

How to overcome biases against creativity: The role of familiarity and confidence in original solutions

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Abstract

Despite the societal relevance of innovation, humans favor traditional over more original solutions, conceivably because of the increased uncertainty that comes with trying novel approaches. Here, we tested whether this anti-creativity bias can be counteracted by increasing familiarity with, and confidence in, creative solutions. Participants chose between creative and traditional uses for given objects. In study 1 ($N = 67$ international adults), these objects repeated either identically or conceptually during the experiment; and in study 2 ($N = 68$ international adults), choice options were either self-generated or externally provided. Measures of response preference indicated lasting attraction towards the traditional approach, independent of repetition type (study 1). This attraction towards the norm was also found for self-generated creative ideas, but it was considerably reduced compared to other-generated ideas (study 2). Instead of increasing familiarity, building confidence in creative solutions might thus be the key to reduce corresponding uncertainty and promote innovation.

“The difficulty lies, not in the new ideas, but in escaping from the old ones, which ramify, for those brought up as most of us have been, into every corner of our minds.”

(p. viii, Keynes, 1937).

This quote by John Maynard Keynes is part of his *General Theory of Employment, Interest and Money* (Keynes, 1936), which made him one of the most influential economists of the last century. It is particularly remarkable that this is the very last sentence of the preface of his work before he starts to introduce his pioneering ideas, which then revolutionized scientific economics and public policy. The lure of tradition which Keynes describes clearly interferes with the successful implementation of innovative ideas, thus hampering scientific and societal progress (Hennessey & Amabile, 2010). Against this background, it seems vital to focus on ways to overcome this sticky nature of established beliefs and procedures. As creative ideas, per definition, deviate from the standard approach to handle a specific situation (Runco & Jaeger, 2012), they are unfamiliar and come with increased uncertainty whether the novel behavior will lead to the desired goal (Amabile, 1996). In two preregistered experiments, we tested whether increasing familiarity with creative solutions and thus counteracting this uncertainty might be the key to facilitate the selection of creative ideas.

State of research

The scientific investigation on how creative ideas emerge has attracted scholars for centuries (see for an historical overview Runco & Albert, 2010). Despite this longstanding research tradition, it took until the end of the twentieth century when the underlying cognitive processes of creative thought and behavior have been put to closer investigation (e.g., Finke et al., 1996; Hayes, 1989). Since then, the neurobiological foundations of creative cognition (e.g., Beaty et al., 2015; 2016; Benedek & Fink, 2019) as well as the moderating influence of

situational characteristics (e.g., Benedek et al., 2014; Jia et al., 2009) have been studied thoroughly.

Most of this research, however, has a strong focus on the generation of original ideas, mainly neglecting cognitive foundations of idea evaluation and selection. This disbalance is rooted in the assumption that the more ideas are generated the more likely it should be that at least one of them is excellent (“quantity leads to quality”; Osborn, 1953). Yet, the availability of an outstanding idea does not guarantee that this idea will be selected eventually. On the contrary, when it comes to selecting one idea out of a pool of potential options, human behavior is far from being optimal (Rietzschel et al., 2006) as there is a strong bias towards feasible instead of more original solutions (Mueller et al., 2012; Reis et al., in press; Rietzschel et al., 2010).

To shed light on the cognitive underpinnings of this bias, recently a response-dynamics paradigm of creative idea selection was proposed (Reis et al., in press). Within this paradigm, participants had to choose between a traditional and a more creative use for visually presented objects by moving a mouse-cursor to a corresponding target area. Crucially, there was not only a bias towards traditional uses on a choice level, but it extended to the implementation of creative responses. That is, movement trajectories for “creative use” trials indicated significantly more attraction towards traditional use options than vice versa. A later study corroborated these findings and found similar effects for dedicatedly positive and negative creative uses (Reis et al., under review).

Present work

The present studies aim to elucidate potential boundary conditions of these earlier findings, thus providing avenues to reduce this bias against creativity. A whole body of research suggests that increasing familiarity with a stimulus, for instance through repeated encounters, leads to a more positive evaluation (Zajonc, 1968; Bornstein, 1989). This so-called *mere-exposure effect* has been found for varying stimuli and presentation types (Montoya et al., 2017)

and can also bias momentous decisions like voting behavior (Pfister et al., 2023) or financial investment choices (Brielmaier et al., under review). A possible explanation for these findings is that repeated encounters make a stimulus more predictable, or in other words less uncertain, which in turn leads to positive affect (Bornstein, 1989; Lee, 2001). Creative solutions are by definition unfamiliar, which might explain why decision-makers are less torn towards them than to traditional, and by definition, familiar solutions. In line with such reasoning, implicit biases against creativity have been found to be particularly pronounced for actors who either feel in general high levels of uncertainty or who currently aim to reduce a state of uncertainty (Mueller et al., 2012).

Therefore, in two experiments, we tested whether the bias against creativity might decline when familiarity with original options increases. In study 1, we manipulated whether items repeated identically or conceptually (study 1). In study 2, we manipulated whether the ideas to choose from were provided by other actors or had been self-generated by the participants beforehand (study 2).

Both experiments were preregistered (study 1: https://osf.io/a3rwt/?view_only=1fc918d0cbef498081c116bc4e7e9d52, study 2: https://osf.io/h8p7y/?view_only=de198ed6e5694123a133eabe939eda76). Raw data, all materials, the program file and the analysis syntax are available on the Open Science Framework (https://osf.io/fehwb/?view_only=110021e256f348fabf4f586698b7fe53). Our study protocol was approved by the the local ethics committee and adhered to all legal requirements of the study country.

