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Perceived control and the pleasantness of choosing: How much choice is too much choice?

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ABSTRACT

We can choose between various options in a multitude of situations every day. General consensus states that the ability to choose between different alternatives enhances our sense of agency, i.e., our perceived control and perceived causality over our environment. As sense of agency is thought to be a rewarding experience, abundant choice options might be preferable to fewer choice options. However, too much choice could also lead to increased cognitive effort and an overburdening of individuals, e.g., when engaging in consumer behaviour. The present experiments elucidate the interplay of sense of agency, pleasantness of choice, and perceived effort dependent on the available number of choice options. Results indicate that, surprisingly, sense of agency and pleasantness of choice peak around four choice options, with further choice options decreasing pleasantness and increasing perceived effort of the selection process. Moreover, perceived control and pleasantness of choice were strongly associated, further supporting the notion of sense of agency as a rewarding experience.

Introduction

Consider this scenario: You're running out of shampoo and go to your local supermarket to buy a new shampoo bottle. The shampoo aisle houses about 40 alternatives from which you can choose. Do you consider this abundancy of choice options helpful or a nuisance? Does it increase your experience of control over your purchase, or does it feel overwhelming to the point of decreasing your ability to choose?

We are faced with choice scenarios like this every day, be it the choice between shopping alternatives, emojis while texting, or pizza toppings for fast food deliveries. A general assumption in the literature relating to sense of agency and perceived control reflects the idea that an increasing number of options increases our experience of control (Antusch et al., 2021; Barlas et al., 2018; Schwarz et al., 2019, 2023; Sebanz and Lackner, 2007; Wenke et al., 2010): After all, the more choice we have, the more precisely we can control our environment via our choice. And as having and exercising control is thought of as rewarding, and is being considered a powerful action (selection) motivator, an abundancy of choice options should lead to a situation being perceived as more pleasant (Burger and Cooper, 1979; Eitam et al., 2013; Gozli, 2019; Karsh and Eitam, 2015; Karsh et al., 2016; Leotti and Delgado, 2011; Leotti et al., 2010; Reis et al., 2023; Schwarz et al., 2022; White, 1959; but see Schwarz et al., 2023 for an example of a more complex control-reward association in joint actions). Indeed, the formation of our sense of control (as a crucial aspect of our sense of agency) assumes that the more precisely we can achieve a desired goal, the more strongly we assume authorship and control over a given situation on an implicit as well as an explicit level (e.g., Haggard, 2017; Synofzik et al., 2008)[1].

However, an increased number of options also seems to increase the cognitive effort involved in choosing as is suggested by the increased selection time (i.e., reaction time) needed to make the choice (e.g., Berlyne, 1957; Hick, 1952). Likewise, increased cognitive effort may lead to action selection disfluency thereby reducing our sense of control over our actions and their effects (Chambon et al., 2014; Haggard and Chambon, 2012; Sidarus and Haggard, 2016; Wenke et al., 2010).

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[1] Please note that both, sense of control and sense of causality (i.e., authorship assumptions), are conceptually the primary aspects of sense of agency, and both have often been synonymously referred to as "sense of agency" in the literature. However, as closely related as both aspects may be, sense of control and sense of authorship reflect different emphases with regards to sense of agency ("Am I in control?" vs. "Was that me?") and may not always co-align. In the present experiments, I have studied sense of agency with a focus on its control aspect (i.e., perceived control or sense of control), and I will thus use sense of control, perceived control, experienced control, etc. to refer to all statements in relation to these measurements, but I will use sense of agency, perceived agency, experienced agency, etc. in all statements of a more general nature.

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Moreover, evidence suggests that too much choice can also prove demotivating (Botti and Hsee, 2010; Iyengar and Lepper, 2000). Indeed, an adverse impact of abundant choice options has been discussed in research on consumer psychology. Corresponding studies on consumer behaviour have tried to clarify optimal option numbers to facilitate purchase decisions, thereby weighing the preference of consumers for large assortments against choice overload, i.e., the consumers' inability to actually make a choice when more choice items are available (e.g., Hamilton and Chernev, 2012). Interestingly, a meta-analysis on choice overload finds a null effect over 50 studies with some experiments finding that too much choice stifles consumer behaviour and others that it facilitates choice and satisfaction (Scheibehenne et al., 2010). Making choices too difficult, e.g., by giving too many options, may also increase "sludge", i.e., increase friction that makes it harder for individuals to do what they want to do (Shahab and Lades, 2024). The current question of sense of agency in relation to choice option abundancy may help to reveal when choice overload occurs and when it does not.

Thus, the question remains: do more choice options equate more perceived control? Are they associated with a higher pleasantness of choice? Or do we – at some point – reach a plateau or even experience a decrease in our sense of control and in the pleasantness of the experience? How do these experiences relate to the perceived effort of choice – and how do they relate to implicit markers of cognitive effort such as response times or response durations?

In the present experiments, I asked participants to choose between a given set of keys eliciting a given set of emojis with absolute control over the choice so that specific keys were assigned to specific emojis and selecting a key would always elicit the chosen emoji. Moreover, in every trial, all combinations of keys to emojis were always fully displayed so that participants did not have to memorize key-emoji associations.

While the participants could freely choose between conditions, the outcome had no actual relevance to the participants in terms of financial reward or a superordinate task – aside from potential affective responses based on the experimental procedure. The reasoning behind this choice in paradigm lies in its comparability to other basic paradigms in the field of sense of agency research – many of these paradigms ask participants to choose between options without a clear relevance of outcome (e.g., Sebanz and Lackner, 2007; Schwarz et al., 2019; Sidarus et al., 2016; Weller et al., 2020). Philosophically, one could argue that a choice without preference is more akin to picking than choosing (Shoval et al., 2022; Ullmann-Margalit and Morgenbesser, 1977). However, as studies in the field (i.e., sense of agency research) and related fields (e.g., human action control) have consistently used the terminology of choice (e.g., free choice, forced choice, etc.) for these basic paradigms of "picking", I will keep with that terminology to avoid confusion.

In Experiment 1, dependent on block, participants had the choice between one,[2] two, four, eight, and sixteen different key-emoji mappings; in Experiment 2, participants could choose between two, four, six, eight, and ten different key-emoji mappings. I assumed that higher number of options would relate to higher perceived control and a higher pleasantness of choice. However, as I also assumed perceived effort to increase with higher choice options, as well as reaction times as an implicit marker of cognitive effort, I hypothesized that sense of control and pleasantness of choice would either plateau after a certain number of options or decrease with a specific turning point for sense of control and pleasantness of choice. These hypotheses were preregistered (see Methods).

[2] Of course, in blocks with only one option, participants did not truly have a choice; however, for ease of description, I will still include this option in the list of choice options.

