

How Restrictions of Autonomy affect the Sense of Agency

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### Abstract

This study examined how restrictions of autonomy affect the sense of agency. Normally, such a research would take place in a lab setting. However, due to COVID-19 this was not possible. We decided to perform an online research instead. This online research consisted of two studies, first we investigated the relation between restrictions of autonomy and the sense of agency in an online environment with not much control and interaction, subsequently, we investigated the relation in an online setting with more control and interaction. We expected that improving the online research setting would be related to a stronger negative association between restricted autonomy and the sense of agency. To check for the relation between autonomy and the sense of agency, 47 participants performed the Time Interval Estimation task (TIE) in a within-subject design. In addition to this, the data of the two studies was merged to compare the relation between autonomy and the sense of agency between both studies. To do so, the experiment was added as a between-subject variable. Contrary to the first study, we found no prove of a relationship between restricted autonomy and the sense of agency. Thus, improving the online research setting did not lead to finding a stronger negative association. However, we did find that the improved online research setting had led to a higher quality of the methodology of the study. Future studies should use a bigger sample and conduct research in a real-life lab setting.

*Keywords:* autonomy, sense of agency, TIE-task, self-determination

### How Restrictions of Autonomy affect the Sense of Agency

During the current COVID-19 pandemic, autonomy is an even more interesting topic. To decrease the spread of the virus and to curb the pandemic and its collateral damage, governments all across the world were forced to apply a sophisticated set of measures. Plenty of these measures had -and still have- an impact on the extent to which people are able to determine their own behavior (e.g. lockdown, curfew, maximum amount of visitors, social distancing etc.). Because people are restricted in their behavior and therefore their freedom of choice, one could argue that people are being restricted in their autonomy, i.e. people are externally regulated in their actions (Ryan & Deci, 2006). These restrictions can threaten the extent to which people feel in control over their own actions and its consequences, in other words, it can threaten people their sense of agency (Moore, 2016; Haggard, 2017). This explanation of the sense of agency is supported by another study (Haggard & Chambon, 2012) that describes the sense of agency as one experiencing their self as directing their actions and by this also the events in their environment. Note that again it is specifically mentioned that it is about the experience of being in charge and not per se about actually being in charge. Hence, one may experience control when there is none. With regards to the COVID-19 measures, one may experience their social distancing as voluntary and not so much as forced. This COVID related example clearly illustrates that the distinction between free and forced behavior is not easily to be made.

In general, free behavior entails that one is self-governing and not externally restricted in their actions. Thus, one can decide what to do and when to do it (Ryan & Deci, 2006). From a deterministic perspective, one could argue that even when someone is not being externally regulated, behavior could still be forced; but such a philosophical discussion is outside the scope of this study. So, if free behavior means freedom what to do and when to do it, then forced behavior automatically means that one is not free to choose what to do and when to do it. But how to correctly infer whether behavior is autonomous or forced? In order to determine if behavior is either free or forced, Synofzik, Vosgerau, and Newen (2008) suggested that there should be made a distinction between the feeling of agency (implicit sense of agency) and the judgement of agency (explicit sense of agency). The implicit sense of agency refers to a low conscious experience of being an agent in which one does not consciously reflect on this feeling. The explicit sense of agency refers to higher-order cognitions about the experience of being an agent. In other words; one consciously thinks about the extent to which they are in charge (Moore, Middleton, Haggard & Fletcher, 2012; Saito, Takahata, Murai & Takahashi, 2015). In order to explain to what extent human

behavior is self-determined, or free/autonomous, Ryan and Deci (2012) constructed and expanded the Self-Determination Theory (SDT). The SDT studies the underlying motivations of human behavior; why do people behave like the way they do? In the SDT-paradigm, Ryan and Deci (2012) compare the motivation of externally motivated actions (heteronomous) with the motivation of internally motivated actions (autonomous). They emphasize that, among other psychological needs (competence & relatedness), autonomy is critical for one's psychological fitness and welfare. Ryan and Deci (2006) stress that people cannot always be autonomous; people can feel like they have to conform to social norms, they feel pressured by evaluations and they are influenced by whether or not they are rewarded or punished. Because all these aspects can affect the agent their feeling of autonomy, it could possibly also affect their experience of being in charge of their actions and outcomes (sense of agency). In addition to this, Caspar, Christensen, Cleeremans and Haggard (2016) highlighted Milgram's study on coercion to illustrate that social compulsion may restrict autonomy and hence could affect the standard experience of being in charge of one's own actions and outcomes and thus the sense of agency.

But why is the sense of agency so important? Because the sense of agency is thought to play an important role in all kinds of favorable and also undesired behaviors. Locke and Latham (1990) found that the sense of agency is critical for setting goals, because the experience of sense of agency makes it possible to form goals that are based on an intrinsic motivation, and goals that are formed on an intrinsic motivation are a strong driver of behavior. Hence, the absence of the sense of agency can result in the limitation of beneficial behavior. Setting goals is also important because it influences what one actually achieves (Latham, 2004). This suggestion is supported by the Goal-setting theory (Locke & Latham, 1994), this theory indicates that it is beneficial to set specific goals rather than opaque ones; people that set specific goals tend to perform better. Goals are also a manner to evaluate one's contentment because it generates standards against which you can measure satisfaction. E.g. when one wants to lose 30 pounds of weight, they are likely to only be satisfied when that goal is reached. Thus, reaching goals tends to increase satisfaction, which is interesting because satisfaction seems positively associated with happiness (Michalos, 1980). Next to this, the sense of agency is likely to be helpful in controlling and changing one's own behavior (Carver & Scheier, 2001; Bandura & Adams, 1977). Providing insights on how the sense of agency contributes to people controlling and changing their behavior, could be beneficial for all kinds of behavioral interventions. E.g. smoking, alcohol abuse, drugs abuse and all other forms of abuse one can think of. However, the sense of agency is not only

malleable in a way that positively stimulates the human behavior, it also seems to be of big influence on multiple mental disorders, of which the most famous is Schizophrenia. The symptoms of schizophrenia can be classified as either positive or negative. Positive symptoms represent the anomalous existence of perceptions. Whereas negative symptoms represent the non-appearance of standard functions (Moore, 2016). Moore (2016) suggests that schizophrenia problems that are related to the sense of agency are mostly part of the positive symptoms group. Most of the patients with positive schizophrenia symptoms feel like as if they are not in charge over their own behavior and the resulting outcomes. Because the sense of agency plays an important role in the construction and achievement of goals, the regulation of behavior and mental disorders, it is relevant to further study it.

