

# **Opposing Effects of Response Time in Human-Chatbot Interaction – The Moderating Role of Prior Experience**

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**Appendix (available online via <http://link.springer.com>)**

## Online Appendix A

### Supplementary Analysis on Delayed Response Time Condition

In general, research and practice have used two different ways to implement a delayed response time in a chatbot: dynamic delays and static delays (e.g., Holtgraves and Han 2007; Appel et al. 2012; Gnewuch et al. 2018; Schanke et al. 2021). While static delays have a predefined delay duration regardless of the message (e.g., Appel et al. 2012; Toader et al. 2019), dynamic delays take into account the message's length or complexity in order to calculate delays individually for each chatbot message (e.g., Gnewuch et al. 2018; Schanke et al. 2021). To confirm that the results of our experiment do not hinge on either of these delay types, we implemented both a dynamic delay (72 participants) and a static delay (63 participants):

- **Dynamic delay:** The dynamic delay was calculated based on the linguistic complexity of the chatbot's response and the complexity of the previous message (i.e., either from the user or the chatbot) using the Flesch-Kincaid grade level (Kincaid et al. 1975). Accordingly, less complex responses (e.g., "Hello") had a very short delay (if at all), whereas more complex responses (e.g., "Alright, I'm looking for a better plan for you now. Stay tuned!") had a longer delay (e.g., up to 4 seconds; see Table A1). We calibrated and refined the dynamic delay in a pilot study with 79 participants (Gnewuch et al. 2018). The average response delay was 2.3 seconds.
- **Static delay:** The static delay was set to 2.3 seconds to match the average delay of the dynamic delay condition in the pilot study (Gnewuch et al. 2018). All messages were delayed by the same amount of time, regardless of message complexity.

Our analysis confirms no difference in user perception between dynamic and static delays. Specifically, we find no statistically significant differences in terms of perceived response time ( $t(133) = -.851, p = .396$ ), social presence ( $t(133) = -.310, p = .757$ ), and intention to use ( $t(133) = .336, p = .737$ ). Similarly, regarding our control variables, there were no significant differences between the dynamic and static delay subgroups in terms of prior chatbot experience ( $\chi^2(1) = .030, p = .862$ ), age ( $t(133) = .011, p = .991$ ), gender ( $\chi^2(1) = .656, p = .418$ ), sociability ( $t(133) = 1.34, p = .183$ ), education ( $\chi^2(3) = 6.12, p = .106$ ), prior messenger experience ( $t(133) = 1.88, p = .062$ ), and chat duration ( $t(133) = .135, p = .893$ ). Building on these results, we do not differentiate between the two types of delay in our main analysis.

Table A1: Formula and examples for the calculation of dynamic delays

| Example                                                                                                                                                                                                                                                                                                                                                                                   | Sender  | Message                                                                                        | Complexity <sup>a</sup> | Delay <sup>b</sup> | Total delay |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|------------------------------------------------------------------------------------------------|-------------------------|--------------------|-------------|
| 1                                                                                                                                                                                                                                                                                                                                                                                         | User    | <i>Hello</i>                                                                                   | - 3.40                  | 0 ms               | 0 ms        |
|                                                                                                                                                                                                                                                                                                                                                                                           | Chatbot | <i>Hi! How can I help you?</i>                                                                 | - 2.62                  | 0 ms               |             |
| 2                                                                                                                                                                                                                                                                                                                                                                                         | User    | <i>I paid about 32 €</i>                                                                       | - 1.94                  | 0 ms               | 1,892 ms    |
|                                                                                                                                                                                                                                                                                                                                                                                           | Chatbot | <i>Got it. How many minutes did you spend on the phone last month (national calls)?</i>        | 2.28                    | 1,892 ms           |             |
| 3                                                                                                                                                                                                                                                                                                                                                                                         | User    | <i>Hi, I am looking for a new mobile phone plan. can you help me?</i>                          | 0.63                    | 1,214 ms           | 3,567 ms    |
|                                                                                                                                                                                                                                                                                                                                                                                           | Chatbot | <i>Okay, let's start! First, I need some information about your current mobile phone plan:</i> | 4.64                    | 2,353 ms           |             |
| <p><i>Note.</i> <sup>a</sup> Calculated using the Flesch-Kincaid grade level formula: <math>C = 0.39 * (\#words / \#sentences) + 11.8 * (\#syllables / \#words) - 15.59</math> (Kincaid et al. 1975)</p> <p><sup>b</sup> Calculated based on the following formula: <math>D = \begin{cases} (0.5 * \ln(C + 0.5) + 1.5) * 1000, &amp; C &gt; 0 \\ 0, &amp; C \leq 0 \end{cases}</math></p> |         |                                                                                                |                         |                    |             |