Methods

Participants

Experiment 1

I recruited 88 participants for an online study; this sample size was based on a power calculation assuming an effect size of $d_z = 0.32$ in accordance with previous work (Schwarz et al., 2019) to ensure a power of 1-β= 0.80, increased by 10 % to replace possible drop-outs.[3] Based on preset criteria (incomplete or faulty data sets [$n = 3$]; failure to perform the experimental task as signified by no variation in ratings across all conditions [$n = 18$]), I excluded 21 participants, resulting in a final sample of $N = 67$ participants (mean age = 29.0 years, SE = 1.28, range 19–65; 53 females, 13 males, 1 non-binary). Participants were categorized as "failed to perform the experimental task" if the sum of absolute values of all subsequent pair-wise differences in perceived control ratings between conditions (i.e., |cond1-cond2| + |cond2-cond3| + |cond3-cond4| + |cond4-cond5|) was < 3 % of the rating scale. The final sample size still allowed for sufficient power of 1-β = 0.80 to detect effect sizes of $d_z \geq 0.35$. Because the number of exclusions exceeded our expectations, I chose to perform the main calculations on sense of control on the reduced sample as originally planned, but as a control analysis repeated the calculations with the full sample (except for participants with incomplete or faulty data sets) to ensure that participant exclusion was not the main driving point for any found effects. Results for the full sample mirrored the results of the reduced data set (for details see Supplementary Material). Participants gave informed consent prior to the experiment and received monetary compensation for participation.

Experiment 2

I recruited 95 participants; this sample size was again based on a power calculation assuming an effect size of $d_z = 0.32$ in accordance with previous work (Schwarz et al., 2019) to ensure a power of 1-β = 0.80. Because of the exclusion number in Experiment 1, sample size was increased by 20 % to replace possible drop-outs, resulting in a sample size of ≥ 95. Based on preset criteria (incomplete/faulty data sets [$n = 1$]; failure to perform the experimental task as signified by no variation in ratings across all conditions [$n = 15$]), I excluded 16 participants, resulting in a final sample of $N = 79$ participants (mean age = 25.9 years, SE = 0.88, range 18–62; 57 females, 21 males, 1 non-binary). With this sample, I was able to detect an effect size of $d_z \geq 0.32$ with a power of 1-β = 0.80, as originally planned. However, to parallel the analyses in Experiment 1, I chose to repeat the calculations with the full sample as a control analysis (except for participants with incomplete or faulty data sets) to ensure that participant exclusion was not the main driving point for any found effects. Results for the full sample mirrored the results of the reduced data set (for details see Supplementary Material). Participants gave informed consent prior to the experiment and received monetary compensation for participation.

Stimuli and apparatus

Both experiments were programmed using E-Prime 3.0 and provided to the participants via E-Prime Go 1.0. The participants were required to use a Windows computer (Windows 7 or newer) and a keyboard with the keys C, V, B, N, D, F, H, J, E, R, U, I, 3, 4, 8, 9 (Experiment 1) and C, V, B, N, D, F, H, J, R and U (Experiment 2). These keys were chosen so that even for a block of 16 choice options, participants could relatively comfortably reach every key using a standard German QWERTZ keyboard. Sixteen (Experiment 1) and 10 (Experiment 2) different

[3] I had originally planned to recruit a sample size of 87 participants but noticed an incomplete dataset during data collection so that I collected an additional dataset.

emojis from iOS 8.3 were used as stimuli. As the set of emojis used in Experiment 2 was a subset of the emojis used in Experiment 1, overall 16 different emojis were used in the course of these experiments.

Control (as an aspect of sense of agency), effort and pleasantness ratings were entered on a visual analog scale ranging from 0 (“no control“, “no effort“, and “very unpleasant“, respectively) to 100 (“total control“, “a lot of effort“, and “very pleasant“, respectively). The control question read “How strongly did you feel in control over the emoticon in this trial?” (German original: “Wie viel Kontrolle hattest du in diesem Durchgang über den Emoticon?”), the effort question read “How effortful was the selection of a key during this block?” (German original: “Wie viel Mühe hat dir die Tastenwahl in diesem Block gemacht?”), and the pleasantness question read “How pleasant was the selection of a key during this block?” (German original: “Wie angenehm hast du die Tastenwahl in diesem Block empfunden?”). When the scale appeared on the screen, the cursor line participants were asked to move with the mouse was always presented at the center of the scale.

Procedure

The experiment consisted of five different block types that varied with regards to the number of response options available to the participant (1, 2, 4, 8, or 16 for Experiment 1 and 2, 4, 6, 8 or 10 for Experiment 2). Each type of block occurred twice per participant, so that each participant completed ten blocks in total and each of these blocks comprised 24 trials. The order of blocks was randomized. Additionally, at the beginning of the experiment the participant completed a short practice block with four response options that consisted of six trials. The number of response options for the practice block was the same for all participants to ensure the same experience, and was not altered within the practice block to avoid confusion because experimental blocks would also always feature the same number of options within block. Nevertheless, this means that participants were slightly more practiced in choosing between four options than between other numbers of options. The participants' task was to press different keys after which they saw an emoji depending on the key they pressed.[4] As all key-emoji mappings were fully displayed during the selection process, participants made fully informed choices with regards to the outcome of the key presses they chose to execute. The key-emoji mapping was randomized across participants but remained constant throughout the experiment for each participant. Key-emoji mappings were always the same within block, with the mappings being displayed at the same location on the screen throughout the block. At the beginning of each block the participants were informed about which keys they could press during the following block, and they saw an overview of the key-emoji mapping.

Participants were instructed to choose a key spontaneously at the beginning of each trial to avoid forming strategies instead of actually choosing (such as always pressing the same key) and they were informed that it was not important to react as fast as possible. At the beginning of each trial a fixation cross was presented in the middle of the screen together with the overview of the key-emoji mapping at the top and bottom of the screen so that participants had full knowledge and control over the choice of emoji at any given time (see Fig. 1). The fixation cross disappeared after 500 ms, but the overview of the mapping remained visible until the participant pressed a key. Upon keypress the screen went blank and after a jitter of 200, 400, 600, 800, 1000 or 1200 ms the respective emoji was presented for 250 ms with an action-outcome contingency of 100 %. Jitter times were introduced to elicit some basic variance in control experience and to ensure that the investigated effects on control ratings were not restricted to specific inter-stimulus intervals, as sense of agency measures have been shown to be sensitive to inter-stimulus intervals in past experiments (e.g., Schwarz et al., 2018). The next trials started after an interval of 500 ms. If the participant pressed a key before the fixation cross disappeared or two keys were pressed simultaneously, an error message was presented for 2000 ms, and the trial was repeated.

After every third trial the control question was presented which resulted in a total of 16 control ratings per condition (8 rating trials per block, two blocks per condition). After each block, except for the practice block, the pleasantness and effort questions were presented. This procedure resulted in a higher number of control ratings per condition than pleasantness and effort ratings. The reasoning behind that choice lay with elevating the participants' motivation to honestly evaluate their perceived control (or pleasantness/effort) at every respective rating occurrence by limiting the number of overall rating incidences. Moreover, separating perceived control ratings from pleasantness and effort ratings was meant to ensure that these questions were evaluated individually, hopefully dissuading participants from rating similarly on all rating scales for purposes of ease, especially in a non-laboratory environment. However, the difference in data points per scale should be considered during data interpretation. Additionally, at the end of the experiment the participants were asked whether they used a specific strategy when selecting a key to press.

Data analysis

This study was designed as a two-experiment effort, with both experiments overlapping in several option numbers to increase power for a combined analysis (i.e., 2, 4, and 8 options), and the singular experiments then elucidating missing numbers of choice options, i.e., Experiment 1 additionally focusing on more extreme numbers, and Experiment 2 additionally focusing on missing option numbers in-between. For a general, high-powered picture[5] of the impact of option numbers on perceived control, pleasantness of choice, and perceived effort, I thus opted to first present the combined analysis, followed by an in-depth analysis of the individual experiments to elucidate on their specific focus of option numbers.

