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Low power warm-up effect: Understanding the effect of power on creativity over time☆

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ABSTRACT

Prior research suggests that having power makes individuals more creative, because the powerful are more willing to break with convention. We investigate the possibility that lower power individuals can also be creative when given the opportunity to warm up by completing a creative task more than once. In Study 1 ($N = 153$), we divided a creative ideation session into two consecutive rounds and found that low (vs. high) power individuals were less creative in the first round (replicating prior research), but low power individuals improved in the second round, attenuating the low power disadvantage. We replicated this effect in Study 2 ($N = 121$; pre-registered), with a different creativity task (i.e., structured imagination task) and expanded timeframe (i.e., five rounds instead of two). In Study 3 ($N = 179$; pre-registered), we again replicated the warm-up effect using two different creativity tasks that allowed us to rule out an alternative explanation. We conclude by discussing the theoretical implications of our findings for research on the dynamic effects of power on creativity and the practical implications for creativity, social equality, and education.

Creativity is defined as the generation of ideas, insights, or solutions that are both novel and useful for solving a problem (Amabile, 1983, 1988; Sternberg & Lubart, 1999). Prior research has shown that feeling powerful boosts creativity because the powerful are less likely to conform to the status quo (Brinol, Petty, Valle, Rucker, & Becerra, 2007; Galinsky, Magee, Gruenfeld, Whitson, & Liljenquist, 2008; Galinsky, Rucker, & Magee, 2015; Weick & Guinote, 2008). This low power disadvantage might perpetuate inequality because creativity is a highly desirable skill that leads to profit and recognition (Burgelman, 1983; Ford & Gioia, 2000; George, 2007; Hennessey & Amabile, 2010; Kanter, 1985; Runco, 2004). If low power individuals cannot effectively participate in the creative process, this could limit their opportunities and cement their position toward the bottom of the hierarchy. We argue that the low-power disadvantage on creative tasks is not inevitable and that low power people can boost their creative performance with the opportunity to warm up, thus opening the opportunity for those low in power to be more creative than existing research suggests.

Although creativity is ostensibly valued, expressing creative ideas can draw criticism (Mueller, Melwani, & Goncalo, 2012; Staw, 1995). Thus, creativity requires the willingness to diverge from existing solutions in a novel direction, even if doing so might be socially controversial (Amabile, 1996; Goncalo & Staw, 2006; Katz, Mann, Shen, Goncalo, & Ferguson, 2022; Mok & Morris, 2010; Shalley & Zhou, 2008; Shalley, Zhou, & Oldham, 2004). Power is often defined as the control of valued resources over others (French & Raven, 1959; Keltner, Gruenfeld, & Anderson, 2003) and feeling powerful has been found to liberate people from the influence of others (Galinsky et al., 2008). Prior research has shown that feeling powerful boosts creativity by lowering conformity pressure and making people more willing to candidly share their novel ideas, even if they are not socially desirable (Brinol et al., 2007; Galinsky et al., 2008; Galinsky et al., 2015; Weick & Guinote, 2008). In addition to feeling free of influence, the powerful are also more capable of abstract processing (Lammers, Galinsky, Gordijn, & Otten, 2012; Magee & Smith, 2013), cognitive flexibility (Guinote, 2007), risk-taking (Anderson & Galinsky, 2006), and action taking (Fast, Gruenfeld, Sivanathan, & Galinsky, 2009; Galinsky, Gruenfeld, & Magee, 2003; Magee, Galinsky, & Gruenfeld, 2007)—all of which might give high power individuals a creative advantage over low power individuals (Duguid & Goncalo, 2015; Galinsky et al., 2008).

In the current research, we propose that low power individuals can

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overcome their creative disadvantage and be as creative as high power individuals when they are given the opportunity to "warm up" by completing a creative task more than once. Past research investigating the relationship between power and creativity has measured creativity at a single timepoint (e.g., Duguid & Goncalo, 2015, Study 4; Galinsky et al., 2008). For example, Galinsky et al. (2008) asked participants to generate one drawing of an alien from another planet that was later rated for its novelty (i.e., the structured imagination task). However, the creative process often unfolds over time, during which individuals generate multiple outputs sequentially or across rounds (Ward, Smith, & Finke, 1999; Martindale, 1999; Perry-Smith & Mannucci, 2017; see also Burroughs, Moreau, & Mick, 2008; Nijstad, De Dreu, Rietzschel, & Baas, 2010).

Why might we expect the creativity of low power individuals to increase across multiple rounds of a creative task? We argue that this occurs because the experience of being creative can, in and of itself, have positive psychological consequences (Sassenberg & Moskowitz, 2005; Goncalo, Vincent, & Krause, 2015; Khessina, Goncalo, & Krause, 2018). Engaging in the process of creative ideation entails the free and unfettered exploration of alternative ideas and perspectives (Goncalo & Katz, 2020)—a process of divergent thinking that can boost feelings of autonomy (Kim, Goncalo, & Rodas, 2023) and liberation from emotional and psychological constraints (Goncalo et al., 2015; Kim, Zeppenfeld, & Cohen, 2013). In other words, for those with low power, initial constraints on the free expression of creative ideas might be overcome with initial engagement with the creative task. Conversely, we expect the creativity of high-power individuals to remain relatively static across rounds of a creative task. Since high (vs. low) power individuals are relatively free from constraints and relatively creative right from the start (Duguid & Goncalo, 2015, Study 4; Galinsky et al., 2008), we expect that the effect of warming up will have less of an impact on their subsequent creative performance. Thus, we predict that low (vs. high) power individuals will be less creative at the beginning of a creative task but will eventually catch up to their high-power counterparts, thus overcoming their initial creative disadvantage. We call this the *low power warm-up effect*.

1. Open science statement

Following the latest guidelines, all studies were run with IRB approval and conformed to APA ethical standards. For each study, all measures, manipulations, and exclusions in the study are disclosed. Studies 2 and 3 were pre-registered and thus the method of determining the final sample size is disclosed. No analyses were conducted until data collection was complete. We determined exclusion criteria in an a priori manner and preregistered these decisions in Studies 2 and 3. To safeguard data quality, we excluded participants who did not pass two simple attention checks. Non-responses (e.g., non-words for the creative idea generation task, or simple lines for the drawing task) were excluded from the analysis, although the participant's responses apart from the non-responses were included in the analysis (if any).