Study 1

In our first experiment, we adapted the original response-dynamics paradigm of creative idea selection (Reis et al., in press) by decreasing the number of presented items but increasing the number of experimental blocks. Thus, each object was presented more often and at the same time the temporal distance between these repetitions was considerably shortened. Furthermore, we examined whether a potential change of the bias against creativity over time is due to an increase of perceptual or conceptual familiarity. Therefore, half of the items repeated identically (e.g., the same picture of a bottle), while the other half repeated conceptually (e.g., different pictures of varying bottles). Following earlier investigations (Reis et al., in press; Reis et al., under review), we expected a clear preference for traditional over creative responses, which should also be visible when assessing how each response is enacted. Moreover, we assumed this effect to recede over time because of an increased familiarity with the presented stimuli (Zajonc, 1968). This effect, however, should not be limited to repeated presentations of the exact same object but might generalize to conceptually similar stimuli (see also Gordon & Holyoak, 1983). Accordingly, for all items we expected the pull towards traditional options to decline during the experiment, but this decrease might be particularly pronounced for identical compared to conceptual repetitions.

Method

Participants

We collected data of 67 participants. Following prior studies on response-dynamics in creative idea selection (Reis et al., in press), we expected a small-to-medium effect size of $d_z = 0.40$ for the comparison of traditional and creative trials. To detect such an effect with a power of $1 - \beta = 80\%$, 51 participants would be required ($\alpha = .05$, two-tailed testing; calculated with the `power.t.test` function in the statistics package R, version 4.0.3). However, we additionally accounted for dropout and increased our sample size by 30 %. As preregistered, we excluded

data of participants with less than ten valid trials per condition ($n = 15$). As we further had to exclude an unexpectedly high number of participants due to empty cells ($n = 21$), our final sample consisted of 31 participants (16 females, 14 males, 1 prefer not to say; age: $M = 33.8$, $SD = 14.3$ years). To counter reduced statistical power ($1 - \beta = 80\%$ for effect sizes of $d_z \geq 0.52$), we report additional exploratory analyses based on a larger sample (see supplemental results). Participants were recruited via Prolific (13 different nationalities; most common: UK ($n = 8$) and South Africa ($n = 6$)). All participants provided written informed consent and received a compensation of 4£.

Materials and Procedure

For our stimuli, we relied on the validated item pool of a previous study (Reis et al., in press), consisting of 20 objects with two uses each (traditional and creative). However, for the present experiment, we only used half of these items to shorten the time between each repetition. For each participant, half of the objects were identical throughout the study (i.e., the exact same picture of an item), while for the remaining objects we used a different picture of the given item in each block.

We tested our hypotheses in an online experiment which was programmed with lab.js (Henninger et al; 2022). The experimental setup builds on the free-choice version of the response-dynamics paradigm of creative idea selection (Experiment 1 in Reis et al., in press). Accordingly, participants indicated before each trial whether they planned to select a traditional or a creative use for the upcoming object. The corresponding screen showed two boxes, labelled “Traditional task” and “Creative task”. The order of both boxes was determined randomly for each participant, and they made their decision by clicking on the corresponding box. Next, we asked participants to click on a small black square in the middle of the screen to center the position of their mouse cursor. The next screen showed the home area (60 px x 60 px) in the bottom center as well as two target areas (230 px x 30 px) in the upper left and upper right side of the screen (all distances refer to a reference screen size of 800 x 600 px and were scaled to

match the display resolution of each individual participant). Each target area presented one possible item use in written form and the home area showed a bold uppercase letter, which depended on the participant's prior task choice ("C" for creative use, "T" for traditional use). Between both target areas, an image of the target object was presented (bounding box: 100 px x 100 px). However, this object as well as the corresponding uses only appeared after participants had clicked on the home area and we randomized for each trial which use (traditional or creative) appeared in which target area (left or right). We instructed participants to click on the corresponding use as fast as possible and measured the time they required to leave the home area after target item onset (Initiation Time, IT). Moreover, we tracked the time from leaving the home area until approaching the center of one of both target areas to less than 20 px (Movement Time, MT) and we tracked the position of the mouse cursor by means of the plugin *mousetrap* (Kieslich & Henninger, 2017). The following trial started directly after participants had clicked on one of both response options. In contrast to the original study (Reis et al., in press), we increased the number of experimental blocks from two to five while decreasing the number of trials per block from 40 to 20. Thus, each item repeated twice per block.

At the end of the experiment, participants worked on the *remote associates task* (RAT; Mednick, 1962), as an established and validated measure of convergent thinking. Within this task, they had 40 seconds to find a common associate for three terms (e.g., fish, mine, rush: gold). There were 15 trials in total and after each trial we presented feedback including the correct answer.

Data analysis

We compensated for varying screen sizes by scaling all trajectories to a uniform display resolution. That is, the distance from the center of the home area and each target area was 100 x-units (xu) on the x-axis and 200 xu on the y-axis. Afterwards, all left going movements were mirrored to the right and we time-normalized trajectories from movement onset to reaching the

target area to 101 points by linear interpolation. Furthermore, to account for varying click times, we appended the last coordinate of the movement after time normalization. The signed area between this trajectory and a straight line from start-to endpoint of the movement was determined as the Area Under the Curve (AUC; in xu^2).