To this end, I first analysed common option numbers in both experiments (i.e., option numbers 2, 4, and 8). For the dependent variables perceived control, pleasantness of choice, and perceived effort, I computed analyses of variance (ANOVAs) with the within-subjects factors *option number* (2 vs. 4 vs. 8) and the between-subjects factor *experiment*, with follow-up ANOVAs to elucidate the difference in dependent variables between option numbers two and four, and between four and eight, respectively. These analyses were followed by ANOVAs, calculated separately for each experiment, including all available option numbers, with the within-subjects factor *option number* (i.e., 1 vs. 2 vs. 4 vs. 8 vs. 16, and 2 vs. 4 vs. 6 vs. 8. vs. 10). Follow-up paired *t*-tests were computed to test for differences in the respective dependent variable between each level of *option number* with the respective subsequent level (e.g., 1 vs. 2, 2 vs. 4, 4 vs. 8, etc.). Greenhouse Geisser corrections were applied whenever sphericity assumptions were violated. Effect sizes for paired *t*-tests were calculated as $d_z = t/\text{sqrt}(n)$.

To evaluate associations between perceived control, pleasantness of choice, and perceived effort, I first calculated correlations computed separately for each level of the factor *option number*. This was followed

[4] The task was deliberately worded to focus on the action (the keypress) rather than the outcome to emphasize the availability of action choices which is conceptually more related to sense of agency than availability of outcomes. I cannot preclude that a wording that is more relating to the action outcome rather than the keypresses might result in different rating patterns, although I would not assume the results to differ strongly in the current experiments due to the simple and clear action-outcome translation.

[5] The combined data set, even with the reduced sample size based on preregistered exclusion criteria resulted in a power of over 97% given the parameters described in the *Participants* section.

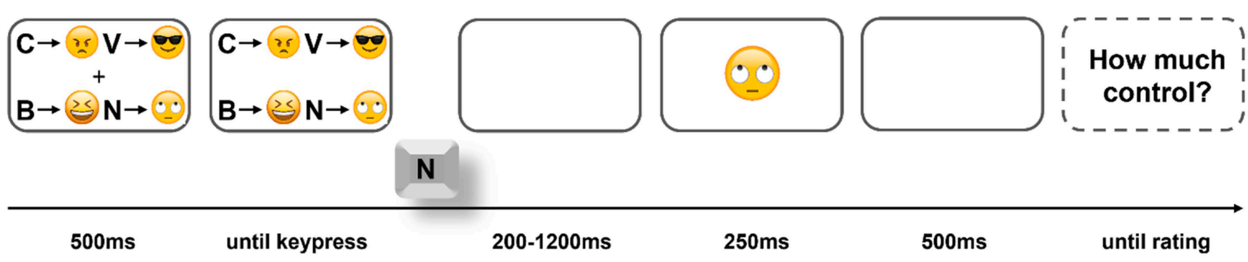

Fig. 1. *Trial procedure for Experiments 1 and 2. [A trial of a 4-option block is shown in which the key N was chosen as an example.]* Participants were informed about all possible key-outcome associations at the beginning of the trial until they performed a keypress. After a jittered delay of 200–1200 ms the respective action outcome was presented (keypress-outcome contingency 100 %). Every third trial participants were asked to rate their perceived control (shown here in a dashed frame). Additionally, after each experimental block, participants were asked how pleasant they perceived the key selection in the respective block and how effortful they perceived the key selection to be.

by a two-step regression analysis (hierarchical regression) with the criterion perceived control, including first *option number* as a predictor, and then the factors *pleasantness of choice* and *perceived effort*. I additionally tested linear, quadratic, and logarithmic models for *perceived control* via mixed effects models in R (lmer package) with *option number, pleasantness of choice*, and *perceived effort* as fixed effects and *subject* as well as *experiment* as random effects. For both ratings we fit separate models for linear, quadratic, and logarithmic coding of all fixed effects and extracted the variance explained for each model (marginal and conditional R^2 as computed with the MuMIn package) in R.[6]

Reaction times (RT) were defined as the time between response cue and the participants' keypress, i.e., the time participants took to select a key in any trial. Response durations (RD) were defined as the time between keypress and key release, i.e., the time participants actually pressed down the key. RT and RD analysis was conducted similarly. First, as preregistered, all trials were excluded that deviated in response time (for RT analysis) or response duration (for RD analysis) >2.5 standard deviation from their respective cell mean (calculated by subject and option number). I then ran an ANOVA with the within-subjects factor *option number*, followed-up by paired *t*-test between each level of option number with the respective subsequent level.

To evaluate associations of RT, RD, and the participants' ratings, I first analyzed correlations between all dependent variables separately for each level of *option number*. Finally, I conducted a hierarchical regression with the criterion perceived control and the predictors *option number* (first step inclusion), *RT* and *RD* (second step inclusion), and *pleasantness of choice* and *perceived effort* (third step inclusion).

Results

Perceived control, pleasantness, and effort

Experiments 1 and 2 overlapped in choice options 2, 4, and 8. The present analysis will first focus on an analysis of these overlapping data points in terms of perceived control, followed by the analysis of rating patterns for perceived control especially regarding choice options unique for each experiment. This analysis pattern will then be repeated for pleasantness and effort ratings.

Perceived control

Participants perceived control differently across varying levels of choice options across both experiments, $F(2, 288) = 5.77, p = .008, \eta_p^2 = 0.04$, $\varepsilon = 0.73$ (GG-corrected), with their sense of control increasing between option levels two and four, but then plateauing at that level with only a slight, descriptive decline between option levels four and eight, 2 vs. 4: $F(1, 144) = 10.25, p = .002, \eta_p^2 = 0.07$; 4 vs. 8: $F(1, 144) = 1.31, p = .254, \eta_p^2 = 0.01$ (see Fig. 2). The effect was stable across experiments as indicated by non-significant main effects and interactions of the between-subjects factor *experiment* in the omnibus test as well as for the follow-up analyses $Fs < 1.48$, $ps > .227$, signifying similar rating patterns for both experiments. As one of the exclusion criteria (almost no variance in ratings potentially indicating a failure to perform the experiment as instructed) led to a larger than expected exclusion of participants, I decided to repeat this calculation with the full set of participants (except for participants with incomplete datasets) to ensure that the exclusion of participants did not drive these effects. The results of this recalculation mirrors the previous analysis, with participants' sense of control increasing between option levels 2 to 4 and then plateauing between option levels 4 to 8, omnibus: $F(2, 354) = 5.62$, $p = .009$, $\eta_p^2 = 0.03$, $\varepsilon = 0.73$ (GG-corrected), 2 vs. 4: $F(1, 177) = 9.93$, $p = .002$, $\eta_p^2 = 0.05$; 4 vs. 8: $F(1, 177) = 1.31$, $p = .254$, $\eta_p^2 = 0.01$. Again, participants' sense of control did not differ between experiments, all $Fs < 2.13$, all $ps > .146$. Thus, the results do not hinge on the exclusion of the respective participants; I will nevertheless put the results for the full set of participants in the Supplementary Material for the main analyses of perceived control, pleasantness of choice, and perceived effort for the sake of transparency.