2. Study 1

In this study, we test our hypothesis that working on a creative task can increase low power individuals' creativity on a subsequent creative task. In order to test this prediction, we divided the creative idea generation session into two rounds. Specifically, all participants were asked to generate creative ideas for 1 min, which constituted the "warm-up round" (i.e., the first round), although the participants were unaware there would be a second round. Once they finished it and moved onto the next section, they were told that they can continue to generate ideas for as long as they wanted, which constituted the second round. We expected that high power individuals would be more creative in the first round, replicating findings from prior research. However, we also expected that the creativity of low power individuals would significantly increase in round 2.

2.1. Method

Participants. One hundred seventy five participants from a large public university in the United States were recruited (51.4% women, $Age_{mean} = 19.82$, $Age_{SD} = 1.19$) for course credit. Out of 175 participants, 15 people failed a simple attention check that asked participants to choose (1) from a 5-point Likert-type scale. Five people did not write the power priming essays per the instruction or left it blank. Eight participants did not follow the creative task instructions or did not generate any ideas—making it impossible to assign a novelty score. When even one idea was able to be scored, we included the response in the analysis. This left 153 participants in total. Based on a sensitivity power analysis with this sample, a statistical power of 80%, and $p < 0.05$, the smallest detectable effect is $f = 0.293$. Sample-size estimates were made with G*Power (Version 3.1; Faul, Erdfelder, Lang, & Buchner, 2007).

Procedure. Participants were randomly assigned to one of two conditions in a single-factor (power: high, low), between-subjects design. After signing a consent form, participants were primed with high (vs. low) power. Participants first completed a bogus leadership test with 7 questions. They were told that they would be assigned to a manager (high power) or employee (low power) role based on the test. However, in reality, the conditions were randomly assigned. When the role was assigned, participants engaged in a resource allocation task, where they either allocated a bonus to employees as a manager or indicated how much bonus they should receive as an employee (Anderson & Berdahl, 2002; Duguid & Goncalo, 2015; Galinsky et al., 2003; Lammers, Galinsky, Gordijn, & Otten, 2008). This served as the first power prime. Following prior research (e.g., Galinsky, Magee, Inesi, & Gruenfeld, 2006, Study 1), we reinforced the first power prime with a second power prime, which was an episodic recall prime (Galinsky et al., 2003), where participants were asked to write about a time they felt powerful (vs. powerless).

Following the power prime, participants were introduced to a creative task, which was to generate novel ideas for a new candle scent following procedures used in previous research (Goncalo & Katz, 2020). Specifically, the participants read the following:

> "This next section is a task about product development. We are looking for some ideas for new types of scented candles that are creative, novel, and unique. Please write as many creative, novel, and unique ideas as possible for new candle scents."

After reading the task instructions, the participants were asked to work on the task for 1 min and were auto-advanced to the next screen after 1 min. Upon finishing this "first round", participants were made aware that they will be given another chance to work on the same task on the following page. They could stop working on this "second round" of the idea generation task whenever they wished. Following the ideation task, the participants responded to the following items: PANAS (Positive and Negative Affect Schedule) scale and power manipulation check items.

Measures. ***Idea novelty***. Two independent coders scored the novelty of participants' candle scent ideas, following Goncalo and Katz (2020). Specifically, two trained coders who were blind to the experimental condition and predictions of the study coded each idea for novelty, which was defined as "the extent to which the idea does not resemble the typical candle scent". Each coder was given a scale of 1 to 5, with the following scale anchors: 1 = *Scent that is extremely common in the set of ideas and in real life, which are the basic and default scents always expected*

to be available; 3 = *Scent that may be seen on occasion or could imagine existing*; 5 = *Scent that really would not have been expected before*. The inter-rater correlation was significant for both round 1 novelty score (ICC = 0.93, $p < 0.001$) and round 2 novelty score (ICC = 0.91, $p < 0.001$) so the scores of the two coders were averaged together.[1]

Positive and negative affect. PANAS scale (Watson, Clark, & Tellegen, 1988) was used to measure participants' mood. These items were averaged after checking for reliability (positive, α = 0.767; negative, α = 0.796).

Power manipulation check. Participants reported to what extent they felt influential, independent, powerful, unimportant (reverse-coded), and subordinate (reverse-coded; Duguid & Goncalo, 2012) on a 7-point Likert-type scale. These items were reliable (α = 0.869) and thus were averaged together.

2.2. Results

Manipulation check. Participants in the low-power condition ($M_{\text{Low-power}} = 3.56$, $SD = 1.27$) reported feeling significantly lower in power than those who were in the high-power condition ($M_{\text{High-power}} = 5.57$, $SD = 0.93$, $F(1,151) = 125.47$, $p < 0.001$, $\eta p^2 = 0.454$, 95% confidence interval (CI) [1.66, 2.37]), indicating successful power manipulation.

Main analyses. For our main analysis, we used a generalized linear model that regressed novelty on power (high, low), round (one, two), and the power x round interaction, where each participant is treated as a random factor, using the lmerTest package in R. The model revealed a main effect of power ($b = 0.742$, $z = 3.39$, $p < 0.001$, 95% CI [0.31, 1.17]), a main effect of round ($b = 0.246$, $z = 2.77$, $p = 0.006$, 95% CI [0.07, 0.42]), and importantly, a significant power x round interaction ($b = -0.387$, $z = -3.09$, $p = 0.002$, 95% CI [−0.63, −0.14]). To decompose this interaction, we looked at the effect of rounds within each power condition. This analysis revealed that idea novelty significantly increased across the rounds in the low power condition ($b = 0.247$, $z = 2.95$, $p = 0.004$, 95% CI [0.08, 0.41]), but not in the high power condition ($b = -0.141$, $z = -1.52$, $p = 0.134$, 95% CI [−0.33, 0.04]).

Simple comparisons revealed that in the first round, high power individuals ($M_{\text{High-power}} = 2.40$, $SD = 0.81$) generated ideas that are more novel than low power individuals ($M_{\text{Low-power}} = 2.02$, $SD = 0.66$, $F(1,144) = 9.64$, $p = 0.002$, $\eta p^2 = 0.063$, 95% CI [0.14, 0.62]). However, in the second round, there were no differences in novelty of ideas between high ($M_{\text{High-power}} = 2.22$, $SD = 0.83$) and low power conditions ($M_{\text{Low-power}} = 2.25$, $SD = 0.83$, $F(1,142) = 0.057$, $p = 0.812$, $\eta p^2 = 0.0004$, 95% CI [−0.31, 0.24])—supporting the low power warm-up effect (see Fig. 1).[2] Low power individuals' idea novelty increased ($F(1,67) = 8.898$, $p = 0.004$, $\eta p^2 = 0.117$, 95% CI [0.08, 0.43]) from the first round to the second round, whereas high power individuals' idea novelty did not change ($F(1,68) = 1.414$, $p = 0.239$, $\eta p^2 = 0.020$, 95% CI [−0.08, 0.30]).[3].