Because the sense of agency can have all kind of important implications, it is important that it is correctly measures. Caspar et al. (2016) discovered there exists an issue with the line of reasoning of the SDT, because it only deduces the sense of agency out of explicit measures and not so much implicit measures. Explicit measures use self-report questionnaires in which participants express how much control they experienced over an action and its outcome (Moore et al, 2012). Hence, the measures depend on directly asking the participants about their experiences, because the mind is fallible this kind of measurements are prone to noise. For example, one might not remember if they experienced a significant amount of control over previous actions and outcomes. Also, this type of measurement only captures the judgement of agency and not so much the actual feeling of agency. Therefore, it does not capture the discrepancy between how people say they feel and how they actually feel. Fortunately, there is another measurement that does capture the feeling of agency (implicit sense of agency) and is therefore able to measure the extent to which people feel in control. The implicit sense of agency can be captured by “intentional binding”. Intentional binding refers to a phenomenon in which the time interval between an action and its outcome is perceived as compressed, which means that the action is perceived to have shifted forwards in time and the outcome backwards. This compressed time interval between the action and its effect is thought to be highly associated with a higher sense of agency whereas a longer time interval is associated with a weaker sense of agency (Moore & Obhi, 2012). In other words; autonomous behavior is related to a shorter time interval between an action and its outcome, whereas forced behavior is related to a longer interval between an action and its outcome. The two most common methods to assess the intentional binding effect are The Libet clock experiment (Libet, 1985) and the Time interval estimation task (TIE).

Because Caspar et al. (2016) realized that explicit measures of the sense of agency only captured the judgement of agency and not the feeling of agency, they decided to also include implicit measures. They did so by adding a TIE-task to their study. In this TIE-task, participants were instructed to harm a fellow participant. In the experiment, there were multiple conditions; sometimes the participants could freely choose which key to press and other times they were forced to press a certain key. The key press led to financial harm or to a hurtful electric shock for the co-participant, this in turn would then lead to an increase in the participants own financial earnings. Findings showed that the perceived time interval between the action and the outcome magnified when the participants were forced, compared to when participants could freely choose the method of harm. Thus, intentional binding occurred when participants were free to choose, but not when they were forced. These findings indicate that restrictions of autonomy are associated with a decrease in the implicit sense of agency. The latter perspective on intentional binding and thus the sense of agency suggests that it arises from intentional (free/autonomous) action. In contrast to this, Buehner and Humphreys (2009) stated that the occurrence of intentional binding and hence the sense of agency, does not depend only on intentional action but rather on the causal beliefs about the relation between an action and its effects. This suggestion is underpinned by a study (Borhani, Beck & Haggard, 2017) in which intentional binding was observed when there were no self-implemented actions. However, with the TIE-task Moore et al. (2012) observed a stronger binding effect for the observation of actions assumed to be autonomous than actions believed to be forced. Which shows that, even if only causal inference is enough for intentional binding to occur, intentions still play a significant role in the constitution of it.

To further investigate the role of intentions/autonomy in the constitution of the sense of agency, we conducted a research. Due to COVID-19 we were forced to perform this study online, we decided to perform it in two parts; one study without control and interaction between the researcher and the participant; this allowed for fast data collection, and the second study with more control and interaction between the researcher and the participants (optimized online environment).

### **Experiment 1**

The first experiment was conducted via Prolific, an online research platform. Prolific does not allow for interaction between the researcher and the participants but it does allow for recruiting a big sample. Because previous research (Caspar et al., 2016; Borhani, Beck & Haggard, 2017; Moore et al., 2012) already succeeded in observing the intentional binding effect and we had the possibility to recruit a big sample, we expected to find that restrictions

of autonomy would be negatively related to the sense of agency, i.e. the more autonomy is being restricted, the lower the sense of agency.

### Method

#### Participants

189 participants were recruited through the use of Prolific. The participation entry requirements were: being the age of 18 to 65, fluent in English, having a 95% approval rate on Prolific, and normal or corrected to normal vision. The participants had to complete the TIE-task within one hour, two participants failed to do so and were therefore excluded from the data. Thus, 187 participants finished the experiment. But, after the experiment one participant mentioned that their data was not usable, therefore this participant was removed from the data and that left us with 186 complete participants. The study had a 2 (choice vs. no-choice) x 3(200, 500 and 800ms) within-subject design. For their participation, participants earned £2.50. To secure the anonymity of the participants, they were automatically matched to a random ID-number.

#### *Study 2*

#### Procedure

Participants were informed and recruited via the online recruitment platform Prolific. After they signed up for the study, they were directed to the online testing platform Gorilla. They all read the information letter and signed the consent form before they started the Time Interval Estimation (TIE) task. After they completed the task, participants were asked to fill out a questionnaire for the manipulation check and provide demographic information (gender, age, level of education, and employment status). In the end, they reported if their data was usable or not. Reporting that the data was not usable did not result in losing the participation fee and the participants were informed in advance that they would be asked about this.