Experiment 1 additionally focused on more extreme changes in choice options, i.e., the differences between 1, 2, 4, 8, and 16 options. The number of options affected the participants' control ratings, $F(4, 264) = 17.65$, $p < .001$, $\eta_p^2 = 0.21$, $\varepsilon = 0.37$ (GG-corrected); however, this effect was driven mostly by the difference between one and two options, $M_1 = 65.0$, $M_2 = 81.5$, $|t|(66) = 5.16$, $p < .001$, $|d_z| = 0.63$, and two and four options, $M_4 = 86.6$, $|t|(66) = 3.11$, $p = .003$, $|d_z| = 0.38$. Differences between four and eight, and between eight and sixteen options did not reach significance, $M_8 = 85.39$, $M_{16} = 85.0$, all $|t|s < 1.17$, all $ps > .249$, indicating that perceived control only increased until a number of four options was reached and then plateaued on this level (see Fig. 2).

Experiment 2 focused on option numbers 2, 4, 6, 8, and 10 to elucidate sense of agency formation in the critical region between four and six, and six and eight options, respectively, as these comparisons were not included in the design of Experiment 1. Across all conditions, differences in number of options did not affect perceived control, $F(4, 312) = 0.92$, $p = .400$, $\eta_p^2 = 0.01$, $\varepsilon = 0.49$ (GG-corrected). Descriptively, the pattern resembles the control ratings of Experiment 1 with a higher rating for four than two options, $M_2 = 80.4$, $M_4 = 82.9$, $|t|(78) = 1.49$, $p = .070$ (one-tailed), $|d_z| = 0.17$; however, this pattern was not stable enough to reach significance in Experiment 2 in contrast to Experiment 1. Both datasets combined, however, indicate that perceived control does increase from two to four options, even though only slightly. After four options, although the ratings descriptively decrease,

[6] For the quadratic coding, fixed effects were transposed to start at a minimum of zero [fixed effects-min(fixed effects)]^2. For logarithmic coding, a very small term of 0.0001 was added to the fixed effects to avoid fixed effect values of zero as ln(0) = -Inf leads to model error [ln(fixed effects + 0.00001)].

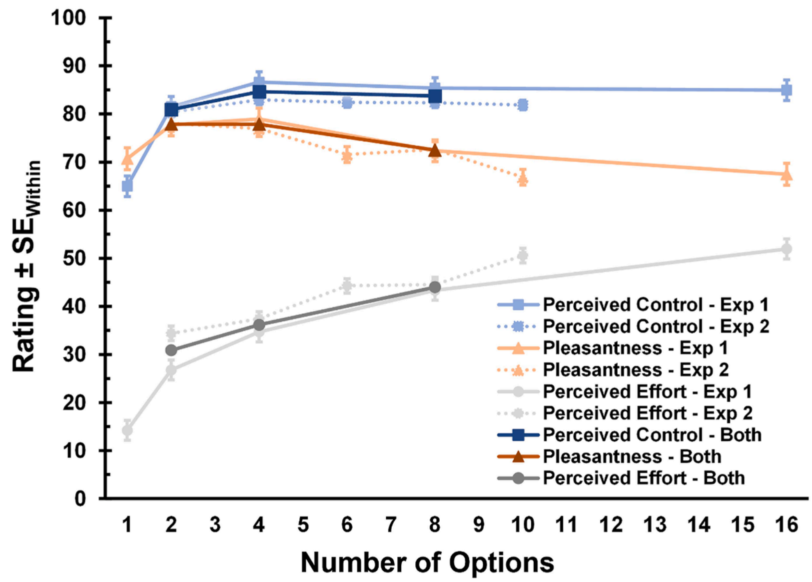

Fig. 2. *Perceived control, pleasantness of choice, and perceived effort ratings dependent on number of options and experiment.* Perceived control peaked around four choice options across both experiments and then plateaued on this level for all further increases in choice options (blue). Pleasantness of choice peaked already at two choice options, remained similarly high for four options, and then decreased with increasing option numbers (orange). Perceived effort increased with increasing choice options (grey). Solid lines represent results of Experiment 1, dashed lines results of Experiment 2. Lighter coloured lines represent results of the individual experiments, darker coloured lines results of the combined results of both experiments. All error bars represent within-subjects standard errors for the respective analysis (SE_{within}; Loftus and Masson, 1994). Please note that the within-subjects standard errors for the combined analysis of both experiments are so small that they are hidden within the data point markers.

this change is not systematic enough for the decrease to reach significance. This finding is mirrored in both individual analyses for Experiments 1 and 2 as well as in the analysis of both experiments combined. Thus, across both experiments, it seems that with a option number of four a maximum of perceived control has been reached (see Fig. 2).

Pleasantness of choice

Again, the first analysis of the pleasantness ratings combined the data of both experiments and focused on the overlapping option numbers 2, 4, and 8. Participants rated the pleasantness of the key/emoji selection differently across these option numbers, $F(2, 288) = 7.20$, $p = .002$, $\eta_p^2 = 0.05$, $\varepsilon = 0.78$ (GG-corrected). However, this effect was not due to a difference in perceived pleasantness between option numbers two and four, $F(1, 144) < 0.1$, $p = .974$, $\eta_p^2 < 0.01$. Rather it was driven by a difference in perceived pleasantness between option numbers four and eight, $F(1, 144) = 15.10$, $p < .001$, $\eta_p^2 = 0.10$, with eight options being perceived as significantly less pleasant than four options (see Fig. 2). The between-subjects factor e*xperiment* did not play a role, neither for main effects, nor interactions, of the omnibus or of the follow-up analyses: all *Fs* < 0.67, *ps* > .416, signifying similar rating patterns for both experiments.

The results of Experiment 1 alone also demonstrated an influence of option number on the pleasantness of choice, $F(4, 264) = 4.50$, $p = .015$, $\eta_p^2 = 0.06$, $\varepsilon = 0.47$ (GG-corrected). Follow-up *t*-tests revealed perceived pleasantness to peak around two to four options, with a steep increase between one and two options, $M_1 = 70.7$, $M_2 = 77.75$, $|t|(66) = 3.54$, $p < .001$, $|d_z| = 0.43$, a plateau between two and four options, $M_4 = 78.9$, $|t|(66) = 0.49$, $p = .627$, $|d_z| = 0.06$, and a decrease between four and eight options, $M_8 = 72.3$, $|t|(66) = 3.50$, $p < .001$, $|d_z| = 0.43$. A further increase in option numbers from eight to sixteen, slightly decreased pleasantness even further, $M_{16} = 67.5$, $|t|(66) = 2.11$, $p = .039$, $|d_z| = 0.26$ (see Fig. 2).