Since dynamic delays are calculated individually based on user input, there is some variation in the chatbot's response time in each conversation. Therefore, very long delays would have been associated with a slow response time that might have negatively influenced participants' responses. To test this possibility, we conducted a supplementary analysis of the relationship between the average response time of the chatbot with dynamic delays and users' social presence perceptions. First, we calculated the chatbot's average response time for each interaction based on conversation data ( $M = 2.35$ ,  $SD = 0.20$ ). Subsequently, we estimated an OLS regression with average response time as the independent variable and social presence as the dependent variable (see Table A2). The results showed that average response time did not significantly influence social presence ( $b = .583$ ,  $p = .459$ ). In addition, we estimated a second model with chatbot experience as a moderator, which also revealed a non-significant main effect ( $b = .691$ ,  $p = .568$ ) and interaction effect ( $b = -.066$ ,  $p = .967$ ). Finally, to explore the possibility of non-linear relationships between average response time and social presence, we estimated quadratic and logarithmic regression models, finding no significant effects ( $p$  values of .856 and .466, respectively). Taken together, these results suggest that differences in the actual response time of the chatbot with dynamic delays did not affect participants' social presence perceptions.

Table A2: Supplementary analysis on average response time of the chatbot with dynamic delays ( $N=72$ )

|                                                                               | Model 1             |                    |          |  | Model 2             |                    |          |  |
|-------------------------------------------------------------------------------|---------------------|--------------------|----------|--|---------------------|--------------------|----------|--|
|                                                                               | DV: Social Presence |                    |          |  | DV: Social Presence |                    |          |  |
|                                                                               | Coefficient (SE)    | 95% CI             | <i>p</i> |  | Coefficient (SE)    | 95% CI             | <i>p</i> |  |
| Intercept                                                                     | 2.360 (1.847)       | [-1.32, 6.04]      | .205     |  | 2.221 (2.807)       | [-3.38, 7.82]      | .432     |  |
| Average Response Time <sup>a</sup>                                            | 0.583 (0.783)       | [-0.98, 2.14]      | .459     |  | 0.691 (1.206)       | [-1.71, 3.10]      | .568     |  |
| Prior Chatbot Experience <sup>b</sup>                                         |                     |                    |          |  | -0.055 (3.791)      | [-7.62, 7.51]      | .988     |  |
| Average Response Time <sup>a</sup><br>× Prior Chatbot Experience <sup>b</sup> |                     |                    |          |  | -0.066 (1.610)      | [-3.28, 3.15]      | .967     |  |
| $R^2$                                                                         |                     | 0.008              |          |  |                     | 0.014              |          |  |
| $F$                                                                           |                     | 0.555 (df = 1; 70) |          |  |                     | 0.319 (df = 3; 68) |          |  |

Note.  $N = 72$ . DV = dependent variable; SE = standard error; CI = confidence interval. \*  $p < .05$ ; \*\*  $p < .01$ ; \*\*\*  $p < .001$ .

<sup>a</sup> calculated based on conversation data for each interaction with the chatbot with dynamic delays. <sup>b</sup> 1 = experienced user.