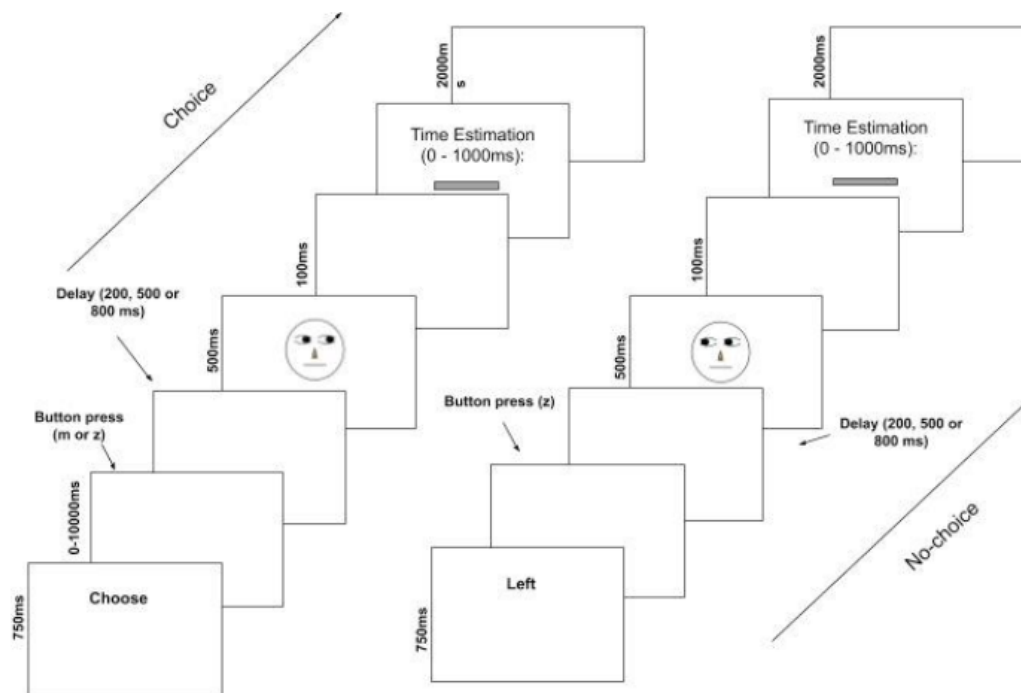
#### Materials

The TIE-task (figure 1) was used to measure the implicit sense of agency. The participants were instructed to make a virtual face look either left or right. They did so in two conditions; the free condition and the forced condition. In the free condition the word “Choose” appeared on the screen as a cue for 750ms. After the cue disappeared the participants had to make the face look either right or left, they did so by pressing ‘z’ (left) and ‘m’ (right). In the forced condition either the word “Left” or “Right” appeared on the screen, forcing the participants to press ‘z’ (left) or ‘m’ (right), so no choice anymore. In this condition the key press had to correspond with the cue. In both conditions the participants were only allowed to press a key after the cue disappeared. They could press a key every

moment for the next 10 seconds once the cue was gone. The time interval between the key press and the appearance of the face varied between 200, 500 and 800ms. The face stayed on the screen for 500ms and was then substituted for a blank screen for 100ms. Once the blank screen disappeared the participants were asked to estimate the time interval between the key press and the appearance of the face on the screen. To enter their estimation the participants had to type it using the digits on their keyboard.

**Figure 1.**

*Detailed overview of TIE-task*



**Figure 1.** Illustration of choice and no-choice (left cue) time interval estimation (TIE) trials.

After performing the TIE-task, the participants were asked about their subjective experience. These questions also helped to check whether or not the manipulation had worked out. The checklist involved 7 questions for both the free and forced condition. The first 6 questions focused on the individual experience of the free condition; “To what extent did you enjoy this situation?”, “To what extent did you struggle with this situation?”, “To what extent did you find this situation unpleasant?”, “To what extent do you think that this situation was natural?”, “To what extent do you think that this situation was unnatural?”, and “To what extent did you feel that your autonomy was restricted in this situation?”. To answer the questions, they used a nine points-Likert scale (1 = not at all, 9 = very much). In addition, the seventh question focused on the number of times they pressed either “z” or “m” in the free



condition; “In this situation, did you make the face look to the right and left in almost equal times?”. On this question the participants could give 4 answers: “No”, “I think so”, “Yes”, “I don’t know”. Subsequently to answering the questions about the free condition, they answered the same questions for the forced condition.

### **Statistical procedure**

The autonomy factor (choice vs. no choice) and the time interval factor (200ms, 500ms & 800ms) were applied within subjects. To measure the relation between the autonomy (choice vs. no-choice) delay (200, 500 and 800ms) and the time interval estimation, the average score of the time interval estimation was calculated for each participant in both conditions, after that, the aggregated average in both conditions was calculated. Next to preparing the data, it was checked on outliers and it was examined if the data met the assumptions of normality, homoscedasticity and independence of scores. When the data was prepared and the assumptions were checked, a repeated-measures ANOVA was performed to measure the relation between the independent variables (autonomy and delay) and the dependent variable (time interval estimation). All analyses were performed with IBM SPSS Statistics 27.

## **Results**

### **Results Time Interval Estimation**

A repeated-measures ANOVA was conducted with choice (choice vs no-choice) and delay (200ms, 500ms, 800ms) as independent variables, and the time estimations as to the dependent variable. There was a main effect of choice ( $F(1,148) = 5.334, p = .022$ , partial  $\eta^2 = .035$ ). Paired-sample t-tests indicated that participants estimated a shorter time interval in choice trials ( $M = 295.87, SD = 142.64$ ) than in no-choice trials ( $M = 303.14, SD = 145.37$ ). The main effect of delay was also significant ( $F(2,147) = 246.546, p < .001$ , partial  $\eta^2 = .770$ ). The interaction between choice and delay was not significant ( $F(2,147) = 2.719, p = .069$ , partial  $\eta^2 = .036$ ). Means and standard deviations for all conditions are shown in Table 1 for illustrative purposes. Subsequently, paired-sample t-tests were conducted between the time interval estimations in choice and no-choice conditions. There was a significant difference between choice ( $M = 295.87, SD = 142.64$ ) and no-choice conditions ( $M = 303.14, SD = 145.37$ );  $t(149) = -2.310, p = .022$ .

### **Table 1.**

*Paired sample t-tests results of interval estimations for 200, 500, and 800ms delays.*

	Choice		No-Choice	
Delay	Mean	SD	Mean	SD
200ms	151.55	113.75	156.5	122.49
			9	
5000ms	288.43	152.47	289.9	153.04
			5	
800ms	447.62	201.02	462.8	203.31
			7	
Overall	295.87	142.64	303.1	145.37
			4	

\* $p < .05$ .

### Reaction Times

Reaction time was the time passing between the removal of the cue and the button press. Since the delay comes after the button press, we did not include the delay as a factor in the analysis. In addition to that, we were concerned that some participants might prefer to use one hand to press both buttons. We did not provide any instruction on that not to restrict autonomy on “how” they will perform the task. Thus, we investigated the effect of pressed key in the reaction time analysis. To investigate the effect of choice (choice vs no-choice) and the pressed key (m vs z) on the reaction times, a repeated measures ANOVA (RM-ANOVA) was conducted. Results showed that neither choice ( $F(1,149) = 2.649, p = .106$ , partial  $\eta^2 = .018$ ) nor the pressed key ( $F(1,149) = 0.001, p = .970$ , partial  $\eta^2 < .001$ ) had a main effect on the reaction times. There was no interaction between the pressed key and choice either ( $F(1,148) = 0.108, p = .743$ , partial  $\eta^2 = .001$ ).

