People Underestimate the Value of Persistence for Creative Performance

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Abstract:

Across six studies we investigated the prediction that people underestimate the value of persistence for creative performance. In Studies 1-3, people consistently underestimated how productive they would be while persisting on a range of creative tasks, and this effect was attenuated in non-creative tasks (Studies 2-3). Study 3 found that the subjectively experienced difficulty, or disfluency, of creative work accounted for persistence undervaluation. Alternative explanations based on idea quality (Studies 1-2) and goal-setting (Study 4) were considered and ruled out and domain knowledge was explored a boundary condition (Study 5). In Study 6 the disfluency of creative work reduced people's willingness to invest in an opportunity to persist, resulting in lower financial performance. This research demonstrates that persistence is a critical determinant of creative performance and that people may undervalue and underutilize persistence in everyday creative problem solving.

Keywords: Creativity, Creative Performance, Persistence, Fluency

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Persistence is the act of continuing to invest effort toward a task or goal and it is considered essential for creative performance. Thomas Edison experimented on over 1,600 filament materials while designing the electric light bulb – including hairs plucked from a friend's beard (Bedi, 2014). When Nobel laureate Linus Pauling was asked how he made so many discoveries, he said, "I think I think harder, think more than other people do" (Pauling, 1990). Creativity research also recognizes the value of persistence. Osborn's classic "no criticism" rule of brainstorming was specifically intended to remove barriers to persistence during group idea generation (1953). Similarly, contemporary social psychological theories of creativity emphasize the importance of intrinsic motivation, a key predictor of persistence (Amabile, 1996), and the value of exhausting the possible solutions in an idea category (De Dreu, Baas, & Nijstad, 2008).

While the link between persistence and creativity is well supported, less is known about whether people recognize the value of persistence in everyday creative problem solving. Do people accurately predict how much persistence benefits their own creative performance? This question is the focus of the current investigation. We begin by discussing the attributes that distinguish highly creative work from less creative work (Amabile, 1983; Schooler & Melcher, 1995) and we discuss how these attributes lead creative work to feel difficult, or cognitively disfluent (Nijstad & Stroebe, 2006). Given that fluency shapes value judgments (Alter & Oppenheimer, 2009), the inherently disfluent nature of creative work may downward-bias people's judgments about the value of persisting. Accordingly, we predict that the disfluency of creative work leads people to

underestimate the value of persisting on creative tasks. In six studies we test this prediction and consider alternative explanations and boundary conditions.

The Attributes of Creative Work

Creativity is defined as the generation of ideas, insights, or solutions that are novel and useful for a given situation or problem (Amabile, 1996; Amabile, Barsade, Mueller, & Staw, 2005; Sternberg, 1999). While social, cognitive, and organizational models of creativity differ in their emphasis, they converge on the idea that the cognitive processes underlying creativity are important and that creativity is likely served by a suite of cognitive processes, rather than a single process (Amabile, 1996; Brown & Paulus, 2002; De Dreu et al., 2008; Hennessey & Amabile, 2010; Smith, Ward, & Finke, 1995). We use the term *creative work* to describe problems or tasks that require relatively high amounts of creativity.

Three attributes tend to distinguish highly creative work from less creative work. First, creative work often utilizes associative thinking. It draws on learned cognitive associations between idea elements, and creative ideas emerge when these elements are associated in new and uncommon ways (Guilford, 1967; Mednick, 1962). Some liken idea generation to a natural selection process whereby cognitive associations are randomly combined, discarded, and recombined until a creative idea emerges (Campbell, 1960; Simonton, 1999, 2003). In contrast, less creative work follows known rules and algorithms, e.g. solving basic math problems[1] (Amabile, 1983; Sloman, 1996). Second,

[1] This distinction between associative and rule-based thought roughly parallels the distinction between associative and rule-based processes in dual-process models of social judgment (Chaiken & Trope, 1999).

creative work tends to involve solving "open" problems, in which the solution path is ill-defined or must be discovered (Amabile, 1983; see also Klahr & Simon, 2001). Because idea associations, rather than rules, guide creative thought, progress can develop in multiple possible directions and often requires trial-and-error. Less creative work involves relatively "closed" problems in which a known rule or algorithm can be applied to reach the solution. Third, people have limited conscious awareness of the mechanisms underlying creative work (Schooler & Melcher, 1995). While people are aware of the rules and procedures they use to solve routine problems, people are less aware of the means by which they solve creative problems, with solutions sometimes leaping into conscious awareness during moments of insight (Kounios & Beeman, 2009; Metcalfe & Wiebe, 1987).