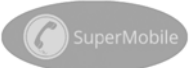
|                                                                                                                 |                |
|-----------------------------------------------------------------------------------------------------------------|----------------|
|  <b>Your Mobile Phone Bill</b> |                |
| <b>Your Mobile Phone Plan</b>                                                                                   |                |
| <u>Monthly charges:</u>                                                                                         |                |
| • <b>Yellow Basic 1000</b>                                                                                      | 19.99 €        |
| <u>Other charges:</u>                                                                                           |                |
| • 2x Data packages 300 MB                                                                                       | 6.00 €         |
| • International calls                                                                                           | 6.30 €         |
| <b>Total charges:</b>                                                                                           | <b>32.29 €</b> |
| <b>Your Usage Details</b>                                                                                       |                |
| <u>Telephony</u>                                                                                                |                |
| • National calls                                                                                                | 652 minutes    |
| • International calls (non EU)                                                                                  | 21 minutes     |
| <u>Text</u>                                                                                                     |                |
| • Text messages sent                                                                                            | 23             |
| <u>Data</u>                                                                                                     |                |
| • Included data volume                                                                                          | 1000 MB        |
| • Data packages                                                                                                 | 450 MB         |
|                                                                                                                 | 1450 MB        |

Figure A1: Fictitious mobile phone bill used in the experiment

## Online Appendix B

Table B1: Participant characteristics

|                                                                           |                      | <i>n</i>                            | %   |     |
|---------------------------------------------------------------------------|----------------------|-------------------------------------|-----|-----|
| <b>Gender</b>                                                             |                      |                                     |     |     |
|                                                                           | Female               | 77                                  | 38% |     |
|                                                                           | Male                 | 125                                 | 62% |     |
| <b>Age</b>                                                                |                      |                                     |     |     |
|                                                                           | < 21                 | 40                                  | 20% |     |
|                                                                           | 21 - 23              | 79                                  | 39% |     |
|                                                                           | 24 - 26              | 57                                  | 28% |     |
|                                                                           | > 26                 | 26                                  | 13% |     |
| <b>Education</b>                                                          |                      |                                     |     |     |
|                                                                           | High-School Graduate | 129                                 | 64% |     |
|                                                                           | Bachelor Degree      | 63                                  | 31% |     |
|                                                                           | Master Degree        | 9                                   | 4%  |     |
|                                                                           | Other                | 1                                   | 0%  |     |
| <b>Prior Messenger Experience</b> (e.g.,<br>Facebook Messenger, WhatsApp) |                      |                                     |     |     |
|                                                                           | Never                | 0                                   | 0%  |     |
|                                                                           | 1-2 times a year     | 0                                   | 0%  |     |
|                                                                           | 1-2 times a month    | 0                                   | 0%  |     |
|                                                                           | 1-2 times a week     | 8                                   | 4%  |     |
|                                                                           | Daily                | 194                                 | 96% |     |
| <b>Prior Chatbot Experience</b>                                           |                      |                                     |     |     |
|                                                                           | Novice               | Never used before                   | 92  | 46% |
|                                                                           | Experienced          | 1-2 times a year                    | 62  | 31% |
|                                                                           |                      | 1-2 times a month                   | 19  | 9%  |
|                                                                           |                      | 1-2 times a week                    | 13  | 6%  |
|                                                                           |                      | Daily                               | 16  | 8%  |
| <b>Sociability</b>                                                        |                      | <i>M</i> = 5.58 ( <i>SD</i> = 0.90) |     |     |