Experiment 1 indicates that pleasantness of choice decreases between four and eight options; however, it is not clear at which point between four and eight options the decrease begins. Experiment 2 with its choice options 2, 4, 6, 8, and 10 aims at elucidating this point a bit further. Participants rated the pleasantness of choice differently dependent on the number of options, $F(4, 312) = 7.63$, $p < .001$, $\eta_p^2 = 0.09$, $\varepsilon = 0.51$ (GG-corrected). Again, the difference between two and four options proved to be too unsystematic to reach significance, $M_2 = 78.0$, $M_4 = 76.9$, $|t|(78) = 0.68$, $p = .501$, $|d_z| = 0.08$, but pleasantness of choice then decreased, 4 vs. 6: $M_6 = 71.6$, $|t|(78) = 2.97$, $p = .004$, $|d_z| = 0.33$. The difference between six and eight options was again not significant, $M_8 = 72.6$, $|t|(78) = 0.79$, $p = .435$, $|d_z| = 0.09$, and then lowered further towards 10 choice options, $M_{10} = 66.9$, $|t|(78) = 3.07$, $p = .003$, $|d_z| = 0.35$ (see Fig. 2).

Perceived effort

As before, the first analysis of the effort ratings combined the data of both experiments and focused on the overlapping option numbers 2, 4, and 8. Participants found key/emoji selection more effortful the more choice options they had, $F(2, 288) = 36.20$, $p < .001$, $\eta_p^2 = 0.20$, $\varepsilon = 0.88$ (GG-corrected). Follow-up analyses confirmed this effect for the comparison of choice options two and four, $F(1, 144) = 13.74$, $p < .001$, $\eta_p^2 = 0.09$, and especially for the analysis of choice options four and eight, $F(1, 144) = 32.91$, $p < .001$, $\eta_p^2 = 0.19$ (see Fig. 2). The between-subjects factor *experiment* did not play a role, neither for main effects, nor interactions, of the omnibus or of the follow-up analyses: all *Fs* < 2.73, *ps* > .101, signifying similar rating patterns for both experiments.

Experiment 1 supports the pattern of increasing effort with increasing number of options even further, $F(4, 264) = 49.71$, $p < .001$, $\eta_p^2 = 0.43$, $\varepsilon = 0.58$ (GG-corrected). All follow-up *t*-tests between subsequent pairs showed systematic increase in perceived effort, 1 vs. 2: $M_1 = 14.2$, $M_2 = 26.8$, $|t|(66) = 4.84$, $p < .001$, $|d_z| = 0.59$; 2 vs. 4: $M_4 = 34.7$, $|t|(66) = 3.72$, $p < .001$, $|d_z| = 0.45$; 4 vs. 8: $M_8 = 43.4$, $|t|(66) = 4.86$, $p < .001$, $|d_z| = 0.59$; 8 vs. 16: $M_{16} = 51.9$, $|t|(66) = 3.92$, $p < .001$, $|d_z| = 0.48$ (see Fig. 2).

Experiment 2 additionally elucidates the perceived effort of participants for missing option numbers in Experiment 1. Again, participants generally perceived more effort the more choice options they were given, $F(4, 312) = 17.93$, $p < .001$, $\eta_p^2 = 0.19$, $\varepsilon = 0.61$ (GG-corrected). However, the increase in effort is less steady than it appeared in

Experiment 1, with only a slight increase between two and four options that proved too unsystematic to reach significance, M_2 = 34.4, M_4 = 37.4, $|t|(78) = 1.49$, $p = .140$, $|d_z| = 0.17$, and then a steeper increase towards six options, M_6 = 44.3, $|t|(78) = 4.32$, $p < .001$, $|d_z| = 0.49$. Perceived effort plateaued again when compared to eight options, M_8 = 44.5, $|t|(78) = 0.20$, $p = .842$, $|d_z| = 0.02$, and then increased further towards ten options, M_{10} = 50.6, $|t|(78) = 3.72$, $p < .001$, $|d_z| = 0.42$ (see Fig. 2).

Association of perceived control, pleasantness, and effort

Correlational analyses, conducted separately for each level of option number, revealed that perceived control is strongly connected to pleasantness of choice at every level of choice options with choices being especially pleasant if participants perceived particularly strong control, 1 choice: $r(65) = 0.59$, 95 %CI [.40;.73], $p < .001$; 2 options: $r(144) = 0.54$, 95 %CI [.42;.65], $p < .001$; 4 options: $r(144) = 0.55$, 95 %CI [.43;.65], $p < .001$; 6 options: $r(77) = 0.46$, 95 %CI [.27;.62], $p < .001$; 8 options: $r(144) = 0.52$, 95 %CI [.39;.63], $p < .001$; 10 options: $r(77) = 0.47$, 95 %CI [.28;.63], $p < .001$; 16 options: $r(65) = 0.54$, 95 %CI [.34;.69], $p < .001$ (see Figure S1 in the Supplementary Material). In contrast, I found no association between perceived control and the participants' perceived effort for any level of option number, $|r|s < 0.17$, $ps > .143$. Across levels of option number, there was a tendency for participants to perceive choice as more pleasant if they perceived less effort, but this association was only significant for option numbers six and ten; 6 options: $r(77) = -0.22$, 95 %CI [−0.42;.00], $p = .047$; 10 options: $r(77) = -0.25$, 95 %CI [−0.44;−0.03], $p = .030$ (see Figure S1 in the Supplementary Material)[7].

I followed these correlational analyses up with a two-step regression analysis with the criterion perceived control, the first step being the inclusion of *option number* as a predictor and the second step the inclusion of *pleasantness of choice* and *perceived effort* as predictors (see Table 1). Option number contributed significantly to the regression model, model: $F(1, 728) = 11.16$, $p < .001$, coefficient: $B = 0.61$, $t = 3.34$, $p < .001$, but only explained 1.5 % of the variance in perceived control on its own. When adding pleasantness of choice and perceived effort to the model, the explained variance in perceived control increased to 30.1 %, $F(3, 726) = 104.28$, $p < .001$. Of both added factors, only pleasantness of choice contributed significantly to the model, pleasantness: $B = 0.50$, $t = 17.23$, $p < .001$; effort: $B = 0.03$, $t = 1.49$, $p = .138$. In the model including all chosen predictors, option number again contributed significantly to the regression model, $B = 0.90$, $t = 5.54$, $p < .001$. These analyses indicate that pleasantness of choice and perceived control are closely associated and influenced by the available number of options, whereas perceived effort does not seem to be a systematic factor of influence.

As an additional analysis, I tested whether the predictors *option number, pleasantness of choice*, and *perceived effort* contributed in a linear, quadratic or logarithmic fashion to the model. Option number explained the most variance when it was coded in a logarithmic model (see Table 2) with a conditional R^2 of 55.2 % and a marginal R^2 of 3.2 %. Thus, I kept *option number* as a logarithmic predictor before including first *pleasantness of choice* and then *perceived effort*. The best fitting model including pleasantness of choice was linear, whereas for perceived effort, the linear and the quadratic models were equally suitable. Altogether, this analysis indicates that option number may be associated with perceived control in a non-linear fashion, whereas the association of perceived control, pleasantness of choice and perceived effort are well represented with a linear model.

Table 1
Results from the two-step regression analysis to elucidate on the association of perceived control, option number, pleasantness of choice, and perceived effort.