### Manipulation check

To see the differences between the subjective experience of choice and no-choice conditions, paired sample t-tests were run for the six questions in the manipulation checklist. None of the variables differed between situations except the perceived autonomy. Perceived restrictions to the autonomy were higher ( $M = 4.11, SD = 2.443$ ) in no-choice than choice trials ( $M = 6.05, SD = 2.234$ ).

**Table 2**

*Paired-sample t-tests results for manipulation-check questions.*

Choice	No- Choice	95% CI
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Variable	Mean	SD	Mean	SD	t(146)	<i>p</i>	LL	UL
enjoyment	4.97	2.137	4.70	2.048	1.802	.074	-0.026	0.563
struggle	2.87	2.065	2.91	1.983	-0.318	.751	-0.339	0.245
unpleasantness	3.25	2.304	3.52	2.303	-1.592	.114	-0.602	0.065
naturalness	4.80	2.172	4.50	2.046	1.755	.081	-0.038	0.642
unnaturalness	4.70	2.327	5.06	2.216	-2.406	0.17	-0.660	-0.065
restriction of autonomy	4.07	2.429	6	2.262	-9.135	<.001**	-2.351	-1.515

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*1 = not at all, 9 = very much; \**p* < .05., \*\**p* < .01.*

## Discussion

In line with existing research, we found that restrictions of autonomy are related to a lower sense of agency. However, the effect size was rather small. So, although there seems to exist an effect, this study was not able to capture a strong relation. Improving the research setting may lead to finding a stronger negative relation between restricted autonomy and the sense of agency.

## Experiment 2

Whereas the first experiment was conducted via a platform that did not allow for interaction between the researcher and the participants, the second experiment used Microsoft Teams to enable the researcher and the participants to interact with each other. This interaction allowed us to secure a quiet environment and to provide clear instructions about the task. We expected that this would to finding a negative relation between restricted autonomy and the sense of agency. In addition, we expected to find a stronger negative relation in the optimized online research setting than the online research setting without interaction. To investigate this, we merged the data of the two experiments and added experiment as a between-subject factor.

## Method

### Participants

For the follow-up study, 50 participants were recruited. The participants were recruited through Sona. The targeting was explicitly focused on Psychology students. On Sona, participants could individually select a timeslot to participate. 50 participants completed

the experiment. In addition to the 2x3 within-subject design, the follow-up study had 2x3x2(original vs. optimized) mixed design. In return for their participation, students could choose to receive either credits (equal to half an hour) or money (€3). Gorilla automatically matched the participants to a random ID-number, this was done in a way that secured the anonymity of the data.

### **Procedure**

After registering for a timeslot, the participants received an e-mail with an invitation for a Teams-meeting. They could join the meeting by clicking on the link in this invitation. In the meeting the researcher first welcomed the participant, after that a couple of requirements were checked. Subsequently, the informed consent was sent to the participant and read by the participant. Next to this, the importance of a correct entry of the interval estimation was emphasized, examples of correct entries were provided by the researcher via sharing a PDF-file on the screen. After the instructions were clear, the participants left the meeting, closed all their open tabs and went to Gorilla to perform the TIE-task. After completing the TIE-task, the participants returned to the meeting by opening the link in the initial e-mail invitation. In the meeting the participants were asked about their general experience of the experiment and the reimbursement was settled. For a sophisticated script of the meeting one can look at the instructions (Appendix A). Once in Gorilla some more information about the experiment was provided, also it was made clear that they could leave the experiment at any time if they felt like doing so. Subsequently the data management was addressed and contact information was provided. Next to this the topic of the study and the task were introduced; the participants were informed that that the interval between the key press and the appearance of the face would vary between 0 and 1000ms. The conditions and the time intervals between the key press and the appearance of the face were randomized in each block, in uniform weights. There were 120 trials separated into 10 blocks, after every two blocks there was a break that lasted for 30 seconds.

### **Materials**

Like the first part of the study, the TIE-task was used to measure the implicit sense of agency. We implemented some minor changes; to make the face look left, participants had to press 'x' instead of 'z'. This decision was made because he received feedback about some countries having different keyboards. Also, the background of the task was now black instead of white. This decision was made to prevent adverse eye/sight effects. After the TIE-task the participants were asked about their subjective experience, this was done by the exact same manipulation check questions as in the first part of the study.

## Statistical procedure

The statistical procedure remained almost equal, but to compare the relation of choice vs no-choice and the time interval estimation between both study contexts, we merged the data of both studies and added the experiment as a between-subjects factor to the within-subjects design, therefore a mixed design was used. Next to this, we checked if the subjective experience differed between the two research contexts.