Table B2: Measurement items and factor loadings

| Construct (source)                                                               | Item |                                                                                                                                                    | Loading        |
|----------------------------------------------------------------------------------|------|----------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| <b>Perceived Social Presence</b><br>(Gefen and Straub 1997)                      | SP1  | I felt a sense of human contact in the chatbot.                                                                                                    | 0.837          |
|                                                                                  | SP2  | I felt a sense of personalness in the chatbot.                                                                                                     | 0.747          |
|                                                                                  | SP3  | I felt a sense of sociability in the chatbot.                                                                                                      | 0.855          |
|                                                                                  | SP4  | I felt a sense of human warmth in the chatbot.                                                                                                     | 0.880          |
|                                                                                  | SP5  | I felt a sense of human sensitivity in the chatbot.                                                                                                | 0.856          |
| <b>Intention to Use</b><br>(Wang and Benbasat 2009)                              | ITU1 | Assuming I have access to the chatbot, I intend to use it to find a suitable mobile phone plan for me.                                             | 0.944          |
|                                                                                  | ITU2 | Assuming I have access to the chatbot, I predict I would use it to find a suitable mobile phone plan for me.                                       | 0.951          |
|                                                                                  | ITU3 | Given that I have access to the chatbot, I plan to use it to find a suitable mobile phone plan for me.                                             | 0.939          |
| <b>Prior Chatbot Experience</b><br>(Ashktorab et al. 2019; Moussawi et al. 2020) | EXP  | How often do you use chatbots (e.g., on Facebook Messenger or websites)?<br>[never (novice); 1-2 times a year / month / week, daily (experienced)] | n/a            |
| <b>Sociability</b><br>(Bruch et al. 1989)                                        | SOB1 | I like to be with people.                                                                                                                          | 0.805          |
|                                                                                  | SOB2 | I welcome the opportunity to mix socially with people.                                                                                             | 0.700          |
|                                                                                  | SOB3 | I prefer working with others rather than alone.                                                                                                    | <i>dropped</i> |
|                                                                                  | SOB4 | I find people more stimulating than anything else.                                                                                                 | <i>dropped</i> |
|                                                                                  | SOB5 | I'd be unhappy if I were prevented from making many social contacts.                                                                               | <i>dropped</i> |
| <b>Gender</b>                                                                    | GEN  | What is your gender? [female; male]                                                                                                                | n/a            |
| <b>Age</b>                                                                       | AGE  | How old are you?                                                                                                                                   | n/a            |
| <b>Perceived Chatbot Response Time</b><br>(Galletta et al. 2006)                 | PRT  | Please rate the chatbot's response time [1 = slow; 7 = fast]<br>(Manipulation check)                                                               | n/a            |

## Online Appendix C

### Supplementary Analysis of User Typing Speed

One possible concern with our results is that they could be dependent on the users' own typing speed (i.e., how fast users type). For example, an instant chatbot response time might be more salient (and thus more impactful) to users who type more slowly than to those who type very quickly. To test this potential confound, we conducted a follow-up analysis on the impact of users' own typing speed. First, using the data from conversations between users and chatbots (e.g., message content, timestamps) during the experiment, we derived a measure of typing speed as the average number of characters typed per second (Soukoreff and MacKenzie 1995). Based on the timestamps, we calculated the users' response time as the elapsed time between each chatbot message and each user message. Subsequently, we calculated the users' typing speed by dividing the length of the messages by the response times. We then calculated the average typing speed across all messages for each user.

We can confirm that there were no statistically significant differences in users' typing speed between the instant and delayed response time condition ( $t(200) = -.040, p = .969$ ). Further, typing speed also did not change the results of our moderated mediation model. Specifically, when we included typing speed as a covariate in our moderated mediation model and reran the analysis in PROCESS, typing speed exhibited no significant impact on social presence ( $b = -.395, p = .214$ ) or on intention to use ( $b = -.544, p = .153$ ). At the same time, the main, interaction, and indirect effects of our model remained significant and consistent in magnitude and direction (see Table C1). Thus, the results confirm the results of our main analysis. Finally, to test whether typing speed as a moderator might provide an alternative explanation for our findings, we ran the same moderated mediation analysis using typing speed instead of prior chatbot experience as the moderator variable. The results in Table C2 show there were no significant effects of typing speed as a moderator ( $p$  values of .539 and .703, respectively). Taken together, the results of our follow-up analysis suggest that users' own typing speed did not affect their perception of the chatbot's response time.