	Model	R^2	*Test*	*Predictor*	*Coefficient*
Step 1	perceived control ~ option number	0.015	$F(1, 728) = 11.16$, $p < .001$	option number	$B = 0.61$, $t = 3.34$, $p < .001$
Step 2	perceived control ~ option number + pleasantness of choice + perceived effort	0.301	$F(3, 726) = 104.28$, $p < .001$	option number	$B = 0.90$, $t = 5.54$, $p < .001$
				pleasantness of choice	$B = 0.50$, $t = 17.23$, $p < .001$
				perceived effort	$B = 0.03$, $t = 1.49$, $p = .138$

Response time (RT) analysis

Experiment 1

Participants generally took longer to make a choice between the given options the more choice options were available, $F(4, 264) = 28.68$, $p < .001$, $\eta_p^2 = 0.30$, $\varepsilon = 0.33$ (GG-corrected). Follow-up tests revealed that whereas one and two choice options did not differ significantly in response times, M_1 = 700 ms, M_2 = 712 ms, $|t|(66) = 0.59$, $p = .558$, $|d_z| = 0.07$, this increase in selection time was noticeable from then onwards, 2 vs. 4: M_4 = 844 ms, $|t|(66) = 5.26$, $p < .001$, $|d_z| = 0.64$; 4 vs. 8: M_8 = 919 ms, $|t|(66) = 2.48$, $p = .016$, $|d_z| = 0.30$; 8 vs. 16: M_{16} = 1167 ms, $|t|(66) = 6.01$, $p < .001$, $|d_z| = 0.73$ (see Fig. 3A).

Experiment 2

Although Experiment 2 also shows a general tendency of longer response times for a higher number of choice options, $F(4, 312) = 8.09$, $p < .001$, $\eta_p^2 = 0.09$, $\varepsilon = 0.78$ (GG-corrected), this increase was only significant between two and four choice options, M_2 = 764 ms, M_4 = 873 ms, $|t|(78) = 4.14$, $p < .001$, $|d_z| = 0.47$. All following increases in choice options did not lead to statistically noticeable differences in selection time, all $|t|s < 1.25$, all $ps > 0.215$ (see Fig. 3A).

Response duration analysis

Recent papers invite the analysis of response durations as an additional measure of cognitive processes derived from simple keypress data (Pfister et al., 2023). Previous studies indicate that response durations reflect monitoring efforts and are easily and systematically adjusted

Table 2
Regression analyses testing the association of the predictors to the criterion; tested associations were linear, quadratic (sq[predictor]), and natural logarithm (ln[predictor]).

Model	*Association of new term*	*conditional* R^2	*marginal* R^2 *(only fixed effects)*
perceived control ~ (1|Subject) + (1|Experiment)		0.513	—
perceived control ~ option number + (1|Subject) + (1|Experiment)	linear	0.532	0.015
	quadratic	0.523	0.008
	logarithmic	**0.552**	**0.032**
perceived control ~ ln(option number) + pleasantness of choice + (1|Subject) + (1|Experiment)	**linear**	**0.628**	**0.264**
	quadratic	0.621	0.261
	logarithmic	0.572	0.114
perceived control ~ ln(option number) + pleasantness of choice + perceived effort + (1|Subject) + (1|Experiment)	**linear**	**0.665**	**0.282**
	quadratic	**0.664**	**0.289**
	logarithmic	0.641	0.265

[7] Degrees of freedom are different due to the different number of participants in the respective experiments. To maximize power, I have included participants of both experiments in the analysis if possible.

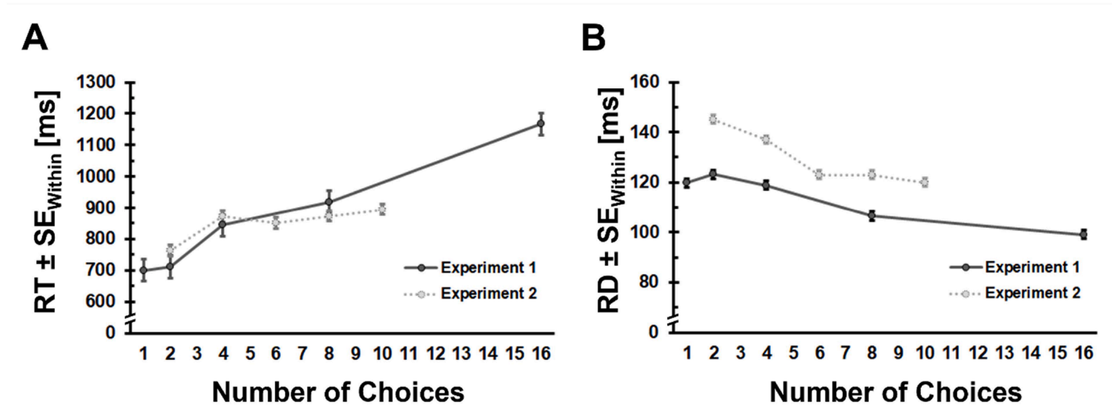

Fig. 3. *Response Times (RT) and Response Durations (RD) dependent on the number of options*. A. Response times generally increased with number of options. B. Response durations generally decreased with number of options. Black lines show results from Experiment 1, light grey lines show results from Experiment 2. All error bars represent within-subjects standard errors for the respective analysis to facilitate interpretation of within-subjects differences (SE_{within}; Loftus and Masson, 1994).

depending on motor performance (e.g., Foerster et al., 2022; Pfister et al., 2023). Specifically, response durations are recommended as an implicit measure for choice confidence and (un)certainty as these variables are likely to affect monitoring demands (Pfister et al., 2023). As choice confidence and (un)certainty are both likely to be associated with sense of control, response durations represent an interesting and independent measure of cognitive processes, adding to the information gained from response time analysis. Moreover, whereas response times likely do not only reflect choice effort but also scanning and processing of choice options, response durations occur after these processes have taken place and thus present a complementary approach that may be less biased by perceptual factors.

Experiment 1

The duration of the participants' keypress was affected by the number of available choice options, $F(4, 264) = 32.75$, $p < .001$, $\eta_p^2 = 0.33$, $\varepsilon = 0.76$ (GG-corrected), with keypress duration decreasing when participants were given a higher number of choice options, 1 vs. 2: $M_1 = 120$ ms, $M_2 = 123$ ms, $|t|(66) = 1.38$, $p = .173$, $|d_z| = 0.17$; 2 vs. 4: $M_4 = 119$ ms, $|t|(66) = 1.72$, $p = .090$, $|d_z| = 0.21$; 4 vs. 8: $M_8 = 107$ ms, $|t|(66) = 5.92$, $p < .001$, $|d_z| = 0.72$; 8 vs. 16: $M_{16} = 99$ ms, $|t|(66) = 4.14$, $p < .001$, $|d_z| = 0.51$ (see Fig. 3B).

Experiment 2

Similarly to Experiment 1, participants tended to decrease their keypress duration when more choice options were offered, $F(4, 312) = 41.26$, $p < .001$, $\eta_p^2 = 0.35$, $\varepsilon = 0.85$ (GG-corrected). Interestingly, this decrease was most noticeable between two, four, and six choice options. Response duration levelled out between six, eight, and ten choice options, 2 vs. 4: $M_2 = 145$ ms, $M_4 = 137$ ms, $|t|(78) = 3.14$, $p = .002$, $|d_z| = 0.35$; 4 vs. 6: $M_6 = 123$ ms, $|t|(78) = 6.06$, $p < .001$, $|d_z| = 0.68$; 6 vs. 8: $M_8 = 123$ ms, $|t|(78) = 0.04$, $p = .966$, $|d_z| < 0.01$; 8 vs. 10: $M_{10} = 120$ ms, $|t|(78) = 1.29$, $p = .200$, $|d_z| = 0.15$ (see Fig. 3B). Together with Experiment 1, this indicates that the further decrease in response duration noticeable in Experiment 1 is most likely due to a slow accumulation of constant slight decreases or occurs between choice options 10 and 16.