Per our preregistration, we excluded error trials (i.e., clicking on the traditional task when indicated to go for the creative one and vice versa) and trials in which IT, MT or AUC deviated more than 2.5 *SDs* from their corresponding cell mean. In addition, we also excluded trials with less than three datapoints as otherwise no meaningful AUC can be determined. In total, we excluded 9.06 % of all trials. Please note that these exclusions did not apply for the analysis of choice frequencies.

Choice frequencies were analysed by means of a two-tailed *t*-test comparing traditional and creative responses for each combination of experimental block and repetition type. For IT, MT and AUC, we tested our hypotheses by means of a repeated measures analysis of variance (rmANOVA). Item use (traditional vs. creative), experimental block (1 vs. 2 vs. 3 vs. 4 vs. 5) and repetition type (identical vs. conceptual) were used as within-subject factors. If Mauchly's test indicated a violation of the sphericity assumption, Greenhouse-Geisser corrections were applied. Significant interaction effects were followed by two-tailed *t*-tests.

Results

Figure 1A displays movement trajectories for each item use condition and Table S1-S3 show means and standard deviations for IT, MT, AUC and each combination of item use, experimental block and repetition type. As shown in Fig. 1B, choice frequencies indicated a strong preference for traditional over creative options. For each combination of experimental block and repetition type significantly more traditional than creative uses were selected, $t_s \geq 2.87$, $ps \leq .005$, $d_s \geq 0.35$.

ITs were not affected by item use, $F < 1$, or block, $F(4,120) = 2.53, p = .109, \eta_p^2 = .08, \varepsilon = .34$, but were significantly higher for conceptual compared to identical repetitions, $F(1,30) = 6.64, p = .015, \eta_p^2 = .18$. There was neither an interaction of item use and block, $F < 1$, nor of item use and repetition type, nor of block and repetition type, $F_s \leq 1.87, p_s \geq .178, \eta_p^2_s \leq .06$. Moreover, there was no three-way interaction of item use, block and repetition type, $F < 1$.

MTs were significantly higher for creative compared to traditional responses, $F(1,30) = 5.57, p = .025, \eta_p^2 = .16$, but there was no main effect of block or repetition type, $F_s \leq 2.18, p_s \geq .116, \eta_p^2_s \leq .07$. There was neither an interaction of item use and block, $F = 1.67, p = .202, \eta_p^2_s = .05, \varepsilon = .41$, nor of item use and repetition type, $F = 1.34, p = .255, \eta_p^2_s = .04$. However, there was an interaction of block and repetition type, $F(4,120) = 3.29, p = .047, \eta_p^2 = .10, \varepsilon = .47$. In block 3 of the experiment, movements were significantly faster for identical compared to conceptual repetitions, $t(30) = 3.77, p = .001, d_z = 0.68$, while such an effect was not present for any other block, $t_s \leq 1.55, p_s \geq .131, d_z_s \leq 0.28$. The three-way interaction of all factors did not approach statistical significance, $F < 1$.

AUCs were significantly larger when going for creative compared to traditional uses (see Fig. 1C), $F(1,30) = 39.72, p < .001, \eta_p^2 = .57$. There was no main effect of block or repetition type for AUCs, $F_s \leq 2.10, p_s \geq .116, \eta_p^2_s \leq .07$. Neither did item use and block interact significantly, $F < 1$, nor item use and repetition type or block and repetition type, $F_s \leq 1.77, p_s \geq .194, \eta_p^2_s \leq .06$. Finally, there was no three-way interaction, $F(4,120) = 1.40, p = .248, \eta_p^2 = .04, \varepsilon = .76$.