Analyses on the positive and negative affect scales revealed there were no differences in positive ($F(1,151) = 0.02$, $p = 0.887$, $\eta p^2 = 0$, 95% CI [−0.10, 0.11]) and negative ($F(1,151) = 0.94$, $p = 0.332$, $\eta p^2 = 0.006$, 95% CI [−0.05, 0.16]) mood between high ($M_{\text{High-power (Positive)}} = 3.64$, $SD = 0.65$; $M_{\text{High-power (Negative)}} = 2.33$, $SD = 0.70$) and low ($M_{\text{Low-power (Positive)}} = 3.62$, $SD = 0.68$; $M_{\text{Low-power (Negative)}} = 2.22$, $SD = 0.64$) power conditions and controlling for mood did not affect the interpretation of any of the results reported in this study as well as in the following studies.[4]

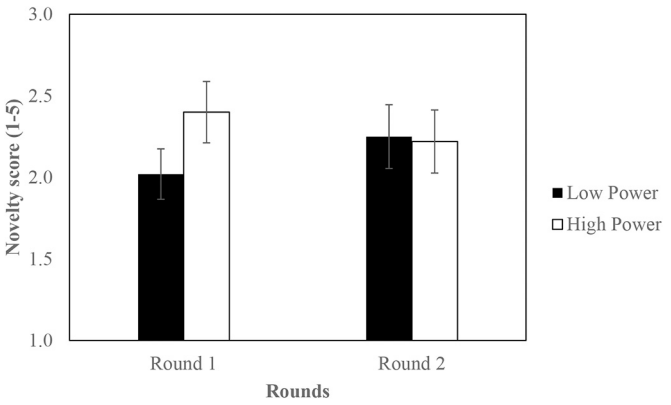

Fig. 1. The effect of high and low power on novelty score across rounds, Study 1. Error bars represent 95% confidence intervals.

2.2.1. Additional analyses testing alternative explanations

Next, we discuss three alternative theoretical explanations for the low power warm-up effect that were raised during the review process. We detail the logic of each explanation and empirical tests.

High-power effort. An alternative explanation for the low power warm up effect could be decreased persistence among the powerful. Persistence is an important factor that has been shown to boost creative performance (Nijstad et al., 2010). It is possible that high power individuals will simply not try as hard in later rounds of a creativity task, because performing the same task twice might seem trivial and research has shown that the powerful persist less on tasks that are deemed as unworthy of their time and effort (DeWall, Baumeister, Mead, & Vohs, 2011; Inesi & Rios, 2013; Lammers et al., 2012). We tested this explanation in two ways. First, we looked at the amount of time participants spent on round 2, where participants could quit when they wanted. Inconsistent with this explanation, there were no differences in time spent on round 2 (in seconds) between the high ($M_{\text{High-power}} = 115.98$, $SD = 103.80$) and low power conditions ($M_{\text{Low-power}} = 105.53$, $SD = 99.83$, $F(1,151) = 0.403$, $p = 0.526$, $\eta p^2 = 0.003$, 95% CI [−22.08, 42.99]).[5] Second, we looked at the number of ideas generated. There were no differences in the number of ideas generated neither in the first ($F(1,151) = 0.03$, $p = 0.862$, $\eta p^2 = 0.0002$, 95% CI [−1.04, 1.24]) nor in the second round ($F(1,151) = 0.03$, $p = 0.863$, $\eta p^2 = 0.0002$, 95% CI [−1.87, 2.23]) between the high ($M_{\text{High-power (Round 1)}} = 6.35$, $SD = 3.43$; $M_{\text{High-power (Round 2)}} = 8.39$, $SD = 6.24$) and low ($M_{\text{Low-power (Round 1)}} = 6.25$, $SD = 3.73$; $M_{\text{Low-power (Round 2)}} = 8.21$, $SD = 6.57$) power participants. Together, these analyses find that high (vs. low) power participants did not choose to quit sooner and did not generate fewer ideas, suggesting against the idea that high power participants invest less effort across the task.

High-power exhaustion. Another explanation for the low-power warm-up effect is that because high (vs. low) power individuals generate more creative ideas in the first round, they exhaust the supply of creative ideas available to them in the second round. This explanation is simply

[1] First, all ideas within a round for each coder were averaged to form an average novelty score per coder per round. Then, after checking for reliability across the two coders per each round, the two coders' novelty scores were averaged to form the final novelty score.

[2] Controlling for time worked on the task or the number of ideas generated did not affect the interpretation of any of the results.

[3] We supplemented the simple comparisons with a repeated measures ANOVA that provides further comparisons of the effect of power across the rounds. We felt this analysis did not provide any additional insights in addition to the main regression analysis in the interpretation of the results, so we report it in the Appendix and note here that it yields similar conclusions as the main regression analysis.

[4] We included the PANAS simply to rule out the possibility that a generally positive or negative mood might be driving our effects.

[5] Log-transformation did not change the results ($F(1,151) = 0.58$, $p = 0.447$, $\eta p^2 = 0.004$, 95% CI = [−0.09, 0.19]).

inconsistent with Study 1's descriptive statistics. If high power participants exhaust their supply of creative ideas in round 1, then their creativity should decrease in round 2. That was not the case, instead their creativity remained consistent across rounds.

High-power idea similarity. Another possibility is that high power participants generated creative ideas in the first round and stuck with them in the second round (sticking with your good ideas can be a reasonable thing to do). In contrast, low-power participants' creativity may have increased in round 2 because they changed up their ideas more so than high power participants. If this is the case, then we should see more overlapping ideas across rounds from high (vs. low) power participants. Two coders counted the number of ideas that overlapped between round 1 and 2 (reliability = 0.92; see full coding instructions in the Appendix) and found no significant difference between high ($M_{\text{High-power}} = 1.45$, $SD = 2.16$) and low power participants ($M_{\text{Low-power}} = 1.41$, $SD = 2.16$, $F(1,151) = 0.009$, $p = 0.924$, $\eta p^2 = 0.000$, 95% CI = [−0.66, 0.72]).