It should be noted that creative work should be thought of as forming a continuum that ranges from highly creative to less creative, rather than a creative/non-creative dichotomy. Conceptualizing creative work as a contiuum is important because almost no work is purely creative or non-creative. For example, following the steps of a recipe to cook a meal is relatively uncreative work, but a missing ingredient or an ambiguity in the instructions could necessitate some creative thinking. Thus, compared to less creative work, highly creative work is work that is more frequently, or more prototypically, characterized by the attributes described above.

To summarize, highly creative work involves fewer rules, less structure, and less awareness of progress than less creative work. Consequently, people engaged in creative work are more likely to encounter instances of feeling stuck or being unsure how to

proceed. In the next section we discuss how this leads creative work to feel inherently disfluent.

The Disfluency of Creative Work

To understand how the attributes of creative work influence how people subjectively experience creative tasks, we draw on the SIAM (Search for Ideas in Associative Memory) theory of idea generation (Nijstad, Diehl, & Stroebe, 2003; Nijstad & Stroebe, 2006). Similar to evolutionary models of creative thinking (Simonton, 1999), the SIAM model conceptualizes creative work as involving the repeated search for ideas in associative memory. An important aspect of the theory is the recognition that attempts at idea association are often unsuccessful (see also Simonton, 2003). When trying to generate a creative idea, one might make an association that has already been considered, does not adequately solve the problem at hand, or one can fail to form an association altogether.

Failed idea associations are prevalent in creative work. In one study, participants generated solutions to a creative problem until they wanted to stop. When asked why they stopped when they did, over two-thirds of the participants reported that they could not think of any more ideas or that they kept thinking of old ideas (Gettys, Pliske, Manning, & Casey, 1987). Failed idea associations are also consequential. For instance, they predict dissatisfaction with task performance (Nijstad, Stroebe, & Lodewijkx, 2006). These studies suggest that disfluency is an inherent feature of creative work. To understand why this is consequential, we consider the impact of fluency on valuation judgments.

Processing Fluency and Valuation

Processing fluency, or subjective feelings of ease or difficulty, impact judgments, valuations, and decisions (Alter & Oppenheimer, 2009). Things that are processed fluently are better liked, better believed, and more seriously considered (Reber, Schwarz, & Winkielman, 2004; Schwarz et al., 1991).

Relevant to the current research, fluency also influences value judgments (Alter & Oppenheimer, 2008; Shah & Oppenheimer, 2007). For instance, in one study a fluently processed form of currency – a $1 bill – was judged to have more purchasing power than an equally valuable but less familiar Susan B. Anthony $1 coin (Alter & Oppenheimer, 2008). Another study asked participants to rate the quality of a fictitious company's stock and found that participants placed more value on a brokerage firm's ratings when that firm's name was fluent (e.g. Artan) compared to disfluent (e.g. Lasiea) (Shah & Oppenheimer, 2007). This research suggests that as a task becomes more disfluent, the perceived value of persisting decreases. For some tasks this is reasonable – tasks that *feel* difficult actually *are* difficult, and persisting may yield diminishing returns. However, for creative tasks, in which disfluency is an inherent feature, feelings of disfluency may downward-bias valuations of persistence. In the current research we predict that the disfluency of creative work leads people to underestimate the value of persisting on creative tasks, and that this effect is attenuated in non-creative[2] tasks.

[2] For ease of labeling and study presentation, we refer to tasks that require relatively more creative work as *creative tasks* and tasks that require relatively less creative work as *non-creative tasks*.

We think undervaluing persistence has important implications for creative performance. First, it means that people systematically undervalue a central route to creativity, as identified in prominent theoretical models (Amabile, 1996; De Dreu et al., 2008; Osborn, 1953). Second, given evidence from the brainstorming literature that the quality of idea generation improves over time, undervaluing persistence may be particularly problematic. In contrast to general fatigue accounts, which would predict that idea quality deteriorates over time (Baumeister, Bratslavsky, Muraven, & Tice, 1998), classic brainstorming research finds evidence that ideas become more creative over the duration of a brainstorming session (Christensen, Guilford, & Wilson, 1957; Parnes, 1961). Thus, undervaluing persistence may lead people to prematurely conclude their creative work and potentially leave their best ideas undiscovered.