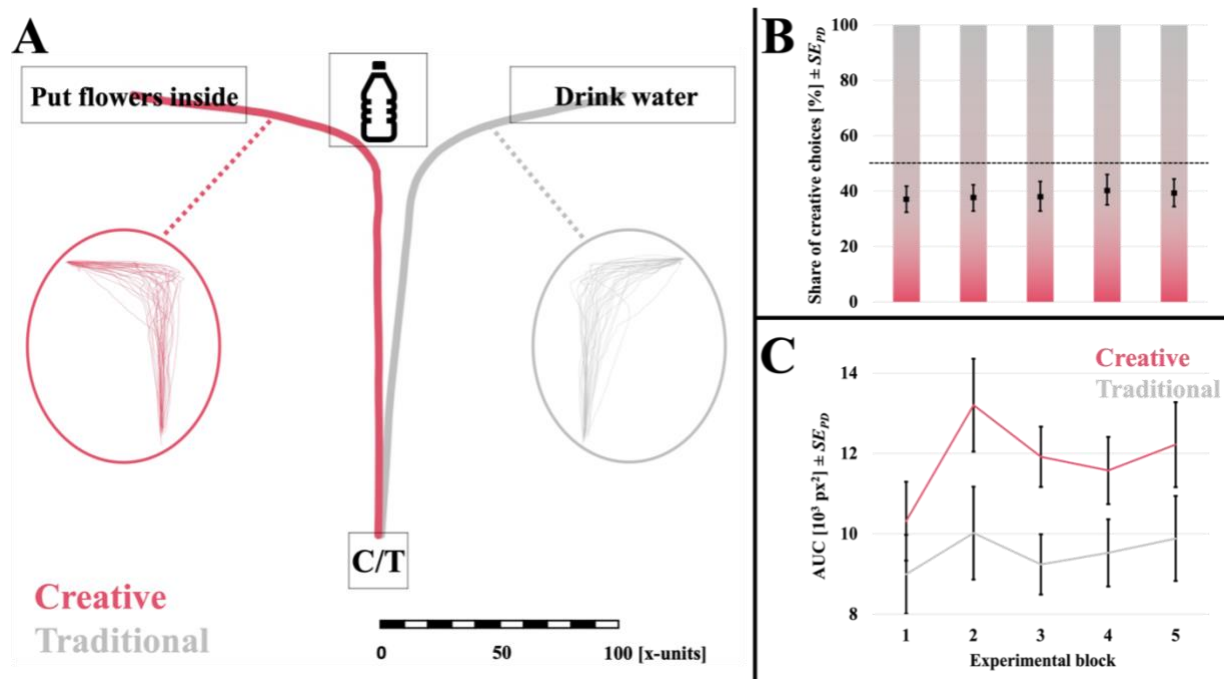


Fig. 1. Study design and main results of experiment 1. (A) Experimental setup and time normalized movement trajectories when participants selected either a creative use (red line; here: “Put flowers inside”) or a traditional use (grey line; here: “Drink water”) for a given item (here: bottle). Thin lines represent average trajectories of each single participant for both item use conditions. (B) Share of creative choices for each experimental block. Error bars represent standard errors of the paired differences. Dashed line indicates a uniform distribution of choices. (C) Area Under the Curve (AUC) for each item use condition and experimental block. Error bars indicate standard errors of the paired differences.

Discussion

We found a significant bias towards the traditional approach, even when opting for the creative option eventually. This bias did not decline over time and its temporal development was independent of whether an object repeated identically or conceptually. Accordingly, increasing familiarity with creative options through repeated exposures does not seem to counteract attraction towards conventional ideas.

Study 2

In study 1 and in previous research (Reis et al., in press; Reis et al., under review), the actor who came up with a creative use was different to the person who was supposed to choose between the generated options. This is a common real-world scenario, for example in organizational settings where decision-makers make a final decision based on options provided

by subordinates. However, an idea which is not your own, might still be fraught with doubts regarding the feasibility of this approach, even when familiarity with this idea is high. In line with such reasoning, many studies suggest that humans tend to evaluate their own behavior and corresponding action outcomes in more favorable terms than behavior of others (Alicke, 1985; Brown, 1986). For instance, research on product design indicates that own design concepts compared to concepts by others are judged more positively (Nikander et al., 2014). Crucially, such *self-enhancement biases* have been found to be particularly amplified for favorable characteristics (Brown, 1986; Dunning et al., 1989), like creativity is one (James et al., 1999). Furthermore, generating creative options offers much more opportunity to differentiate yourself from other actors compared to coming up with a traditional option where there is usually only one correct answer.

Thus, a bias towards self-generated options might be enhanced for creative compared to traditional ideas, which in turn could counteract the hampering influence of the standard use. We tested this hypothesis in a similar setup as for study 1, but we manipulated whether response options were self-generated or presented as ideas by other participants.

Method

Participants

Based on a similar power-calculation as for study 1, we recruited a new sample of 68 participants via Prolific (one additional participant compared to study 1, as we aimed to balance idea origin over participants, see for details Materials and Procedure section). After excluding datasets with less than ten valid trials per condition ($n = 5$), our final sample consisted of 63 participants (2 non-binary, 27 females, 34 males; age: $M = 31.3$, $SD = 10.0$ years). This sample size provided a power of $1 - \beta = 80\%$ for effect sizes of $d_z \geq 0.36$. Participants reported 17 different nationalities, with the UK ($n = 15$), Poland ($n = 13$), and Italy ($n = 8$) as the most

common responses. As experiment 2 was a bit more time-consuming than experiment 1, participants received a slightly higher compensation of 4.5£.

Materials and Procedure

The second experiment consisted of an idea generation and an idea selection phase. The latter was similar as for study 1, except of the presented uses. For half of the items, these response options had to be generated by the participants beforehand. During this idea generation phase, we presented pictures of items for which participants had to come up with either a traditional or a creative use (see Fig. S1A). Participants entered their response in a free-text box, the only limitation being a maximum length of 18 characters including spaces. Similar to study 1, these objects were part of the item pool from Reis et al., (in press). For the other half of the items, we used the validated uses from this previous study. These predetermined response options were also presented within the idea generation phase (see Fig. S1B). Whether for a specific item the corresponding uses had to be self-generated or whether they were externally provided was balanced over participants. In total, the idea generation phase consisted of 40 trials in randomized order. Each object was presented twice, one time in each item use condition. The idea selection phase consisted of 4 blocks with 40 trials each.

Data analysis

All pre-processing steps and exclusion criteria were similar to study 1. However, we additionally preregistered to exclude strong outliers ($IT > 3,000$ ms, $MT > 5,000$ ms, $AUC > 30,000$ xu², and $AUC < -20,000$ xu²) as otherwise such extreme values might lead to an underestimation of the standard deviation, which can distort the following ± 2.5 *SD* cut-off criterion (see also Van Selst & Jolicoeur, 1994). Overall, 19.33 % of all trials had to be excluded due to these preregistered criteria. Choice frequencies were analysed by means of a two-tailed *t*-test comparing traditional and creative responses for each idea origin condition. For IT, MT and AUC, we calculated a rmANOVA with item use (traditional vs. creative) and idea origin

(self-generated vs. externally provided) as within-subject factors. Significant interactions were further investigated by two-tailed t -tests comparing the respective measure between traditional and creative trials for each idea origin condition.