2.3. Discussion

Replicating prior work (Duguid & Goncalo, 2015; Galinsky et al., 2008), we found that high power individuals are indeed initially more creative than low power individuals. However, we also found support for our hypothesis that when individuals are given a chance to warm up, then low power individuals are able to "catch up" to the creativity of high power individuals—the "low power warm-up effect".

We considered a few different alternative explanations for the low-power warm-up effect, including that high power participants (1) invested less effort across rounds, (2) exhausted their creative ideas in round 1, (3) stuck with their creative ideas from round 1, and (4) a general positive and negative affect explanation. We did not find support for any of these explanations (see above, Additional Analyses Testing Alternative Explanations) (See Table 1).

One limitation of Study 1 is that we only measured idea novelty at two points in time, thus raising questions about the trajectory of the low power warm-up effect and whether our results would generalize to the creative process as it unfolds over multiple rounds. Accordingly, in Study 2, we measure creativity across five rounds. This design increases the generalizability of our findings, because individuals often engage in multiple rounds when engaging in creative tasks (Perry-Smith & Mannucci, 2017). Additionally, in order to test the robustness of Study 1's findings across different measurements of creativity, we adopt another commonly used task that demands creativity—the structured imagination task (Galinsky et al., 2008; Ward, 1994).

3. Study 2

Study 2 was pre-registered here: https://aspredicted.org/ee5fi.pdf. In this study, we replicate the results from Study 1, while extending the number of rounds from two to five. We also used a different task to measure creativity. Following Ward (1994), we used a structured imagination task—a task that was also used by Galinsky et al. (2008) in the original study showing that power boosts creativity. We expected that high (vs. low) power individuals would be more creative at the beginning (e.g., first round, out of five rounds). This would directly replicate the findings of Galinsky et al. (2008). However, we also expected that low power creativity would increase across rounds—the low power warm-up effect. In sum, we hypothesize an interaction of power condition and creative output sequence such that low (vs. high) power condition participants experience a steeper increase in creativity over the trials.

3.1. Method

Participants. We recruited 160 participants from a large public university in the United States (59.2% women, $\text{Age}_{\text{mean}} = 36.02$, $\text{Age}_{\text{SD}} = 14.01$) in exchange for $3 US Dollars. Four participants signed up but did not take the survey. Twenty-six participants did not finish the survey. Consistent with our pre-registered exclusion criteria, we excluded 5 participants who failed the attention check—which asked participants to choose a specific number of a Likert-type scale—and 4 participants that spent an excessive amount of time (i.e., 3SD outside the mean) on any of the drawings. This left a total of 121 participants. Based on a sensitivity power analysis with this sample, a statistical power of 80%, and $p < 0.05$, the minimum effect that can be found is f = 0.330.

Procedure. Participants were randomly assigned to one of two conditions in a single-factor (power: high, low), between-subjects design. After signing a consent form, we manipulated power using the same protocol as in Study 1. Afterwards, participants engaged in the structured imagination task, where they imagined traveling to a planet unlike earth and drawing an alien that is local to it (Ward, 1994). This task captures the extent to which participants can overcome the cognitive constraint imposed by existing knowledge (e.g., extraterrestrials developed by science fiction writers; or animals on earth that have typical properties such as bilateral symmetry) and produce a novel output. The participants were asked to generate five drawings, one after the other on separate pages. Specifically, the participants read the following:

> "Please draw an alien that lives on a planet unlike earth. Please feel free to draw in whichever way you would like. We will ask you to draw 5 times."

The responses were recorded on an on-line survey platform Qualtrics, which allowed us to track information, such as time spent drawing. The participants drew an alien by clicking their mouse. Following the structured imagination task, the participants completed a survey described below.

Measures. *Novelty*. Following the coding procedure of Ward (1994), two independent coders scored the novelty of participants' alien drawings, defined as "the extent to which the creature does not resemble the typical alien", on a 4-point scale.[6] Each coder was given a scale of 1 to 4, with the following scale anchors: 1 = *An extremely typical alien (e.g., from science fiction movies)*; 2 = *A typical alien with a slight variation*; 3 = *An atypical alien with some characteristics of a typical alien*; 4 = *An alien that really would not have been expected before*. The inter-rater correlation was significant for each drawing ($\text{ICC}_{\text{drawing1}} = 0.797$, $\text{ICC}_{\text{drawing2}} = 0.847$, $\text{ICC}_{\text{drawing3}} = 0.839$, $\text{ICC}_{\text{drawing4}} = 0.807$, $\text{ICC}_{\text{drawing5}} = 0.846$, all $ps < 0.001$), so the two coders' scores were averaged together.

***Positive and negative affect*.** We used the same items from Study 1, which were averaged after checking for reliability (positive, α = 0.759; negative, α = 0.777).

***Power manipulation check*.** We used the same items from Study 1, which were averaged after checking for reliability (α = 0.896).

3.2. Results

Manipulation check. Participants in the low-power condition ($M_{\text{Low-power}} = 2.64$, $SD = 1.23$) reported feeling significantly lower in power than those who were in the high-power condition ($M_{\text{High-power}} = 5.45$, $SD = 1.05$, $F(1,119) = 182.32$, $p < 0.001$, $\eta p^2 = 0.605$, 95% CI [2.40, 3.23]), indicating a successful power manipulation.

Main analyses. For our main analysis, we used a generalized linear

[6] To provide further guideline, the coders were made aware of the original scoring scheme from Ward (1994), where the following characteristics were outlined as being atypical: (a) lacked a major sensory organ (i.e., eyes, ears, nose), (b) had atypical numbers of a sensory organ (e.g., three eyes), (c) demonstrated an unusual configuration of the sensory organs (e.g., eyes located below the nose), (d) had an exaggerated or unusual ability (e.g., eyes that had laser beams), or sensory organs that served an atypical function (e.g., ears for protection).

Table 1
Correlations table (Study 1).