Association of Response Time, Response Duration, and the participants' ratings

Neither the participants' response times, nor the participants' response durations were associated significantly with perceived control, pleasantness of choice or perceived effort on any level of choice options. To elucidate further on possible interactive influences of option number, RTs, RDs, pleasantness of choice, and perceived effort on perceived control, I conducted another hierarchical regression analysis with the criterion perceived control (see Table S1 in the Supplementary Material). I included *option number* in the first step of the analysis, followed by *response times* and *response durations* in a second step, and finally *pleasantness of choice* and *perceived effort* in a third step. As before, option number contributed significantly to the regression model, model: $F(1, 728) = 11.16$, $p < .001$, coefficient: $B = 0.61$, $t = 3.34$, $p < .001$, but only explained 1.5 % of the variation in perceived control on its own. The inclusion of response times and response durations did not add significantly to the model, change: $F(2, 726) = 2.60$, $p = .075$, increasing the explained variance of the perceived control ratings by 0.7 % to 2.2 % total. The explanatory power of the model remained significant mainly due to the inclusion of *option number* as a predictor, model: $F(3, 726) = 5.471$, $p = .001$; $B_{ON} = 0.77$, $t = 3.88$, $p < .001$. Individually, response times contributed slightly to the model, whereas response durations did not, $B_{RT} = -0.01$, $|t| = 2.25$, $p = .025$; $B_{RD} = 0.02$, $t = 0.68$, $p = .498$. The further inclusion of pleasantness of choice and perceived effort contributed significantly to the model, change: $F(2, 724) = 148.92$, $p < .001$; model: $F(5, 724) = 64.19$, $p < .001$; coefficient: $B_{PloC} = 0.50$, $t = 17.24$, $p < .001$, $B_{PE} = 0.03$, $t = 1.30$, $p = .195$, with a big increase in explained variance by 28.5 % to 30.7 % total. Pleasantness of choice was by far the strongest contributor to the model, being associated most closely with the participants' perceived control.

Discussion

The present experiments were designed to elucidate how choice options affect our sense of agency, in particular our sense of control, and how this is associated with pleasantness of choice and perceived effort during the selection process. Considering the amount of choice options we are given in many everyday situations these are increasingly relevant questions: if choice option abundancy leads to an overburdening of individuals (and thus a decreasing sense of control or pleasantness of choice) it might be useful to limit offered choice options in particular situations, such as shopping scenarios. Likewise, if choice option minimization leads to a loss of experienced control, we might consider adapting the number of alternative options when possible.

To explore this question, the present experiments asked participants to choose between keypresses eliciting different emojis. Interestingly, across both experiments, a "sweet" spot for perceived control and pleasantness of choice emerged around four choice options (Fig. 2); at choice option four, perceived control reached its maximum and then plateaued at this level; at choice options two and four, pleasantness of choice also reached its maximum and then subsequently decreased. The selection effort increased with increasing choice options, as evidenced by the participants' subjective ratings as well as the participants' selection time (RT). Please keep in mind, however, that pleasantness of choice as well as selection effort were rated only once per block (i.e., twice per condition), contrary to perceived control (see Methods section).

These results indicate that, indeed, there is no benefit to excessive choice options in a scenario with no specific need or desire; in fact, the decreasing enjoyment in selecting an option for higher numbers of choice options indicates that a limitation of choice options might be beneficial in these situations. Likewise, the results clearly show that participants need some level of choice options for optimal sense of agency formation, as well as an experience of pleasantness during the action selection process. These results qualify previous evidence that suggests that sense of control generally increases with choice options (e. g., Barlas et al., 2018; Schwarz et al., 2019; Wenke et al., 2010) – as more choice options do lead to increased sense of control, but only up to a point of four options. These findings are directly in line with previous evidence that suggests that too much choice can, in fact, have detrimental effects on action selection and have a demotivating effect on agents (Botti and Hsee, 2010; Botti and Iyengar, 2006; Cunow et al., 2023; Iyengar and Lepper, 2000). These findings also inform consumer psychology by providing a cognitive-affective foundation for effects of choice overload (e.g., Hamilton and Chernev, 2012); i.e., choice overload might occur in situations during which the ease of the choice process is disrupted by choice option abundancy (as evidenced by high perceived effort) so that it counteracts the benefit of high actual control in situations of choice option abundancy and is thus connected to a lower motivation to choose. The decrease in pleasantness of choice for higher option numbers indicates such a motivational effect. Future studies might look into further manipulating these variables experimentally to test this hypothesis.

Objective vs. experienced control

The present results additionally inform the discussion of objective versus experienced control (Schwarz et al., 2022; Seubert et al., 2024). Objectively, control over the selection outcome increases with increasing choice options because we can more precisely choose which exact outcome we will produce. Thus, our desired outcome is more precisely matched by the actual outcome. If our desired outcome is not among the possible options, we need to compromise by choosing a different option instead, leading to a different outcome than we would have liked to achieve, i.e., a loss in actual control. This is especially prominent in the one-option condition – here, participants had to press a specific key leading to a specific outcome leaving them with very little control. Nevertheless, control ratings were still surprisingly high (even though lower than for conditions with more alternatives from which they could chose; see Fig. 2). One explanation for this finding is that participants did not only evaluate control in terms of generating different outcomes but also temporal control of when an outcome occurs, which is perfect across all experimental condition. Potentially, these ratings might further reflect the absolute predictability of the action-effect sequence in this paradigm leading to a somewhat illusionary sense of control (e.g., Schwarz et al., 2022). Alternatively, it could reflect the general ease of the action execution and selection process that is also mirrored in high pleasantness and low effort ratings, similar to evidence indicating that action selection fluency affects sense of agency positively (e.g., Chambon and Haggard, 2012). That is, in circumstances of few choice options, sense of control could be increased due to the ease of process, but decreased by low actual control, whereas for higher number of choice options, sense of control would be increased by high actual control, but decreased by an effortful process. Future studies might further look into this potential interpretation. Taken together with previous evidence, these results suggest that actual control and experienced control deviate in specific circumstances (e.g., Schwarz et al., 2022, 2023; Seubert et al., 2024; Ueda et al., 2021), an indication that a precise separation between both phenomena is necessary – and that we cannot simply assume from objective circumstances of control how agents will experience that control.

Perceived control and pleasantness of choosing

An interesting finding of the current results is also the close association between perceived control and pleasantness of choice: pleasantness of choice explained > 25 % of the variance in perceived control ratings (or vice versa). Please keep in mind that this strong association was found despite separating the evaluation process for perceived control (multiple evaluations within each block) and pleasantness of choice (one evaluation per block) thereby potentially reducing the association between both. This strong connection is in line with previous experiments that conceptualize sense of agency as a rewarding experience motivating agents to choose specific actions (e.g., Burger and Cooper, 1979; Eitam et al., 2013; Leotti et al., 2010; Reis et al., 2023; Schwarz et al., 2022). In short, the present results indicate that sense of control and pleasantness of choice are indeed closely associated, but that abundancy of choice options does not equate either higher perceived control or a higher experience of enjoyment during the selection process. This is particularly remarkable, because the present experimental protocol had participants choose repeatedly from the same pool of possibilities. This situation can be expected to foster a positive impact of choice option abundancy, as there was very little situational variety for conditions with fewer choice options and thus a higher potential for the emergence of boredom after repeated exposure. Of course, a close association of perceived control and pleasantness of choice does not necessarily mean that there is a causal relation between both. Potentially, the number of options affects both, sense of control and pleasantness of choice, similarly with no causal connection between pleasantness and perceived control.