Results

For externally provided response options significantly more traditional than creative uses were selected, $t(67) = 2.02$, $p = .047$, $d_z = 0.25$. However, as shown in Fig. 2A, such an effect was not found for self-generated ideas, $t < 1$.

Means and standard deviations for IT, MT, AUC and each combination of item use and idea origin are presented in Table S7. Movement initiation (IT) was descriptively, however not statistically significantly, faster for traditional than for creative responses, $F(1,62) = 2.90$, $p = .093$, $\eta_p^2 = .04$. There was neither an effect of idea origin on ITs, nor an interaction of both factors $F_s < 1$.

MTs were significantly shorter when going for the traditional than for the creative option, $F(1,62) = 28.48$, $p < .001$, $\eta_p^2 = .31$. Moreover, MTs were significantly shortened for self-generated compared to externally provides solutions, $F(1,62) = 14.37$, $p < .001$, $\eta_p^2 = .19$, and there was an interaction of both factors (see Fig. 2B), $F(1,62) = 5.01$, $p = .029$, $\eta_p^2 = .07$. For both idea origin conditions, MTs were significantly higher for creative than for traditional trials, however this effect was smaller for self-generated compared to externally provided ideas (Self-generated: $t(62) = 2.69$, $p = .009$, $d_z = 0.34$; Externally provided: $t(62) = 6.65$, $p < .001$, $d_z = 0.84$).

Movements in “creative use” trials were more torn towards the opposing option than vice versa, as reflected in larger AUCs, $F(1,62) = 21.07$, $p < .001$, $\eta_p^2 = .25$. Furthermore, AUCs were smaller for self-generated compared to externally provided ideas, $F(1,62) = 10.23$, $p = .002$, $\eta_p^2 = .14$, and item use and idea origin did not interact significantly, $F(1,62) = 2.17$, $p = .146$, $\eta_p^2 = .03$.

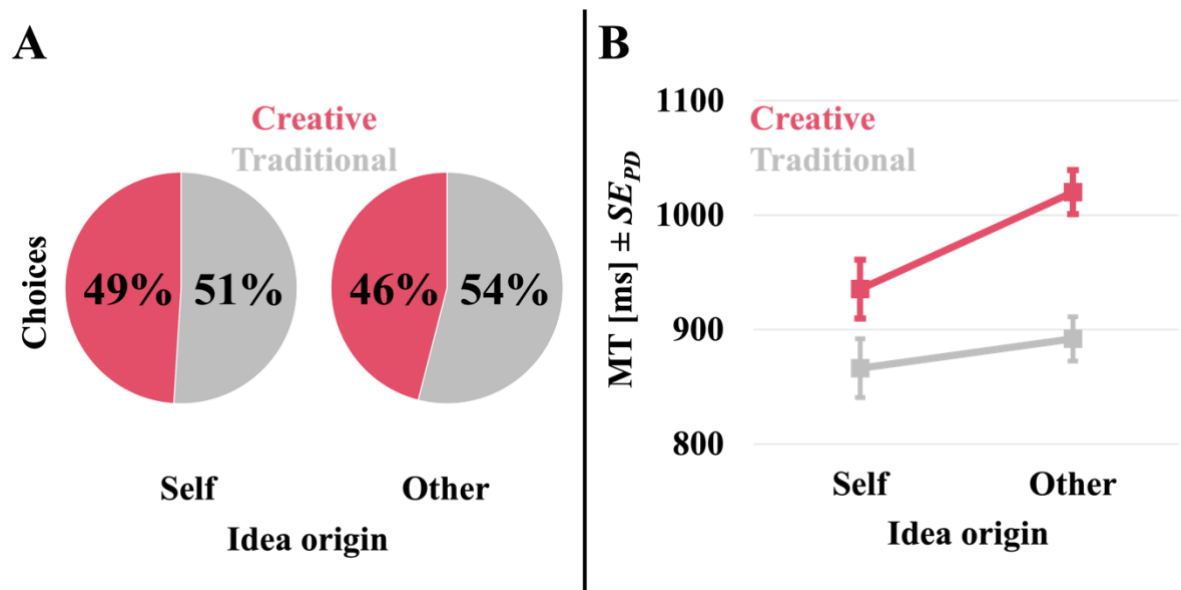


Fig. 2. Main results of study 2. (A) Choice frequencies for both idea origin conditions. The share of creative choices is shown in red and share of traditional choices is shown in grey. (B) Movement time (MT) for both idea origin and item use conditions. “Creative use” trials are shown in red and “traditional use” trials are shown in grey. Error bars represent standard errors of the paired differences.

Discussion

Similar to study 1, unfolding of hand movements when selecting creative ideas indicated significant attraction towards the standard approach. This effect, again, was stable throughout the experiment (see supplemental results). However, when response options had been self-generated, there was no preference for traditional over creative item uses on a choice level and the effect of item use on movement times was, even though still present, remarkably reduced. Self-enhancement biases, thus, seem to partially counteract biases against creativity.