Measure	1	2	3	4	5	6	7	8	9
1. High (vs. low) power[a]	**1**	**0.250****	**−0.020**	**0.014**	**0.014**	**0.052**	**0.012**	**0.079**	**0.674****
2.Novelty (round 1)		**1**	**0.538****	**0.047**	**−0.137**	**−0.029**	**−0.099**	**−0.099**	**−0.069**
3.Novelty (round 2)			**1**	**0.024**	**−0.191***	**−0.047**	**0.072**	**−0.069**	**−0.201***
4.Idea number (round 1)				**1**	**0.326****	**−0.005**	**−0.022**	**−0.127**	**−0.014**
5.Idea number (round 2)					**1**	**0.646****	**0.043**	**−0.086**	**0.114**
6.Persistence (second round)						**1**	**0.031**	**−0.013**	**0.022**
7.Positive affect							**1**	**−0.105**	**0.133**
8.Negative affect								**1**	**0.001**
9.Power manipulation check									**1**

Note. a: 0 = low power condition; 1 = high power condition.
First round persistence is identical across all participants, as it was set to 1 min by design.
* $p < 0.05$, ** $p < 0.01$.

model that regressed novelty on power (high, low), drawing sequence (1 to 5), and the power x drawing sequence interaction, where each participant is treated as a random factor. The model revealed a main effect of power ($b = 0.491$, $z = 2.30$, $p = 0.023$, 95% CI [0.07, 0.91]), a main effect of drawing sequence ($b = 0.180$, $z = 5.61$, $p < 0.001$, 95% CI [0.12, 0.24]), and importantly, a significant power x drawing sequence interaction ($b = -0.095$, $z = -2.08$, $p = 0.038$, 95% CI [−0.18, −0.01]). To decompose this interaction, we looked at the effect of drawing sequence within each power condition. This analysis revealed that drawing novelty significantly increased across the drawing sequence in the low power condition ($b = 0.179$, $z = 5.42$, $p < 0.001$, 95% CI [0.11, 0.24]) and in the high power condition ($b = 0.085$, $z = 2.72$, $p = 0.007$, 95% CI [0.02, 0.15]). However, consistent with our hypothesis, the increase was significantly stronger for low power than for high power, as indicated by the significant power x drawing sequence interaction.[7]

We also analyzed the effects of power on each drawing. Fig. 2 depicts the means by power condition across the drawing sequence. ANOVA results show that in the first round, high power individuals ($M_{\text{High-power}} = 2.45$, $SD = 1.08$) generated more novel output than low power individuals ($M_{\text{Low-power}} = 2.05$, $SD = 1.02$, $F(1,108) = 4.165$, $p = 0.044$, $\eta p^2 = 0.037$, 95% CI [0.01, 0.81]). However, in rounds two through five, there were no differences in novelty ($p_{\text{drawing2}} = 0.397$, $p_{\text{drawing3}} = 0.075$, $p_{\text{drawing4}} = 0.958$, $p_{\text{drawing5}} = 0.799$) between high ($M_{\text{HPdrawing2}} = 2.81$, $M_{\text{HPdrawing3}} = 2.77$, $M_{\text{HPdrawing4}} = 2.70$, $M_{\text{HPdrawing5}} = 2.89$) and low ($M_{\text{LPdrawing2}} = 2.62$, $M_{\text{LPdrawing3}} = 2.40$, $M_{\text{LPdrawing4}} = 2.71$, $M_{\text{LPdrawing5}} = 2.84$) power individuals.[8]

3.2.1. Additional analyses testing alternative explanations

We again tested the same alternative explanations described in Study 1. As in Study 1, we did not find empirical support for these alternatives. Thus, for brevity, we summarize the results here and report the full analyses in the Appendix.

(1) High power effort. To test whether high (vs. low) power participants invested less effort across the rounds of the task, we analyzed the following variables: *time spent on each drawing, click count, and size of the drawing space that participants used* (each variable was captured by the online survey platform). These variables did not significantly differ between the two power conditions in any of the five rounds. *(2) High power exhaustion.* As in Study 1, the idea that high power participants exhausted their creative drawing ideas in round 1 is not consistent with the descriptive statistics. High power participants' drawing ideas actually increased in novelty across rounds, rather than decrease. *(3) High power output similarity.* Following the additional analysis from Study 1, we coded for the similarity of drawings across the five rounds. Specifically, we coded for how much subsequent drawings were similar to the first drawing on a four-point scale (where 1 is "very similar" and 4 is "not similar at all"), with the help of two independent coders ($\alpha = 0.839$). The results showed that there were no differences in the similarity of drawings between high ($M_{\text{High-power}} = 2.74$, $SD = 0.99$) and low power participants ($M_{\text{Low-power}} = 2.78$, $SD = 0.95$, $F(1,105) = 0.040$, $p = 0.843$, $\eta p^2 = 0.000$, 95% CI [−0.41, 0.34]).[9]

3.3. Discussion

The results showed that high power individuals drew aliens that are significantly more novel in the first drawing, directly replicating previous research (Galinsky et al., 2008, Study 2). However, we also found support for our hypothesis that low (vs. high) power individuals would benefit more from warming up. Indeed, the results showed that low power individuals' drawings eventually became as novel as high power individuals', resulting in no difference in novelty between the two power conditions in rounds 2 to 5. The results further showed that having (vs. not having) power increased novelty, replicating previous research (Duguid & Goncalo, 2015; Galinsky et al., 2008). And drawings from later (vs. earlier) rounds were significantly more novel—consistent with findings from prior research (Lucas & Nordgren, 2015, 2020) that persistence increases creativity (See Table 2).

In a third experiment, we sought to investigate possible alternative explanations for our results stemming from the fact that all participants completed an identical creativity task across rounds. For instance, it is possible that in the second and following rounds, the creative task becomes easier for all participants simply because everyone was asked to perform the same task a second time (a differential learning explanation). It is also possible that the low-power people kept working on one novel idea and steadily perfected it in the following rounds of the same task (our idea similarity supplemental analyses suggest against this explanation, but cannot rule it out completely). To address these alternative explanations, Study 3 used different creativity tasks across rounds. Adopting different tasks across rounds will test the low power warm-up effect in a context that precludes task learning or task familiarity effects across rounds.

4. Study 3

Study 3 was pre-registered here: https://aspredicted.org/aj6x5.pdf. In this study, we test whether feelings of autonomy gained from a creative task will allow low power individuals to overcome their low power disadvantage and catch up with high power individuals' creativity on a

[7] Controlling for mood did not affect the interpretation of the results and we reported it in the Appendix.

[8] Following our pre-registered analysis plan, we supplemented the main analysis with a coefficient plot that provides further comparisons of the effect of power across the drawing sequence. We felt this analysis did not aid in the interpretation of the results, so we report it in the Appendix (Fig. 4) and note here that it yields similar conclusions as the main analysis.

[9] The similarity scores for each round were averaged in this analysis. We report the results for each round separately in the Appendix.