Overview of Studies

Across six studies we investigate our hypothesis that people underestimate the value of persistence for creative performance. Each study followed a similar format. In the first stage, participants worked on a task for a set period of time. Next, participants estimated how much their performance would benefit from additional time to work on the task (referred to here as persistence). In the second stage of the study, participants actually persisted on the task. This procedure allowed us to compare people's predicted value of persistence with the actual value of persistence. Study 1 provides an initial test of our hypothesis using a creative idea generation task. Study 2 expands the scope of the design to include three creative tasks and three non-creative tasks. We predict that people will underestimate the value of persistence for creative tasks and this will be attenuated in

non-creative tasks. In these studies we also measure idea quality to address the possibility that idea quality diminishes over time, in which case people would be right to devalue persistence. In Study 3 we test the underlying mechanism. Specifically, we test whether persistence undervaluation is predicted by the disfluency of creative work. In Studies 4-5 we provide evidence against an alternative explanation based on goal-setting and test a boundary condition based on domain knowledge. In Study 6 we investigate a consequence of undervaluing persistence. Specifically, we test whether the disfluency of creative work reduces people's willingness to invest in an opportunity to persist, to the detriment of their financial performance.

Study 1: Underestimating the Value of Persistence

Study 1recruited students the week before Thanksgiving to complete a Thanksgiving-themed idea generation task. Participants generated solutions for 10 minutes, predicted how many more solutions they could generate while working on the task for an additional 10 minutes (i.e. persisting), and then persisted for 10 minutes. We predicted that participants would underestimate how many solutions they could generate while persisting on the task. We also measured the quality of the ideas generated in order to address the concern that idea quality diminishes over time, which would lead one to question whether participants are truly undervaluing persistence.

Method

Participants. Twenty-four students from Northwestern University (M_{age}=20.54, SD_{age}=1.32; 18 women) were recruited to the laboratory to participate in a 30-minute

session in exchange for $8. We recruited as many participants as we could in the week leading up to Thanksgiving break.

Procedure. Participants arrived to the laboratory in groups of 1-7 and completed the study individually at computer stations. In the first stage of the study, participants worked on a Thanksgiving-themed idea generation task for 10 minutes. Idea generation tasks test people's divergent thinking abilities and are widely recognized measures of creativity (Amabile, 1996; Guilford, 1967). In our task participants were asked to "Generate as many original ideas for things to eat or drink at a Thanksgiving dinner as you can." To incentivize task performance participants learned their responses would be rated for originality by outside judges and that each idea rated as above average would earn a raffle ticket into a $50 lottery.

After working on the task for 10 minutes, participants reported how many ideas they generated. In the second stage of the survey, participants were asked to work on the task again (i.e. persist) for an additional 10 minutes. Before persisting on the task, participants responded to the question, "How many more ideas do you think you will generate with the additional 10 minutes?" This question was our measure of predicted performance while persisting. After participants recorded their prediction, they persisted on the task for 10 minutes, providing a measure of actual performance while persisting. Our main analysis compared participants' predicted and actual number of solutions generated[3].

[3] We refer to the number of ideas generated or the number of problems solved as *performance* or *productivity,* rather than as *ideational fluency* as is typical of some creativity research. We do this to avoid confusion between processing fluency (general feelings of ease or difficulty) and ideational fluency (the number of ideas generated).

Originality ratings. As a measure of idea quality, we recruited 41 people from Amazon's Mechanical Turk (Mturk; M_{age}=36.95, SD_{age}=13.21; 23 women) to rate the originality of the ideas generated. Ideas were presented in a randomized order and originality was rated on a three-point scale (1=below average, 2=average, 3=above average). Raters showed high inter-rater reliability (α=.90). For each participant we calculated an originality score for ideas generated during the initial time period and for ideas generated while persisting.

Results

On average, people generated 21.79 ideas initially (*SD*=14.37). We predicted that people would underestimate how many ideas they would generate while persisting. A paired-samples t-test revealed that predicted performance while persisting (*M*=9.83, *SD*=6.21) was significantly lower than actual performance while persisting (*M*=15.04, *SD*=9.63), *t*(23)=-3.68, *p*=.001, *d*=.75, *CI*[-8.14,-2.28].

Next we tested whether the quality of ideas generated while persisting differed from ideas generated initially. A paired-samples t-test revealed that ideas generated while persisting (*M*=1.88, *SD*=.21) were significantly more original than ideas generated initially (*M*=1.76, *SD*=.17), *t*(23)=3.91, *p*=.001, *d*=.82, *CI*[.06,.18].

Discussion

Persistence is an important determinant of creativity in anecdotal accounts and theoretical models. Despite this attention, Study 1 found that people underestimated how productive they would be while persisting on an idea generation task. In order to address the concern that the quality of ideas decreases over time, we also measured the quality of the ideas generated and found that ideas generated while persisting were significantly

more original than ideas generated initially. Given that people underestimate the value of persisting and that creative quality may increase over time, these results suggest the intriguing possibility that undervaluing persistence may lead people to lose out on their most creative ideas by quitting too soon. In Study 2 we expand the scope of our investigation by testing our predictions across different creative and non-creative tasks.