General Discussion

Human and societal evolution have been strongly driven by creative achievements like the invention of the wheel, the steam engine or the internet (Hennessey & Amabile, 2010). Despite this positive connotation, initially, most innovations have to face substantial doubts regarding practicability and usefulness, often leading to immediate rejection (Staw, 1995). This skepticism is rooted in the inherent uncertainty which comes with leaving the beaten path and opting for novel, creative approaches (Amabile, 1996; Goncalo et al., 2015; Mueller et al., 2012). As such uncertainty is usually experienced as aversive (Heider, 1958), most humans prefer traditional over original approaches (Rietzschel et al., 2010). Crucially, the lure of established ideas is not restricted to the decision on which idea to implement but it is even present when the choice for a creative idea has already been made (Reis et al., in press).

Here, we present two preregistered experiments, in which we tested whether increasing familiarity with creative ideas can reduce uncertainty regarding corresponding options and therefore counteract this bias against creativity. To examine this hypothesis, we used the response-dynamics paradigm of creative idea selection (Reis et al., in press) and tracked hand movements while participants chose between two possible item uses (creative vs. traditional). To test the influence of increased familiarity, items repeated either identically or conceptually during the experiment (study 1) and we manipulated whether choice options were self-generated or provided by other actors (study 2). In both experiments, participants' hand movements were significantly torn towards the standard approach, even after an original response had been selected repeatedly. This effect was independent of whether the encountered object repeated identically or conceptually (study 1) and was still present when participants had come up with creative options themselves (study 2). However, for self-generated compared to

externally provided ideas, choice frequencies indicated no preference for the standard use and also movement times indicated lower attraction towards traditional ideas.

Overall, our findings point towards an even stronger influence of established traditions on creative behavior than previously assumed. Default beliefs and procedures, which might have been established over decades through thousands of repetitions, apparently cannot be overridden by a few encounters with a novel approach. For instance, earlier research found that people require an average of 66 days to form a new habit (Lally et al., 2010). It yet is unpleasant news that we did not find any reduction of this bias against creativity over time, especially as the first encounters with a novel behavior usually have by far the most tremendous effect on forming novel associations (Lally & Gardner, 2011).

However, there seem to be mechanisms which at least to some extent can counteract this bias against creativity. As we did only find a reduction of this bias for own compared to externally provided ideas but not due to repeated encounters, merely increasing familiarity with creative options does not seem to be the key to more innovation. Instead, self-generated creative ideas might be less affected by established traditions than externally provided creative ideas because confidence in the feasibility of these options is increased. This assumption is in line with earlier research on product design (Nikander et al., 2014) but yet requires to be tested explicitly in future research.

Moreover, we found substantial, interindividual variation in our findings (see Fig. 1A). Thus, there might be actors who experience none or at least significantly less attraction to the norm than other individuals. Whether such reduced cognitive conflict can be the cause (in terms of self-selection) or effect (in terms of long-term training) of outstanding creative achievements, also needs to be explored in future research.

Concluding, our results provide further evidence that creative behavior is tremendously hampered by established traditions. Increasing familiarity with original ideas, unfortunately, does not seem to be the crucial antidote to counteract this bias. However, our findings pave the way for promising future interventions to enhance creativity like promoting confidence in original approaches.

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Supplemental Online Materials
for
**How to overcome biases against creativity: The role of
familiarity and confidence in original solutions**

Content:

Supplemental results for study 1

Table S1-6

Supplemental results for study 2

Table S7-10

Figure S1

Study 1: Supplemental results

Due to the high number of empty cells, we repeated our main analysis for IT, MT and AUC, using experimental half (1 vs. 2) instead of experimental block as a within-subject factor. Thus, 49 participants could be included in this analysis, and we applied similar exclusion criteria as for our main analysis. As another exploratory analysis, we correlated the number of correctly solved questions in the RAT with the difference between creative and traditional item use trials for each measure (IT, MT, AUC). For this correlation, we included datasets of all participants with at least 10 trials per item use condition ($n = 52$).

Table S4-S6 show means and standard deviations for IT, MT, AUC and each combination of item use, experimental half and repetition type. ITs were descriptively, however not statistically significantly, higher for creative compared to traditional item use trials, $F(1,48) = 3.17$, $p = .081$, $\eta_p^2 = .06$. Moreover, ITs decreased over time, $F(1,48) = 10.80$, $p = .002$, $\eta_p^2 = .18$, and were significantly lower for identical compared to conceptual repetitions, $F(1,48) = 10.82$, $p = .002$, $\eta_p^2 = .18$. There were no two-way or three-way interactions, $F_s \leq 1.17$, $p_s \geq .285$, $\eta_p^2_s \leq .02$.

In line with our main analysis, MTs were significantly higher for creative than for traditional responses, $F(1,48) = 27.96$, $p < .001$, $\eta_p^2 = .37$. Furthermore, MTs decreased over time, $F(1,48) = 8.21$, $p = .006$, $\eta_p^2 = .15$, but were not affected by repetition type, $F < 1$. Item use and experimental half interacted significantly, $F(1,48) = 4.25$, $p = .045$, $\eta_p^2 = .08$. That is, the difference between traditional and creative responses decreased over time, even though for both experimental halves traditional responses were significantly faster than creative ones (first half: $t(48) = 3.85$, $p < .001$, $d_z = 0.55$, second half: $t(48) = 3.36$, $p = .002$, $d_z = 0.48$). There was neither an interaction of item use and repetition type nor of experimental half and repetition type, $F_s < 1$. There was no interaction of all three factors, $F < 1$.