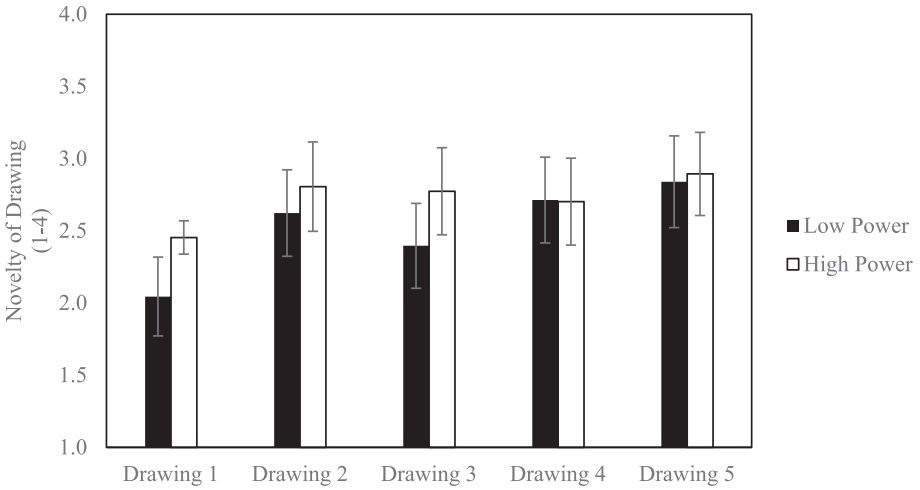

Fig. 2. The effect of high and low power on novelty score across rounds, Study 2. Error bars represent 95% confidence intervals.

Table 2
Correlations table (Study 2).

Measure	1	2	3	4	5	6	7	8	9	10	11	12
1. High (vs. low) power[a]	**1**	**0.193***	**0.083**	**0.174**	**−0.005**	**0.025**	**0.043**	**−0.027**	**−0.035**	**0.052**	**−0.085**	**0.778****
2.Novelty (round 1)		**1**	**0.528****	**0.483****	**0.608****	**0.625****	**0.140**	**0.082**	**0.206***	**−0.048**	**−0.004**	**0.128**
3.Novelty (round 2)			**1**	**0.514****	**0.541****	**0.516****	**−0.013**	**0.022**	**0.082**	**−0.033**	**0.066**	**0.024**
4.Novelty (round 3)				**1**	**0.430****	**0.427****	**0.149**	**0.103**	**0.183**	**0.055**	**0.042**	**0.129**
5.Novelty (round 4)					**1**	**0.690****	**0.022**	**0.133**	**0.152**	**−0.067**	**−0.001**	**0.010**
6.Novelty (round 5)						**1**	**0.047**	**0.006**	**0.152**	**−0.008**	**−0.038**	**0.000**
7.Drawing space avg.							**1**	**0.388****	**0.325****	**−0.123**	**0.188***	**0.035**
8.Drawing time avg.								**1**	**0.415****	**−0.167**	**−0.055**	**0.050**
9.Click count avg.									**1**	**−0.073**	**−0.033**	**−0.037**
10.Positive affect										**1**	**−0.090**	**0.140**
11.Negative affect											**1**	**0.008**
12.Power manip. Check												**1**

Note. a: 0 = low power condition; 1 = high power condition.
* $p < 0.05$, ** $p < 0.01$.

different creativity task. To test this possibility, we adopted two different creative ideation tasks and asked participants to work on each task one after the other. We expected to replicate the findings from Study 1.

4.1. Method

Participants. We recruited 188 participants from a large public university in the United States (66.5% women, $Age_{mean} = 19.97$, $Age_{SD} = 1.18$) for course credit. Consistent with our pre-registered exclusion criteria, we excluded 9 participants who failed the attention check—which asked participants to choose a specific number of a Likert-type scale. This left a total of 179 participants. Based on a sensitivity power analysis with this sample, a statistical power of 80%, and $p < 0.05$, the minimum effect that can be found is $f = 0.211$.

Procedure. Participants were randomly assigned to one of four conditions in a 2 (power: high, low) x 2 (task order: shopping cart task first, dormitory task first), between-subjects design. After signing a consent form, the participants were primed with high (vs. low) power using the same power manipulation as Study 1. Afterwards, participants engaged in one of two ideation tasks. One task asked participants to generate shopping cart ideas for the elderly (Herd & Mehta, 2019). Specifically, participants read:

> "This next section is a task about product development. We are working on designing a shopping cart specifically designed for an elderly person (65+ years of age). We are looking for some new ideas that are creative, novel, and unique. Please write as many creative ideas as possible for a shopping cart for the elderly."

The other ideation task was to generate ideas to improve university dormitories where the students are living (or have lived) (adapted from Duguid & Goncalo, 2015, Study 1). Specifically, participants read:

> "A recent survey suggested that many students are dissatisfied with the on-campus dormitories. We would like to ask you to give us creative, novel, and unique suggestions to improve our university dormitories. Your creative suggestions can be about anything, ranging from dining to location, and others. Please write as many creative ideas as possible for dormitory improvement."

Participants worked on the ideation task for one minute (i.e., round 1). In round 2, participants switched tasks and worked on the other ideation task for one minute (i.e., shopping cart task and then dormitory task, or dormitory task and then shopping cart task).

Measures. ***Idea novelty.*** Two independent coders scored the novelty of the participants' shopping cart and dormitory improvement ideas, just as in Study 1. The inter-rater correlation was significant for both shopping cart task novelty score (ICC = 0.87, $p < 0.001$) and dormitory task novelty score (ICC = 0.88, $p < 0.001$) so the scores of the two coders were averaged together.

Importance of following instructions. At the end of the two ideation tasks, participants responded to a one item question (5-point Likert type scale) that asked the extent to which they agreed with the statement "I believe it is important to follow task instructions".

Positive and negative affect. We used the same items from Study 1, which were averaged after checking for reliability (positive, $\alpha = 0.740$; negative, $\alpha = 0.758$).

Power manipulation check. We used the same items from Study 1,

which were averaged after checking for reliability (α = 0.863).

4.2. Results

Manipulation check. Participants in the low-power condition ($M_{\text{Low-power}} = 3.35$, $SD = 1.06$) reported feeling significantly lower in power than those who were in the high-power condition ($M_{\text{High-power}} = 5.43$, $SD = 0.78$, $F(1,177) = 224.40$, $p < 0.001$, $\eta p^2 = 0.559$, 95% CI [1.80, 2.35]), indicating successful power manipulation.

