trimmed means analysis, F= 1.32, p = .252 or the equal group size analysis, F(1,376) = 1.12, p =.291.

Intent to treat analyses

We conducted additional analyses that included the 26 participants that were removed for failing the response style manipulation check. As a result, the dataset consisted of 427 participants as opposed to the 401 participants included in the original analyses. The results were consistent with the primary analyses.

Main effect of Response Style. See Table D1 for detailed results regarding the main effect of response style.

Main effect of perceived conversation partner. See Table D2 for detailed results regarding the main effect of perceived conversation partner.

Interaction between perceived conversation partner and response style. In line with the pre-registered analyses, there was a significant Perceived Conversation Partner*Response Style interaction for social connection (p = .02) and feelings about the positive experience (p = .008), and there was no significant interaction for our rapport (p = .14) or positive mood (p = .18) variables.

More responsive chatbot compared to a less responsive human. See Table D3 for detailed results regarding the t-tests comparing the responsive chatbot to a less responsive human.

Table D1. *Intent-to-treat analysis: Main effect of response style (Study 4)*

	More responsive condition (n = 212)	Less responsive condition (n = 215)	*F*	*p*	*Cohen's d*	95% CI
Rapport	4.92 (0.89)	3.92 (1.33)	82.70	<.001	0.88	[0.67, 1.08]
Social connection	5.10 (1.18)	4.76 (1.26)	8.71	.003	0.28	[0.09, 0.48]
Positive affect: SPANE	3.75 (0.98)	3.30 (1.13)	19.80	<.001	0.43	[0.23, 0.62]
Feelings about positive experience	6.88 (1.98)	6.66 (2.12)	1.23	.267	0.11	[-0.08, 0.30]

Table D2. *Intent-to-treat analysis: Main effect of perceived conversation partner (Study 4)*

	Chatbot condition (n =214)	Human Condition (n = 213)	*F*	*p*	*Cohen's d*	95% CI
Rapport	4.40 (1.27)	4.43 (1.21)	0.35	.558	0.02	[-0.17, 0.21]
Social connection	4.92 (1.22)	4.94 (1.25)	0.07	.787	0.02	[-0.17, 0.21]
Positive affect: SPANE	3.49 (1.12)	3.56 (1.05)	0.773	.380	0.07	[-0.12, 0.26]
Feelings about positive experience	6.79 (2.02)	6.75 (2.09)	0.023	.880	0.02	[-0.17, 0.21]

Table D3. *Intent-to-treat analysis: t-tests comparing more responsive chatbot condition to less responsive human condition (Study 4)*

	More responsive chatbot condition (n = 110)	Less responsive human condition (n = 111)	*t*	*df*	*p*	*Cohen's d*	95% CI
Rapport	4.81 (0.96)	3.87 (1.26)	6.23	205.46	<.001	0.84	[0.55, 1.12]
Social connection	4.95 (1.27)	4.64 (1.33)	1.78	217.82	.038	0.24	[-0.03, 0.51]
Positive affect: SPANE	3.64 (1.04)	3.27 (1.10)	2.54	218.67	.006	0.34	[0.07, 0.61]
Feelings about positive experience	6.64 (2.04)	6.39 (2.21)	0.86	217.96	.194	0.12	[-0.15, 0.38]