Moreover, our experimental design allowed a direct comparison of the association strength between sense of control, pleasantness of choice, perceived effort, and number of choice options. Interestingly, while the number of choice options was associated with sense of control, its contribution in explaining the variance in the participants' control ratings was by far outmatched by pleasantness of choice. Perceived effort, on the other hand, did not contribute significantly to the explanation of the participants' variance in sense of control ratings. This confirms the close association of a positive affect to the experience of control, as previously stated. The rather small contribution of the number of choice options can be explained by the surprisingly early rise to maximum in perceived control with little change in ratings for higher numbers of choice alternatives. An especially interesting result relates to the lack of contribution of perceived effort (as well as response times as an implicit measure of cognitive effort) to the explanation of the participants' variance in sense of control ratings. This stands in contrast to the assumption that cognitive effort decreases sense of agency as indicated by the literature on action selection fluency (e.g., Chambon and Haggard, 2012; Chambon et al., 2014; Haggard and Chambon, 2012; Sidarus and Haggard, 2016; Wenke et al., 2010). Action selection fluency assumes that if cognitive effort is increased due to paradigm demands, the participants' sense of agency (specifically sense of control) decreases. Following this logic, perceived cognitive effort should be expected to be associated with sense of control as measured in the present experiments. However, whereas pleasantness of choice and sense of control seem directly associated, the impact of effort on sense of control might be more complex and either more situationally variable or involve a more indirect effect that remains invisible here.

Implicit measures

Finally, I tested how reaction times or response durations might be associated with sense of control, pleasantness of choice or perceived effort. Even though both variables showed systematic variation across choice numbers, within-condition variation did not show a particularly close connection of either variable to the subjective ratings. This could indicate that these ratings rely too strongly on higher-order reasoning processes to relate to such direct measures of cognitive control. Indeed, whereas typical paradigms in human action control have affected sense of agency (e.g., manipulations of cognitive control, action-effect binding, temporal perception of action-effect sequences; cognitive control: e.g., Sidarus and Haggard, 2016; Wenke et al., 2010; action-effect binding: Schwarz et al., 2018; temporal perception: e.g., Haggard et al., 2002; Haggard, 2017), so far no implicit measure has been found that directly relates to explicit sense of agency (e.g., Antusch et al., 2021; Gutzeit et al., 2023; Saito et al., 2015; Schwarz et al., 2019; Schwarz and Weller, 2023). As it is, it seems that the complexity of the construct "sense of agency", or more precisely sense of control, cannot be easily captured by easy access methodology such as RTs or RDs.

Implications and ideas for (real-life) choosing scenarios

Does the present pattern of results mean that it would be better to limit choice options to a maximum of four in most circumstances? No, it does not necessarily. In the present experiments, we gave participants a choice of random emojis in a neutral situation. But what if these participants had a specific need for a positive emoji to fulfill their communicative purpose? What if individual participants were more inclined to choose between larger sets of choice options whereas others would have been satisfied with just a small subset? The present results indicate that four choice options are enough for a maximum sense of control and pleasantness of choice in situations without specific outcome needs. If these needs are directed by the situation or by individual preference, one could speculate that more choice options might be more appropriate because choice overload might be reduced if the consumer limits interesting items by preference. So how can we incorporate these results without losing potential choice options? A possibility could be that, e.g. in online settings, among an abundancy of choice options, four alternatives are highlighted by previously set parameters (such as consumers' reviews, product specifications such as eco-conscious vs. conventional products, etc.). Another possibility could be that individuals first choose a general important feature (e.g., valence of emoji, eco-friendliness of products), and in a second step are offered a more limited set of options pertaining to that feature. Indeed, such set-ups could decrease potential facilitators of choice overload, such as a lack of categorization of options and information overload (Scheibehenne et al., 2010). Both aspects make it more difficult for individuals to find relevant information, thus likely increasing sludge (Shahab and Lades, 2024). This could indicate that sense of agency formation and sludge could be closely associated. Future studies should evaluate how such set-ups might improve an individual's sense of control and pleasantness of choice during the selection procedure compared to a full set of options in one go.

Limitations

Study limitations pertained mostly to the rather sparse and controlled paradigm; this was intended to isolate the influence of the number of choice options, but, of course, in real-world scenarios other variables are likely to contribute to the formation of perceived control. These additional variables may contribute in an additive fashion or they might even interact with the number of choice options, which is a promising avenue for future research. Moreover, participants were comprised of an adult German sample so that I cannot preclude that cultural differences might affect the perception of control in choosing scenarios.

Finally, the result pattern might look differently for situations of motivated choice. For example, previous evidence suggests that preference for choosing (over not choosing oneself) is stronger in situations in which outcome has relevance for the participants (Shoval et al., 2022). As a counterpoint to this finding, a previous study has found that participants are even willing to sacrifice (small) financial rewards in order to gain control even in situations in which control holds very little relevance for them (Reis et al., 2023) – of course, if the outcome was of relevance, this effect might be even stronger. Moreover, even if the eventual outcome is relevant, sense of agency is not necessarily affected by the outcome but rather by the procedure (Schwarz et al., 2023). Generally speaking, choice has been found to affect sense of agency in motivated situations (i.e., in which the choice outcome holds relevance to the participants) and non-motivated choice paradigms (e.g., Sebanz and Lackner, 2007; Reis et al., 2022; Schwarz et al., 2019, 2023; Weller et al., 2020) alike. Finally, one could argue that, while real-world situations often include motivated choice, often they also do not. Selecting a shampoo bottle out of 40 alternatives can be very similar to the paradigm used in the present experiments in that the relevance of the outcome might be mainly to buy any shampoo bottle, not to find the "right" shampoo bottle. Thus, there is both theoretical and applied validity for investigating motivated and non-motivated choice paradigms in terms of sense of agency.

Conclusions

The present experiments reveal that neither choice option minimization nor choice option abundancy optimizes sense of control (as an aspect of sense of agency) or the pleasantness of the selection experience. Rather, participants favor situations in which some choice (i.e., about four choice options) is given, leading to a maximum of sense of control and pleasantness of choice. For higher numbers of choice options, the selection effort increases, and the pleasantness of the selection process decreases, potentially due to an overburdening of individuals with too many options. A potential application of these results could be online platforms with multiple-step selection processes, offering a limited number of options at any point to facilitate the selection process for consumers while still offering the breadth of available options, thus fostering sense of agency and thereby reducing choice overload.

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Data availability

The preregistration, data and analysis files, are available on the Open Science Framework (Preregistration 1: https://osf.io/dkpe6; Preregistration 2: https://osf.io/t2m34; Project: https://osf.io/wa2nk/).

Declaration of competing interest

The author declares no conflict of interest.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.crbeha.2025.100174.

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