The main effect of item use on AUCs paralleled our main analysis, $F(1,48) = 61.95, p < .001, \eta_p^2 = .56$. There was no significant effect of experimental half or repetition type on AUCs, $F_s \leq 3.61, p_s \geq .063, \eta_p^2_s \leq .07$. There was neither an interaction of item use and experimental half, nor of experimental half and repetition type, $F_s \leq 1$. However, item use and repetition type interacted significantly, $F(1,48) = 5.63, p = .022, \eta_p^2 = .10$. For both repetition types, creative responses showed more attraction to the traditional use than vice versa, however this effect was stronger for conceptual than for identical repetitions (identical: $t(48) = 3.63, p = .001, d_z = 0.52$, conceptual: $t(48) = 7.47, p < .001, d_z = 1.07$). The three-way interaction did not approach significance, $F < 1$.

There was no correlation between the number of correctly solved items in the RAT and the difference between creative and traditional responses for IT, MT or AUC, $t_s < 1$.

Table S1. Means (standard deviations in brackets) of Initiation Time (IT, in milliseconds) for both repetition types, item use conditions and each block within Experiment 1.

Repetition type	Block 1		Block 2		Block 3		Block 4		Block 5	
	Trad.	Crea.	Trad.	Crea.	Trad.	Crea.	Trad.	Crea.	Trad.	Crea.
Identical	1,241.60 (1,646.51)	1,033.16 (1,144.36)	428.48 (218.45)	541.63 (471.75)	419.29 (287.84)	481.81 (364.13)	376.10 (314.19)	562.67 (703.08)	428.36 (462.97)	478.30 (512.16)
Conceptual	1,518.78 (2,068.05)	2,045.55 (3,085.96)	893.04 (788.65)	1,822.99 (3,287.08)	2,964.58 (9,644.12)	1,712.29 (3,905.77)	1,142.56 (1,898.48)	1,088.61 (2,537.70)	1,093.28 (2,430.77)	1,036.39 (1,739.54)

Table S2. Means (standard deviations in brackets) of Movement Time (MT, in milliseconds) for both repetition types, item use conditions and each block within Experiment 1.

Repetition type	Block 1		Block 2		Block 3		Block 4		Block 5	
	Trad.	Crea.	Trad.	Crea.	Trad.	Crea.	Trad.	Crea.	Trad.	Crea.
Identical	1,416.61 (1,662.47)	1,092.99 (512.53)	924.61 (623.80)	1,249.46 (1,888.95)	754.68 (315.15)	922.68 (372.43)	794.28 (299.58)	1,016.76 (497.81)	820.58 (327.18)	859.65 (353.71)
Conceptual	1,162.05 (1,465.86)	997.19 (562.53)	824.14 (305.82)	1,222.53 (1,223.72)	958.49 (533.09)	1,252.05 (847.54)	906.53 (524.88)	980.58 (361.63)	820.41 (470.18)	1,021.82 (530.85)

Table S3. Means (standard deviations in brackets) of Area Under the Curve (AUC, in x-units²) for both repetition types, item use conditions and each block within Experiment 1.

Repetition type	Block 1		Block 2		Block 3		Block 4		Block 5	
	Trad.	Crea.	Trad.	Crea.	Trad.	Crea.	Trad.	Crea.	Trad.	Crea.
Identical	8,436.99 (3,827.31)	11,174.58 (4,840.92)	11,135.59 (8,611.96)	13,214.20 (6,119.08)	8,953.75 (4,603.41)	11,117.82 (5,137.34)	10,390.57 (4,614.53)	11,095.95 (4,308.85)	10,257.46 (4,931.30)	11,682.85 (4,185.13)
Conceptual	9,254.99 (7,627.71)	9,075.31 (7,118.98)	9,001.53 (5,227.56)	13,772.40 (12,794.16)	8,735.13 (5,049.86)	12,426.55 (5,153.71)	8,887.69 (4,675.27)	12,160.68 (5,513.76)	8,895.32 (5,101.73)	13,050.91 (8,755.57)

Table S4. Means (standard deviations in brackets) of Initiation Time (IT, in milliseconds) for both repetition types, item use conditions and each experimental half within Experiment 1.

Repetition type	First half		Second half	
	Traditional	Creative	Traditional	Creative
Identical	659.90 (518.45)	696.74 (503.03)	429.55 (341.02)	470.87 (525.01)
Conceptual	1,063.16 (900.77)	1,471.64 (1,697.35)	915.38 (959.94)	999.29 (2,168.96)

Table S5. Means (standard deviations in brackets) of Movement Time (MT, in milliseconds) for both repetition types, item use conditions and each experimental half within Experiment 1.

Repetition type	First half		Second half	
	Traditional	Creative	Traditional	Creative
Identical	818.88 (415.87)	1,062.69 (729.24)	769.81 (281.59)	857.76 (285.38)
Conceptual	810.65 (266.58)	1,070.44 (598.23)	807.58 (392.05)	908.32 (323.11)

Table S6. Means (standard deviations in brackets) of Area Under the Curve (AUC, in x-units²) for both repetition types, item use conditions and each experimental half within Experiment 1.