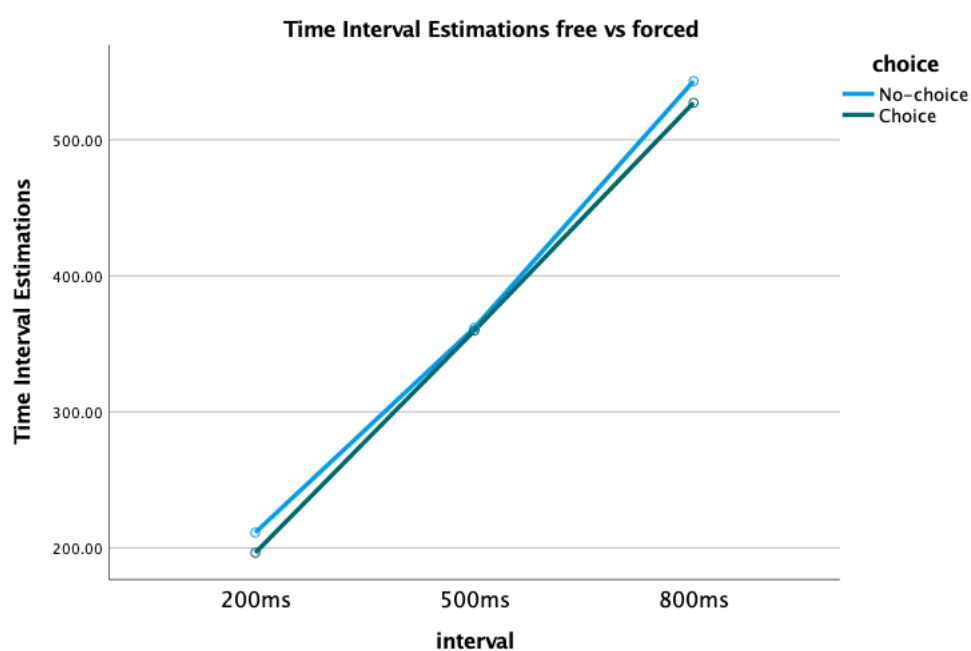
## Results

### Results Time Interval Estimation

A repeated-measures ANOVA was performed with choice (choice vs. no-choice) and interval (200, 500 & 800ms) as predictors and TIE as dependent variable. We observed that, overall, the Time Interval Estimations were lower in the free choice condition ( $M = 361,1$ ,  $SD = 112,7$ ) than in the forced choice condition ( $M = 372.1$ ,  $SD = 116.3$ ). However, this difference was not significant ( $F(1,46) = 3.277$ ,  $p = .077$ , partial  $\eta^2 = .067$ ). So, the TIE did not significantly differ between the free and forced condition. We did find a main effect of interval ( $F(1,46) = 122.950$ ,  $p = < .001$ , partial  $\eta^2 = .845$ ). Thus, as the length of the interval increases, the TIE tends to be higher. Finally, we did not observe an interaction between choice and interval ( $F(1,46) = 1.122$ ,  $p = .335$ , partial  $\eta^2 = .048$ ). Which means that the relationship between choice and TIE does not differ for different intervals.

### Figure 2

*Plot of TIE against choice and interval.*



### Results Reaction Time

We found no prove of a main effect of choice on the reaction time ( $F(1,46) = .475$ ,  $p = .494$ , partial  $\eta^2 = .010$ ). Subsequently, we did not observe a main effect of interval on the reaction time ( $F(1,46) = 2.672$ ,  $p = .080$ , partial  $\eta^2 = .106$ ). Finally we did not observe an interaction between choice and interval ( $F(1,46) = .609$ ,  $p = .548$ , partial  $\eta^2 = .026$ ). These results are comforting, because the task was about the TIE and not the reaction time, so, we did not want to see any significant effects.

### Manipulation check

To check whether thee free and forced condition were actually experienced as free and forced, we performed a paired sample t-test. We found some significant differences in subjective experience of the conditions: the perceived unpleasantness was higher in the forced choice condition ( $M = 3.38$ ,  $SD = 1.90$ ) than in the free choice condition ( $M = 2.79$ ,  $SD = 1.78$ ), the free choice condition felt as more natural ( $M = 5.4$ ,  $SD = 1.95$ ) than the forced choice condition ( $M = 4.62$ ,  $SD = 1.79$ ) and perceived restrictions to autonomy were higher in the forced choice condition ( $M = 5.21$ ,  $SD = 2.26$ ) than in the free choice condition ( $M = 4.11$ ,  $SD = 2.11$ ).

**Table 3**

*Paired-Samples T-test to compare the subjective experience of the choice and no-choice condition.*

Variable	Choice		No- Choice		t(47)	p	95% CI	
	Mean	SD	Mean	SD			LL	UL
enjoyment	4.94	1.823	4.74	1.635	.729	.470	-.337	.729
Struggle	3.83	2.200	3.28	1.885	1.496	.141	-.191	1.496
unpleasantness	2.79	1.781	3.38	1.895	-2.057	.045	-1.179	-2.057
naturalness	5.40	1.952	4.62	1.788	2.825	.007	.226	2.825
unnaturalness	4.51	1.864	5.11	1.832	-1.982	.053	-1.201	-1.982
restriction of autonomy	4.11	2.108	5.21	2.264	-3.105	.003	-1.824	-3.105

### Discussion

In contrast to experiment 1, we did not observe a significant negative relation between restricted autonomy and the sense of agency. Because of the more controlled setting, it was more difficult to recruit a big sample. This lack of participants could have diminished the power. A low power could have been the reason that we were not able to observe a significant

relation between restrictions of autonomy and the sense of agency. Hence, the optimized research setting did not lead to finding a stronger negative relation between restricted autonomy and the sense of agency. However, the effect size, which was higher in experiment 2 than 1, indicates that the optimized research setting could possibly explain more variation in the sense of agency and thus provide a clearer paradigm of the relation between restricted autonomy and the sense of agency. In addition, the overall pattern seems right; i.e. more binding in the free condition than the forced condition. This suggests that the relation might be there, only not yet significant. Subsequently, using a bigger sample could lead to a statistical model that captures a significant negative relation between restricted autonomy and the sense of agency the sense of agency.

#### Combined results

To check if the TIE's differed between the two experiments and if the relation between choice and TIE was different for the two research contexts; we added experiment as a between-subject factor to the repeated measures ANOVA with choice and interval as predictors and TIE as the dependent variable. We found that, overall, the TIE's are higher in the optimized online research setting than in the setting without control and interaction (Table 4) ( $F(1, 196) = 9,295, p = .003$ ). This holds for both the choice and no-choice condition. Subsequently, we found no prove of an interaction between choice and experiment, which means that the relation between choice and TIE did not differ for the experiments (Figure 3).