Table C1: Moderated mediation model with user typing speed as a covariate

|                                                                               | Social Presence       |         |        |        |                | Intention to Use       |         |        |          |                |
|-------------------------------------------------------------------------------|-----------------------|---------|--------|--------|----------------|------------------------|---------|--------|----------|----------------|
|                                                                               | Coeff.                | (SE)    | t      | p      | 95% CI         | Coeff.                 | (SE)    | t      | p        | 95% CI         |
| Chatbot Response Time <sup>a</sup>                                            | 0.702                 | (0.277) | 2.537  | .012*  | [0.16, 1.25]   | -0.109                 | (0.231) | -0.473 | .637     | [-0.56, 0.35]  |
| Prior Chatbot Experience <sup>b</sup>                                         | 2.307                 | (0.656) | 3.520  | .001** | [1.01, 3.60]   | 1.346                  | (0.687) | 1.958  | .052     | [-0.01, 2.70]  |
| Chatbot Response Time <sup>a</sup> ×<br>Prior Chatbot Experience <sup>b</sup> | -1.211                | (0.378) | -3.204 | .002** | [-1.96, -0.46] | -                      | -       | -      | -        | -              |
| Social Presence                                                               | -                     | -       | -      | -      | -              | 0.640                  | (0.127) | 5.032  | <.001*** | [0.39, 0.89]   |
| Social Presence ×<br>Prior Chatbot Experience <sup>b</sup>                    | -                     | -       | -      | -      | -              | -0.341                 | (0.173) | -1.977 | .049*    | [-0.68, -0.01] |
| Constant                                                                      | 2.571                 | (1.017) | 2.529  | .012*  | [0.57, 4.58]   | 3.114                  | (1.196) | 2.604  | .010*    | [0.76, 5.47]   |
| Age                                                                           | -0.028                | (0.026) | -1.104 | .271   | [-0.08, 0.02]  | -0.007                 | (0.031) | -0.239 | .812     | [-0.07, 0.05]  |
| Gender <sup>c</sup>                                                           | 0.004                 | (0.184) | 0.020  | .984   | [-0.36, 0.37]  | -0.137                 | (0.219) | -0.627 | .531     | [-0.57, 0.30]  |
| Sociability                                                                   | 0.152                 | (0.095) | 1.596  | .112   | [-0.04, 0.34]  | -0.006                 | (0.114) | -0.052 | .958     | [-0.23, 0.22]  |
| User Typing Speed                                                             | -0.395                | (0.317) | -1.247 | .214   | [-1.02, 0.23]  | -0.544                 | (0.380) | -1.434 | .153     | [-1.29, 0.21]  |
| <i>R</i> <sup>2</sup>                                                         | 0.090                 |         |        |        |                | 0.173                  |         |        |          |                |
| <i>F</i>                                                                      | 2.757** (df = 7; 194) |         |        |        |                | 5.051*** (df = 8; 193) |         |        |          |                |

Note. *N* = 202. SE = standard error; CI = confidence interval. \* *p* < .05; \*\* *p* < .01; \*\*\* *p* < .001.

<sup>a</sup> 1 = delayed. <sup>b</sup> 1 = experienced user. <sup>c</sup> 1 = male.

Table C2: Moderated mediation model with user typing speed as the moderator

|                                                           | Social Presence     |         |        |        |               | Intention to Use       |         |        |       |               |
|-----------------------------------------------------------|---------------------|---------|--------|--------|---------------|------------------------|---------|--------|-------|---------------|
|                                                           | Coeff.              | (SE)    | t      | p      | 95% CI        | Coeff.                 | (SE)    | t      | p     | 95% CI        |
| Chatbot Response Time <sup>a</sup>                        | -0.279              | (0.603) | -0.462 | .645   | [-1.47, 0.91] | -0.017                 | (0.227) | -0.076 | .939  | [-0.47, 0.43] |
| User Typing Speed                                         | -1.120              | (1.169) | -0.957 | .340   | [-3.43, 1.19] | -0.225                 | (1.115) | -0.202 | .840  | [-2.42, 1.97] |
| Chatbot Response Time <sup>a</sup> ×<br>User Typing Speed | 0.416               | (0.676) | 0.615  | .539   | [-0.92, 1.75] | -                      | -       | -      | -     | -             |
| Social Presence                                           | -                   | -       | -      | -      | -             | 0.553                  | (0.253) | 2.185  | .030* | [0.05, 1.05]  |
| Social Presence ×<br>Typing Speed                         | -                   | -       | -      | -      | -             | -0.111                 | (0.290) | -0.382 | .703  | [-0.68, 0.46] |
| Constant                                                  | 4.237               | (1.372) | 3.088  | .002** | [1.53, 6.94]  | 2.924                  | (1.466) | 1.995  | .047* | [0.03, 5.82]  |
| Age                                                       | -0.024              | (0.026) | -0.930 | .354   | [-0.08, 0.03] | 0.004                  | (0.031) | 0.122  | .903  | [-0.06, 0.06] |
| Gender <sup>b</sup>                                       | -0.059              | (0.188) | -0.313 | .755   | [-0.43, 0.31] | -0.140                 | (0.220) | -0.634 | .527  | [-0.58, 0.30] |
| Sociability                                               | 0.179               | (0.102) | 1.755  | .081   | [-0.02, 0.38] | 0.027                  | (0.120) | 0.222  | .825  | [-0.21, 0.26] |
| <i>R</i> <sup>2</sup>                                     | 0.033               |         |        |        |               | 0.162                  |         |        |       |               |
| <i>F</i>                                                  | 1.100 (df = 6; 195) |         |        |        |               | 5.352*** (df = 7; 194) |         |        |       |               |