Repetition type	First half		Second half	
	Traditional	Creative	Traditional	Creative
Identical	9,581.92 (4,763.58)	11,396.68 (4,772.11)	10,019.31 (3,871.68)	11,402.67 (3,942.68)
Conceptual	8,481.51 (4,879.57)	11,394.44 (4,931.96)	8,451.28 (3,397.56)	11,632.35 (4,588.39)

Study 2: Supplemental results

As an exploratory analysis, we conducted another rmANOVA for each dependent variable (IT, MT and AUC). For this analysis, experimental half (first vs. second) was used as an additional within-subject factor, next to item use (traditional vs. creative) and idea origin (self-generated vs. externally provided). Please note that reduced degrees of freedom for the explorative compared to the main analysis of IT, MT and AUC are because of datasets with empty cells ($n = 3$). Choice frequencies were analysed by means of a two-tailed t -test comparing traditional and creative responses for each combination of idea origin condition and experimental half.

Means and standard deviations for IT, MT and AUC and each combination of item use, experimental half and idea origin are presented in Table S8-S10. In the first half of the experiment, significantly more traditional than creative options were selected for externally provided options, $t(67) = 2.04$, $p = .045$, $d_z = 0.25$. For the second half of the study a similar descriptive, however statistically not significant trend was observed, $t(67) = 1.52$, $p = .134$, $d_z = 0.18$. Regarding self-generated solutions, for neither half of the experiment there was a significant effect of item use on choice frequencies, $ts \leq 1.57$, $ps \geq .121$, $d_zs \leq 0.19$.

ITs were not affected by item use or idea origin, $F_s \leq 1.44$, $ps \geq .234$, $\eta_p^2s \leq .02$, but significantly declined over time, $F(1,59) = 34.02$, $p < .001$, $\eta_p^2 = .37$. There were no interaction effects, $F_s \leq 1.60$, $ps \geq .211$, $\eta_p^2s \leq .03$.

MTs were significantly slower for creative than for traditional responses, $F(1,59) = 30.64$, $p < .001$, $\eta_p^2 = .34$, faster for self-generated compared to externally provided ideas, $F(1,59) = 14.12$, $p < .001$, $\eta_p^2 = .19$, and decreased over time, $F(1,59) = 8.82$, $p = .004$, $\eta_p^2 = .13$. The interaction of item use and idea origin paralleled our main analysis, $F(1,59) = 5.56$, $p = .022$, $\eta_p^2 = .09$. All further interactions missed statistical significance, $F_s \leq 2.25$, $ps \geq .139$, $\eta_p^2s \leq .04$.

We found higher AUCs for creative than for traditional selections, $F(1,59) = 25.71, p < .001, \eta_p^2 = .30$, but there was no effect of experimental half, $F(1,59) = 2.44, p = .124, \eta_p^2 = .04$. AUCs were smaller for own compared to externally provided ideas, $F(1,59) = 6.57, p = .013, \eta_p^2 = .10$. No two-way or three-way interaction was significant, $F_s \leq 2.69, p_s \geq .106, \eta_p^2_s \leq .04$.

Table S7. Means (standard deviations in brackets) of Initiation Time (in milliseconds), Movement Time (in milliseconds) and Area Under the Curve (in x-units²) for both idea origin and item use conditions in Experiment 2.

Idea origin	Initiation Time		Movement Time		Area Under the Curve	
	Traditional	Creative	Traditional	Creative	Traditional	Creative
Self	289.80 (154.72)	301.57 (168.49)	866.28 (260.43)	935.36 (283.48)	10,093.99 (3,140.06)	10,884.47 (2,764.70)
Other	292.46 (167.55)	300.49 (173.14)	891.85 (247.59)	1,020.04 (310.01)	10,431.13 (2,812.16)	11,721.40 (3,132.70)

Table S8. Means (standard deviations in brackets) of Initiation Time (IT, in milliseconds) for both idea origin and item use conditions and both experimental halves within Experiment 2.

Idea origin	First half		Second half	
	Traditional	Creative	Traditional	Creative
Self	313.02 (168.84)	332.82 (184.66)	267.00 (153.48)	267.97 (164.73)
Other	326.21 (191.15)	334.57 (201.38)	266.63 (162.63)	265.75 (159.89)

Table S9. Means (standard deviations in brackets) of Movement Time (MT, in milliseconds) for both idea origin and item use conditions and both experimental halves within Experiment 2.

Idea origin	First half		Second half	
	Traditional	Creative	Traditional	Creative
Self	908.28 (287.93)	1,007.52 (358.68)	847.85 (272.72)	887.54 (267.12)
Other	933.14 (289.06)	1,076.39 (354.34)	881.12 (263.13)	1,001.94 (319.35)

Table S10. Means (standard deviations in brackets) of Area Under the Curve (AUC) for both idea origin and item use conditions and both experimental halves within Experiment 2.

Idea origin	First half		Second half	
	Traditional	Creative	Traditional	Creative
Self	9,834.12 (3,415.33)	11,057.53 (3,259.34)	10,415.64 (3,532.89)	11,062.17 (3,309.94)
Other	10,044.11 (3,012.26)	11,713.26 (3,649.30)	10,588.15 (3,029.99)	11,941.14 (3,494.89)

A

Please indicate the **traditional/creative** use
for this item:



Please use a maximum of 18 characters (including spaces)

B

The **traditional/creative** use
for this item:



**„Drink water“ /
„Put flowers inside“**

Fig. S1. Procedure of the idea generation phase in Experiment 2. (A) For half of the items, participants had to generate the traditional and a creative use themselves. (B) For the other half of the items, we presented the traditional and a creative use during the idea generation phase.