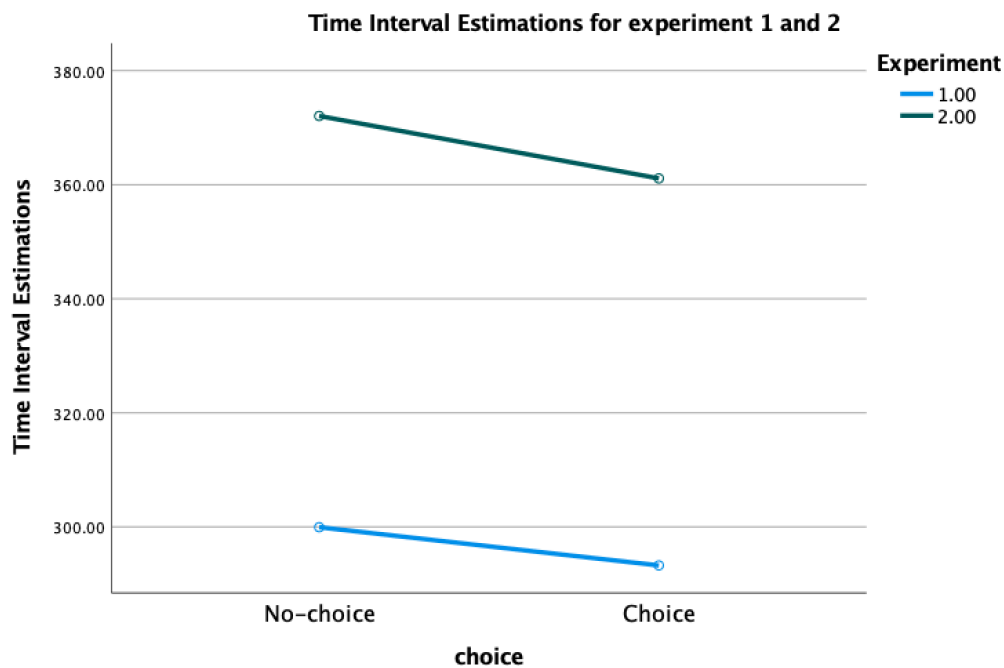
**Table 4**

*Comparison of the TIE of experiment 1 and 2 (Optimized)*

	Choice		No-choice	
	Mean	SD	Mean	SD
Experiment 1	293.253	144.418	299.951	146.440
Experiment 2 (Optimized)	361.119	112.726	372.068	116.294

**Figure 3**

*Plot of TIE against choice and experiment.*



The reason that the mean TIE's are higher in experiment 1 than 2, might be provided by the minimum TIE's of experiment 1 (Table 5). These low minimum estimations for both the free and forced condition imply that some participants entered nonsense answers; almost equal to zero. The fact that the minimum TIE's of experiment 2 were considerably higher, suggests that the meeting in Microsoft Teams, with the (more) controlled setting and clear(er) instructions had an effect.

**Table 5**

*Minimum and Maximum TIE in experiment 1 and 2*

Experiment 1	Minimum	Maximum
Choice	1.02	761.84
No-choice	.75	801.77
Experiment 2		
Choice	85.25	704.90
No-choice	91.38	805.65



To further investigate to what extent we had improved the research setting, we compared the amount of data that usable for analysis. For experiment 1, 79.2% of the data was usable, whereas for experiment 2, 94% of the data was usable. This relative difference indicates that the instructions and (more) controlled setting contributed to the understanding of the task.

Finally, we compared the experience of the manipulation in both studies. We found no significant interaction effects (Table 6) between experiment and the choice/no-choice condition. This means that the relationship between choice/no-choice and the items of the manipulation check, did not differ between the two experiments. Next to this, we examined the main effects of experiment on the different manipulation check items (Table 7). We found only a main effect of the experiment on the extent to which people experienced the situation as a struggle. I.e. in general, experiment 2 felt more as a struggle (figure 4).

**Table 6**

*Manipulation check items against the interaction of experiment and choice/no-choice*

Dependent variables	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>p</i>
enjoyment	.166	1	.166	.102	.750
struggle	6.449	1	6.449	3.281	.072
unpleasantness	1.931	1	1.931	.940	.333
naturalness	2.714	1	2.714	1.143	.286
unnaturalness	.412	1	.412	.209	.648
restriction of autonomy	11.556	1	11.556	3.564	.061

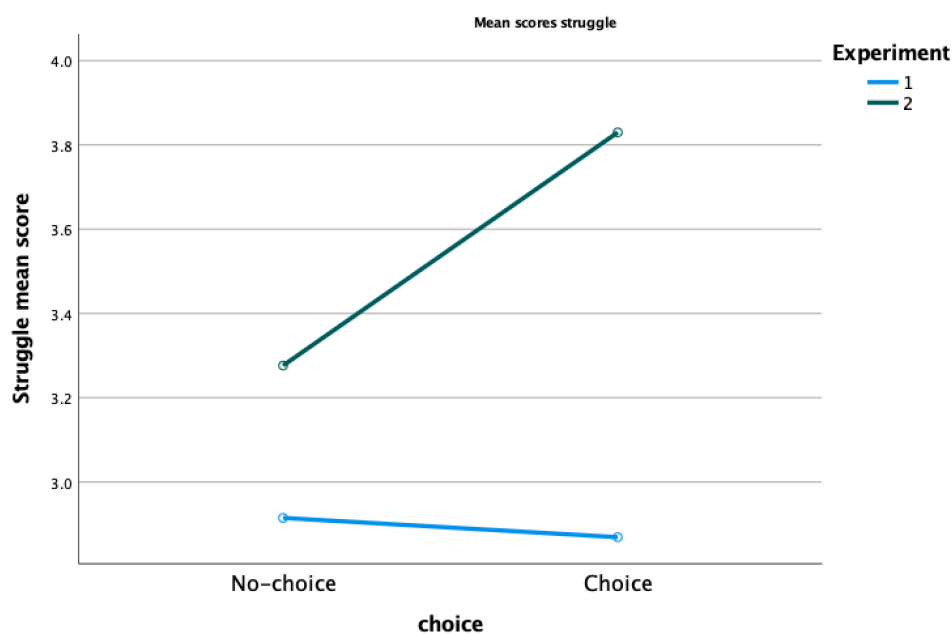
**Table 7**

*Main effects of experiment on manipulation check items*

Dependent variables	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>p</i>
enjoyment	.006	1	.006	.001	.975
struggle	31.422	1	31.422	5.001	.026
unpleasantness	7.220	1	7.220	.944	.332
naturalness	8.671	1	8.671	1.389	.240
unnaturalness	.326	1	.326	.043	.836
restriction of autonomy	10.724	1	10.724	1.440	.232

**Figure 4.**

*Main effect of experiment on struggle*



#### General discussion

This two-part study investigated how restrictions of autonomy affect the sense of agency. Due to COVID-19 measures it was conducted online. The first part took place in an environment without interaction and control, whereas the second part took place in an

environment with interaction and control. In the part without interaction and control, we found that restrictions of autonomy are related to a lower sense of agency. However, the observed relation was not that strong. The aim of the second part of the study was to investigate how improving the online research setting would relate to the association between restricted autonomy and the sense of agency. We expected that improving the online research setting would be related to a stronger negative association between restricted autonomy and the sense of agency. Contrary to this hypothesis, we did not find prove of a significant negative relation between restricted autonomy and the sense of agency. However, the more controlled setting complicated the recruitment of a large sample, therefore, the sample was rather small. Because this small sample could have lowered the power, we should be careful with interpreting the results. Because a bigger sample could possibly lead to actually finding a significant negative relation between restricted autonomy and the sense of agency. The idea that a bigger sample might lead to finding a significant relation, is supported by the fact that the binding was stronger in the free condition than the forced condition; because this suggests that the operationalization of autonomy succeeded and that the relation might actually exist. So, in contrast to experiment 1, in experiment 2 we did not find evidence for a negative relation between restricted autonomy and the sense of agency, but the results suggest that a bigger sample could lead to actually capturing a significant negative relation.