Note. *N* = 202. SE = standard error; CI = confidence interval. \* *p* < .05; \*\* *p* < .01; \*\*\* *p* < .001.

<sup>a</sup> 1 = delayed. <sup>b</sup> 1 = male.



## Online Appendix D

Table D1: Questionnaire

| Construct                                                      | Item |                                                                                                              | Source                                        | Measurement                                                                                                                    |
|----------------------------------------------------------------|------|--------------------------------------------------------------------------------------------------------------|-----------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|
| <b>Perceived Social Presence</b>                               | SP1  | I felt a sense of human contact in the chatbot.                                                              | (Gefen and Straub 1997)                       | Seven-point Likert scale<br>(1 = “strongly disagree”; 7 = “strongly agree”)                                                    |
|                                                                | SP2  | I felt a sense of personalness in the chatbot.                                                               |                                               |                                                                                                                                |
|                                                                | SP3  | I felt a sense of sociability in the chatbot.                                                                |                                               |                                                                                                                                |
|                                                                | SP4  | I felt a sense of human warmth in the chatbot.                                                               |                                               |                                                                                                                                |
|                                                                | SP5  | I felt a sense of human sensitivity in the chatbot.                                                          |                                               |                                                                                                                                |
| <b>Intention to Use</b>                                        | ITU1 | Assuming I have access to the chatbot, I intend to use it to find a suitable mobile phone plan for me.       | (Wang and Benbasat 2009)                      | Seven-point Likert scale<br>(1 = “strongly disagree”; 7 = “strongly agree”)                                                    |
|                                                                | ITU2 | Assuming I have access to the chatbot, I predict I would use it to find a suitable mobile phone plan for me. |                                               |                                                                                                                                |
|                                                                | ITU3 | Given that I have access to the chatbot, I plan to use it to find a suitable mobile phone plan for me.       |                                               |                                                                                                                                |
| <b>Prior Chatbot Experience</b>                                | EXP  | How often do you use chatbots (e.g., on Facebook Messenger or websites)?                                     | (Ashktorab et al. 2019; Moussawi et al. 2020) | Five-point Likert scale<br>(1 = “never”; 2 = “1-2 times a year”; 3 = “1-2 times a month”; 4 = “1-2 times a week”; 5 = “daily”) |
| <b>Sociability</b>                                             | SOB1 | I like to be with people.                                                                                    | (Bruch et al. 1989)                           | Seven-point Likert scale<br>(1 = “strongly disagree”; 7 = “strongly agree”)                                                    |
|                                                                | SOB2 | I welcome the opportunity to mix socially with people.                                                       |                                               |                                                                                                                                |
|                                                                | SOB3 | I prefer working with others rather than alone.                                                              |                                               |                                                                                                                                |
|                                                                | SOB4 | I find people more stimulating than anything else.                                                           |                                               |                                                                                                                                |
|                                                                | SOB5 | I’d be unhappy if I were prevented from making many social contacts.                                         |                                               |                                                                                                                                |
| <b>Gender</b>                                                  | GEN  | What is your gender?                                                                                         | -                                             | [female; male]                                                                                                                 |
| <b>Age</b>                                                     | AGE  | How old are you?                                                                                             | -                                             | [1-99]                                                                                                                         |
| <b>Perceived Chatbot Response Time</b><br>(Manipulation check) | PRT  | Please rate the chatbot’s response time.                                                                     | (Galletta et al. 2006)                        | Seven-point Likert scale<br>(1 = “slow”; 7 = “fast”)                                                                           |

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