Main analyses. Following the pre-registration, we used an ANOVA to conduct simple comparisons between the high and low power condition for each round. We broke down the analysis by task order. *(1) Dormitory task first and then shopping cart task.* In round 1, high power individuals ($M_{\text{High-power}} = 2.36$, $SD = 0.72$) generated *dormitory improvement ideas* that are more novel than low power individuals ($M_{\text{Low-power}} = 1.98$, $SD = 0.66$, $F(1,90) = 6.78$, $p = 0.011$, $\eta p^2 = 0.070$, 95% CI [0.09, 0.67]). However, in round 2, there were no differences in novelty of *shopping cart ideas* between high ($M_{\text{High-power}} = 2.97$, $SD = 0.57$) and low power conditions ($M_{\text{Low-power}} = 3.12$, $SD = 0.65$, $F(1,89) = 1.40$, $p = 0.240$, $\eta p^2 = 0.016$, 95% CI [−0.41, 0.10])—supporting the low power warm-up effect even for two different tasks (see Figs. 3A and B).

(2) Shopping cart task first and then dormitory task. The effect held even when the order of the two tasks was switched. Specifically, in round 1, high power individuals ($M_{\text{High-power}} = 3.21$, $SD = 0.66$) generated *shopping cart ideas* that are more novel than low power individuals ($M_{\text{Low-power}} = 2.90$, $SD = 0.67$, $F(1,79) = 4.55$, $p = 0.036$, $\eta p^2 = 0.054$, 95% CI [0.02, 0.62]). However, in round 2, there were no differences in novelty of *dormitory improvement ideas* between high ($M_{\text{High-power}} = 2.08$, $SD = 0.60$) and low power conditions ($M_{\text{Low-power}} = 2.15$, $SD = 0.75$, $F(1,81) = 0.236$, $p = 0.628$, $\eta p^2 = 0.003$, 95% CI [−0.38, 0.23]).[10]

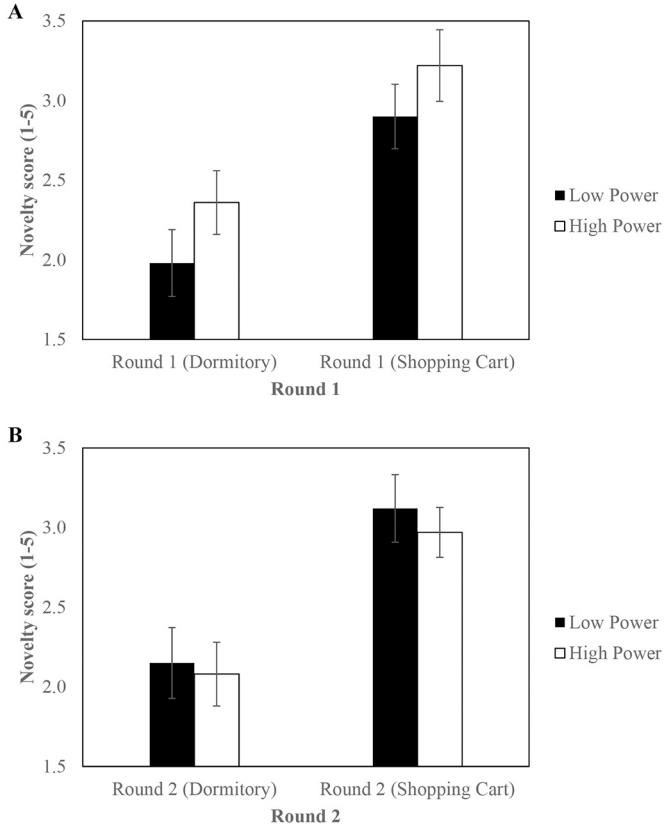

Fig. 3. A. The effect of high and low power on novelty score in round 1, Study 3. Error bars represent 95% confidence intervals.
B. The effect of high and low power on novelty score in round 2, Study 3. Error bars represent 95% confidence intervals.

Additional analyses testing alternative explanations. There were no differences in the number of ideas generated neither in the first ($F(1,177) = 0.71$, $p = 0.400$, $\eta p^2 = 0.004$, 95% CI [−0.87, 0.35]) nor in the second round ($F(1,177) = 0.11$, $p = 0.738$, $\eta p^2 = 0.001$, 95% CI [−0.58, 0.41]) between the high ($M_{\text{High-power (Round 1)}} = 4.34$, $SD = 2.11$; $M_{\text{High-power (Round 2)}} = 3.75$, $SD = 1.64$) and low ($M_{\text{Low-power (Round 1)}} = 4.60$, $SD = 2.01$; $M_{\text{Low-power (Round 2)}} = 3.84$, $SD = 1.74$) power participants. This speaks against the idea that high power participants invest less effort across the task (the high-power effort explanation).

Furthermore, participants in the high-power condition ($M_{\text{High-power}} = 4.54$, $SD = 0.52$) did not report any difference in perceived importance of following instructions compared to those who were in the low-power condition ($M_{\text{Low-power}} = 4.52$, $SD = 0.59$, $F(1,177) = 0.030$, $p = 0.863$, $\eta p^2 = 0.000$, 95% CI [−0.15, 0.18]). This suggests that the effect was not due to differences in rule following by high and low power individuals.

4.3. Discussion

The findings suggest that a creativity task can warm up low power individuals for a subsequent and unrelated creativity task, thereby helping them overcome their low power disadvantage. We did not find evidence that the effect was influenced by differences in task effort (measured as productivity; i.e., the number of ideas generated) or the perceived importance of following instructions, suggesting that it was not high power individuals' tendency to invest less effort or ignore the task instructions that drove the effect. Limiting the amount of time participants can work on round 2 of the creativity task to 1 min, unlike round 2 of Study 1 that allowed participants to quit whenever they wished, made it possible to rule out differential time engagement as a confound—notably there were no differences in time engaged across the two power conditions in Study 1.

5. General discussion

In this research, we identified the low power warm-up effect. Although low power individuals are less creative than high power individuals toward the beginning of the creative task, they eventually catch up and match high power individuals' creativity. We argued that this is due to the creative task providing feelings of autonomy and liberation that eventually helps low power individuals overcome their low-power disadvantage. This finding is important because creative capabilities provide access to important resources, such as profits and recognition (Burgelman, 1983; Ford & Gioia, 2000; George, 2007; Hennessey & Amabile, 2010; Kanter, 1985; Runco, 2004). Thus, if low power individuals—who have less resources as the definition of power denotes (Magee & Galinsky, 2008)—are always less creative than high power individuals (Duguid & Goncalo, 2015; Galinsky et al., 2008), then low power individuals may not gain access to important resources. In this research, we tried to open the opportunity for those low in power to be creative that existing research suggests might be closed by showing that an individual's creative performance is not immutable but rather it can increase through a warm-up.