Next to the findings of the first part of the study, finding no prove of a relationship between autonomy and the sense of agency, is also not in line with the findings of another study that displayed the intentional binding effect (Caspar et al. 2016). Like this study, Caspar and colleagues used the TIE-task to capture the intentional binding effect, in contrast to us, they actually observed the intentional binding effect; they observed that the perceived time interval between an action and its outcome was bigger in the no-choice condition than the choice condition. However, the methodology of their study differed from this study; in their study, participants were instructed to harm fellow participants to gain financial earnings. The choice versus no-choice condition was operationalized by either being free or forced to choose the method of harm. Whereas in this study, there was no such thing as hurting another participant, the choice versus no-choice condition was operationalized in an innocent way, i.e. being free or forced to make a face look in a certain direction. One could argue that the outcome of the action mattered way more in the study of Caspar and colleagues than in this study, because hurting someone else may have a bigger psychological impact than just making a face look left or right. It is likely that people realize that hurting someone is perceived as bad by the majority of people, they might not want to be responsible for such

behavior, therefore, in a context where someone is being forced to show hurtful behavior, they might hold the one responsible that forces them. This idea is supported by Milgram (1963;1974) who discovered a shift of responsibility when people were obedient to someone with authority. So, even though the results of this research suggest that the free and forced conditions were distinctive enough, making a face look either left or right, might not be a strong enough stimulator for someone to experience such a mental dilemma. Our methodology could have just made participants mindlessly follow the instructions, without experiencing any psychological distress, and therefore not a big enough difference between the free and forced condition. Although this line of reasoning seems rather plausible, it does not explain why we did observe the intentional binding effect in the first part of the study. One thing that could explain that we did not find an effect in the second part of the study, is the small sample size. The small effect size indicates that if the relationship between autonomy and the sense of agency exists, it is rather small. Our small sample might not have had the power to detect such a small relationship. Next to this, as already indicated above, it could be that the difference between the free and forced condition was not big enough to make them distinctive. Because in the free condition participants only had two alternatives, compared to one in the forced condition. But, again, this does not explain why initial study did observe a relation.

Although we did not find proof for the existence of a relationship between autonomy and the sense of agency, this study did provide some useful insights. The fact that the mean TIE was higher in the study with the improved online research setting than in the first part of the study with the not so rich online research environment, showed that the Teams-setting did improve the methodology of the study, because it indicates that the controlled research setting and the clear instructions resulted in less nonsense answers. So, it looks like the more controlled setting and the clear personal instructions did their job. This claim is supported by the fact that in the improved online environment, the amount of usable data was considerably larger than in the initial study. More data was usable because there were more completes and more participants understood the task and performed accordingly.

So, in the first part of the study we observed a significant relation between restrictions of autonomy and the sense of agency, but in the second part, after improving the online research setting, we did not observe an effect. Although, this is not in line with previous studies, the second part of the study (with its small sample size) does not allow for undermining existing theories and findings of the first part of the study. With the COVID-19 measures in remission and thus the opportunity for real-life lab experiments to return, there is

hope that the research setting can be further improved. Using a big sample size in a real-life lab setting could enable future studies to further map how restrictions of autonomy affect the sense of agency.

Even though more studies need to be performed, this study has already shown that there is a plausible chance that restrictions of autonomy affect the sense of agency. This could be problematic and should be prevented or solved, because the experience of sense of agency is needed to set goals that are based on an intrinsic motivation (Locke and Latham, 1990). Goals that are based on intrinsic motivation are thought to play an important role in happiness (Michalos, 1980), behavioral regulation and behavioral change (Carver & Scheier, 2001; Bandura & Adams, 1977). A diminished sense of agency and therefore possibly a limited capacity for setting goals could result in all kinds of problems for daily life practices. This illustrates that it is of big importance to guarantee people their autonomy as much as possible, so that the sense of agency will remain high and setting goals and its additional benefits remains achievable. Because the sense of agency seems so important in forming specific goals. The Goal-Setting theory (Locke & Latham, 1994) should broaden its paradigm, which means that they should include autonomy and the sense of agency. Right now, the theory states that it is beneficial to set specific goals rather than opaque ones and that specific goals tend to increase the performance of someone. But it should be added that for someone to set specific goals, they must first experience a sense of agency and that the restrictions of autonomy should therefore be limited.

Future research should first use a bigger sample size, but it should also focus on adjusting the methodology. To make the free and forced condition more distinctive, future research could enlarge the number of alternatives in the free condition and also make the outcome of the action more important. An example of a task could be a task in which participants are either free or forced to steal or not steal different amounts of money from a confederate (e.g. do not steal, steal €10, steal €20 or steal €30). This will result in more alternatives, because one can steal different amounts of money. In addition, being forced to display hurtful behavior towards someone else is more likely to cause negative feelings than just making a face look left or right, this is because the consequences of the action are totally different. These negative feelings are likely to make the forced condition feel as more forced. This claim is supported by Milgram (1963;1974), who demonstrated that being forced to display hurtful behavior may result in a shift of responsibility. Which implies that people do not feel like they are the agent of their behavior if they are forced to display hurtful behavior. Therefore, it is plausible that the participants will perceive the act of stealing money as

something they do not really want to do their self, and thus as forced. Whereas making a face look left or right may not elicit this kind of psychological process but rather lead to mindlessly mental processing and acting. Providing this stronger operationalized distinction between being free or force may lead to finding robust evidence for the intentional binding effect.

To conclude, the results suggest that there exists a negative relation between restricted autonomy and the sense of agency. Even though the optimized online research setting was not able to capture the latter relation, it did improve the methodology considerably. With the use of a bigger sample, the optimized online research setting is also likely to result in finding a significant relation.