In Study 1, we demonstrated that high power individuals are more creative than low power individuals in the first round (out of two rounds) of the creative idea generation session. However, when individuals have warmed up by engaging in the first round, there was no difference in creativity anymore in the second round. In Study 2 (pre-registered), we adopted another widely used task for measuring creativity (i.e., the structured imagination task) and tracked creativity over 5 subsequent rounds. This study again confirmed that high power

[10] Controlling for mood did not affect the interpretation of the results and we reported it in the Appendix.

individuals are more creative than low power individuals at the beginning (i.e., first round), but low power individuals eventually "catch up" with high power individuals because low (vs. high) power condition participants' creativity increased more steeply over trials. In Study 3 (pre-registered), we replicated Study 1 with a different creativity task for each round—demonstrating that a different creativity task can warm low power people up for an unrelated creativity task. This study design helped rule out several alternative explanations for the low power warm-up effect, including high-power exhaustion, high-power idea similarity, and high-power effort (i.e., time engagement). This study also ruled out the possibility of high (vs. low) power individuals considering following instructions as less important.

5.1. Theoretical and practical implications

In this research, we make two theoretical contributions. First, we contribute to the power literature by showing that low power individuals can be similarly creative as high power individuals. In so doing, we introduced the dynamic effect of power on task performance over time—for the first time, to the best of our knowledge. Second, we contribute to the creativity literature by showing that, although the value of persistence in creative output has been shown in prior literature, persistence can be especially rewarding for some individuals (e.g., those in a low power state). In sum, we demonstrated the conditions under which low power individuals can be as creative as high power individuals.

This longitudinal understanding of the effect of power on creativity provides implications for organizations and the society at large, including interventions to address social inequality. For instance, organizations should provide low (vs. high) power individuals (e.g., employees) with sufficient chance to "warm up" so that they can excel in being creative. From a societal perspective, policy makers should protect low power individuals (e.g., students from low socioeconomic status) by securing enough opportunities for them to be creative (e.g., affordable education costs), especially because education quality and/or amount is linked to higher income (Morgan & David, 1963), income disparity reduction (Abdullah, Doucouliagos, & Manning, 2015; Campos, Ren, & Petrick, 2016), health outcomes and behaviors (Cesur, Dursun, & Mocan, 2014; Faeh, Braun, & Bopp, 2011), and economic growth (Aghion, Boustan, Hoxby, & Vandenbussche, 2009). Furthermore, although low power individuals (e.g., racial minorities) are often stigmatized (Major, Spencer, Schmader, Wolfe, & Crocker, 1998) to be low performers (at school or at work) due to lack of motivation (Braveman, Cubbin, Egerter, Williams, & Pamuk, 2010), it may simply be that they are not provided sufficient opportunities to warm up and perform just as well as high power individuals.

5.2. Limitations and future research

In future research it would be interesting to test possible mechanisms that could explain the low power warm-up effect, for example, whether low (vs. high) power participants' feelings of autonomy is lower prior to a creative task, but not anymore after engaging in a creative task (Kim et al., 2023). It would also be important to test whether the (low power) warm up effect emerges on tasks that do not require creativity at all.

Power has been shown to impact various types of behavior (e.g., action and risk taking), task performance (e.g., motor-based performance, interview performance, and self-regulation), cognition (e.g., abstraction), and social perception (e.g., stereotyping) (Galinsky et al., 2015). Our findings open many new opportunities for future research to investigate the possibly dynamic effects of power on other types of task and behavior *over time*. It would also be interesting to test whether other types of threats (e.g., stereotype threats) would yield similar effects to power, such that the stereotyped group performs worse in creative tasks but eventually catches up over time. Lastly, future research can test the moderating factors of the low power warm up effect, such as the stability of power (Sligte, De Dreu, & Nijstad, 2011) or one's creative capabilities.

5.3. Summary of alternative accounts

We considered a number of potential alternative explanations of the low power warm-up effect. First, that high (vs. low) power individuals may have invested less effort across the task. However, we looked at task engagement and did not find differences in time worked on the task (round 2 of Study 1 & rounds 1–5 of Study 2), number of ideas generated (Studies 1 & 3), click count (Study 2), and size of the drawing space that participants used (Study 2) between the two power conditions. Second, we considered the possibility that high power individuals exhaust their novel ideas in round 1. This would predict that the novelty of high power individuals' ideas declines across the task. This was not the case, as high power individuals' ideas maintained their novelty across rounds (Studies 1 and 3) or actually increased (Study 2). Third, we considered that high (vs. low) power individuals may have generated more novel ideas in round 1 and chosen to stick with those ideas in subsequent rounds. This would suggest that high power individuals' ideas would be more similar across the two rounds than the ideas of low power individuals. However, we found no difference in similarity across the two rounds between the two power conditions in Study 1. The results were consistent in Study 2, where we compared the similarity of drawings across the five rounds. Fourth, it is possible that low power individuals became familiar with the specific creativity task in round 1 and this familiarity increased their creativity rather than engagement in the creative task per se (i.e., warming up). We ruled this possibility out in Study 3 by using different creativity tasks in rounds 1 and 2. Fifth, we looked at mood (Studies 1–3) and found no difference between the two power conditions.

A simple alternative explanation of the low power warm-up effect could be that low power individuals became similarly creative as high power individuals because both high and low power individuals' power primes wore off over the trials, leading to similar effects of power in later rounds. However, this explanation would predict that, as the effects of power weaken, low power individuals' novelty should increase across the task and high power individuals' novelty should decrease across the task. That is not what the data showed. High power individuals' novelty remained consistent across rounds in Studies 1 and 3 and even increased across the drawing sequence in Study 2. Instead, across studies, the effect was driven by increases in low power novelty.

Open practices

The studies in this article earned Open Materials, Open Data, and Pre-registration badges for transparent practices. Materials and data for the studies are available at https://osf.io/wue2n/.

The pre-registrations for Studies 2 and 3 can be found at each respective link: Study 2 {https://aspredicted.org/ee5fi.pdf}, Study 3 {https://aspredicted.org/aj6x5.pdf}.

Declaration of Competing Interest

We disclose that there are no actual or potential conflict of interest including any financial, personal or other relationships with other people or organizations within three years of beginning the submitted work that could inappropriately influence, or be perceived to influence our work.

Data availability

Data and study materials are available at https://osf.io/wue2n/.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.

org/10.1016/j.jesp.2023.104474.

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