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## Appendices

### Appendix A

Instructions of TIE-task for participants.

#### *English instructions*

Hello, welcome to our time perception experiment. Thank you for your interest.

First, I will ask you a few questions.

- Are you a university student?
- Are you capable of reading and following English instructions? Okay
- Do you have a working headset? Okay. Could you please put it on?
- Do you have a working keyboard? Is it a bluetooth keyboard? Okay
- Do you have a stable internet connection? Alright
- This experiment will take approximately 30 minutes. Will you be able to focus on the experiment continuously in a quiet environment?

Okay, you meet all the requirements for the experiment. Now I will send you a link in the chat for the informed consent. Please read this carefully and ask questions if you have any. I will be waiting here, after you finish reading you can type your name and click on “consent”. Please let me know when you are done.

<https://research.sc/participant/login/dynamic/E31D8337-EDC1-4FA9-B871-00E1DC94CD03>

You can now find the link in the chat.

The task will be clearly explained once you open the link to the experiment, but there are two things that I

want to address now: Firstly, in the experiment you will be either free or forced to press a key. You can press the key at a

time that you choose-. After this key press a face will appear on your screen with a short or long delay. The delays will change in

time and your task is to estimate the time between the key press and the appearance of the face. You are only allowed to use digits. It

is very important that you correctly enter the estimation. I will now share my screen and show you what a correct entry looks like.

\*show pdf\*

Do you understand the way of entering the estimation?

Secondly, the face that will appear after the delay has an orange nose. Please try and focus on the nose.

Now I will send you a link with which you can start the experiment. Please click on it to see if it is working. Okay, please close all other open tabs and leave this Teams meeting before starting the experiment. Once you finish the experiment, you will see a completion code. Please copy the code and return to this Teams meeting for debriefing and the reimbursement for your participation. You can return to the Teams-meeting via the link in the initial e-mail.

If everything is clear to you, you can now open the link I am sending in the chat and start the experiment. Please open the link to Gorilla first and then leave the meeting.

<https://research.sc/participant/login/dynamic/2997A196-3455-4D29-B666-F8B39323B82F>

- Doing the experiment -

Thank you for coming back to this meeting. You can paste the code in the chat. I'd like to ask you some more questions now.

How did the experiment go in general?

Would you like to receive money or credits for this experiment?

- If money: you can send your iBAN in the chat and we will transfer the money.
- If credits: you can fill in your name and student number, I will make sure that you get the credits assigned.

Finally, do you have any further comments or questions?

Would you like to participate in other studies run by our lab in the future?

Thank you for participation and have a nice day!

### *Nederlandse instructie*

Hallo, welkom bij ons tijd-perceptie experiment. We willen u alvast bedanken voor uw deelname.

Voor u begint, wil ik u een aantal vragen stellen

- Studeert u aan een universiteit?
- Kunt u Engelse instructies lezen en volgen? Okay
- Heeft u een werkende headset? Okay. Zou je deze op kunnen zetten?
- Heeft u een werkend toetsenbord (geen bluetooth!)? Okay
- Heeft u een werkende internetverbinding? Okay
- Het experiment zal ongeveer 30 minuten duren. Bevindt u zich in een rustige werkomgeving waar u zich de komende 30 minuten kunt concentreren?

Oké, u voldoet aan de vereisten. Ik stuur u nu in de chat een link met de informed consent. Lees dit alstublieft zorgvuldig door en stel vragen wanneer u die heeft. Als u klaar bent met lezen dan mag u uw naam intypen en op “consent” klikken. Geef vervolgens in de Teams meeting aan dat u klaar bent.

<https://research.sc/participant/login/dynamic/E31D8337-EDC1-4FA9-B871-00E1DC94CD03>

In de chat kunt u nu de link vinden

De taak zal helder uitgelegd worden wanneer u de link naar het experiment straks opent, maar er zijn twee dingen die ik wil benadrukken. Ten eerste, tijdens het experiment zal u vrij zijn of verplicht worden om bepaalde toetsen in te drukken. U kunt dit doen op een door u gewenst moment, na het indrukken van deze toets zal er na een vertraging een gezicht op het scherm verschijnen. Deze vertraging zal telkens in lengte verschillen. Uw taak zal zijn om de tijd tussen de toets indruk en het verschijnen van het gezicht in te schatten. Het is belangrijk dat u alleen cijfers gebruikt en de schatting op een correcte manier invoert. Ik zal nu mijn scherm met u delen en door een PDF-bestand heen lopen om u te laten zien hoe een correcte invoer eruitziet.

\*show pdf\*

Begrijpt u de manier van invoeren?

Ten tweede, het gezicht wat na de vertraging in beeld zal verschijnen heeft een oranje neus. Focus alstublieft op de neus.

Ik zal u nu een link toesturen waarmee u toegang krijgt tot het experiment. Controleer alstublieft of deze werkt. Sluit alstublieft alle andere tabbladen en verlaat deze Teams-meeting voordat u met het experiment start. Zodra u het experiment hebt voltooid, zult u een code zien. Kopieer dan de code en keer terug naar deze Teams-meeting, dan vragen we hoe het gegaan is en zullen we zorgen dat de credits/vergoeding in orde gemaakt wordt. U kunt terugkeren in de Teams-meeting via de link in e-mail.

Als alles duidelijk is dan kunt u nu de link openen en met de taak starten. Het is belangrijk dat u eerst de link naar Gorilla opent en daarna pas de Teams-meeting verlaat.

<https://research.sc/participant/login/dynamic/2997A196-3455-4D29-B666-F8B39323B82F>

- Nu voeren ze het experiment uit -

Bedankt voor het terugkeren naar deze meeting. U mag de code in de chat sturen. Ik zou u graag nog een paar vragen stellen over het experiment:

Hoe verliep het experiment?

Zou u credits of een vergoeding willen ontvangen?

- Credits: u kunt uw studentnummer invullen in de chat, dan zorgen we dat u de credits toegewezen krijgt.
- Vergoeding: U kunt nu uw iBAN-nummer invullen in de chat, dan zal ik zorgen dat het geld overgemaakt wordt.

Tenslotte, heeft u nog verdere opmerkingen of vragen?

Zou u in de toekomst willen deelnemen aan andere onderzoeken die door ons lab worden gedaan?

Bedankt voor uw deelname en nog een fijne dag!