[Insert Table 1 About Here]

Study 2: Creative and Non-Creative Tasks

Study 1 found that people underestimated how productive they would be while persisting on a creative idea generation task. Study 2 extended these findings by testing three *creative tasks* and three *non-creative tasks*. According to our theorizing, persistence undervaluation should be specific to creative tasks – tasks that require higher amounts of creative work – rather than a general phenomenon. We predicted that people would underestimate how productive they would be while persisting on the creative tasks and that this effect would be attenuated on the non-creative tasks.

Method

Participants. Seven-hundred and five participants (M_{age}=33.68, *SD*=11.86; 385 women) were recruited from Amazon's Mechanical Turk (Mturk) and compensated $0.51. Our recruitment goal was around 100 participants per task. Mturk respondents are recognized as a reliable population that produce data of comparable quality to laboratory and other online platforms (Buhrmester, Kwang, & Gosling, 2011). To further promote data quality, participation was restricted to those with IP addresses located in the U.S.

and a filter was applied to screen out those who previously participated in similar studies. We also included an attention check question. These recruitment procedures were used in all Mturk studies. We excluded 55 participants who failed the attention check (8% of sample) and one outlier we suspected of cheating (the participant generated 100% of the possible solutions). These exclusions left 647 for analysis.

Procedure. Participants received our survey through an online portal provided by Mturk. Participants were assigned to complete one of six tasks (described below). In the first stage of the survey, all participants received task instructions and then worked on their task for 4 minutes. After completing the task participants reported how many solutions they generated. In the second stage of the survey, participants learned they would persist on the task for an additional 4 minutes. Participants estimated how many solutions they could generate during the additional time and, after recording their prediction, persisted on the task for 4 minutes.

Creative and non-creative tasks. This study included three creative tasks and three non-creative tasks[4]. We conceptualize tasks as falling along a continuum from highly creative to less creative, however, for simplicity, we use the categorical labels *creative* and *non-creative* tasks. Based on precedent from previous literature, we chose three creative tasks (unusual uses, advertisement slogans, and anagrams) and three non-creative tasks (word search, math problems, and value-of-words). Next we describe each task.

[4] Tasks were administered across three surveys. The first tested unusual uses, anagrams, advertisement slogans, and word search. The second and third tested math problems and value-of-words. Age and gender did not significantly differ by survey, p's>.20.

Creative task: Unusual uses. This idea generation task is a widely used test of divergent thinking (Guilford, 1967). In this task participants are asked to generate as many uses as they can for a common object. In our study the object was a cardboard box. Examples of ideas generated are *playhouse for a child*, *a doorstop*, and *a weapon*. Participants were told their responses would be rated for originality, defined as novelty and uniqueness. Performance was incentivized with a $1 bonus for participants whose performance ranked in the top 5% on this dimension.

Idea originality was assessed using the same procedure described in Study 1. One-hundred and sixty people from Mturk (M_{age}=38.55, SD_{age}=12.95; 104 women) rated the responses on a 3-point scale (1=below average, 2=average, 3=above average). Each person rated 25% of the responses, to prevent fatigue. Thus, each slogan received approximately 40 ratings. The four groups of raters showed high inter-rater reliability: α*'s*=.90, .91, .92, and .93.

Creative task: Advertisement slogans. This creative production task was adapted from a task described in Sternberg (1999) and is thought to require a combination of convergent and divergent thinking. Participants viewed a picture of a cheeseburger and French fries and were asked to generate slogans for the product. Examples of slogans generated are "*It's okay to have a little grease now and then*", "*The basics are always the best*", and "*Eat a burger and thank a farmer*". Participants were told their ideas would be rated on the dimensions of engagement (whether the slogan captured the viewer's attention) and positivity (whether the slogan generated positivity toward the product). Performance was incentivized with a $1 bonus for participants whose performance ranked in the top 5% on these dimensions.

Slogan quality was assesses via people from Mturk (N=160; M_{age}=37.42, SD_{age}=12.97; 102 women) who each rated 25% of the slogans for engagement and positivity, using three-point scales (1=below average, 2=average, 3=above average). The two dimensions were averaged into a measure of slogan quality. Each slogan received approximately 40 ratings. The four groups of raters showed adequate inter-rater reliability: α*'s*=.73, .74, .77, and .78.

Creative task: Anagrams. Anagrams measure creative problem solving and convergent thinking (Bowden, 1997). In this task participants were shown a string of seven letters and were instructed to form words from the letter string. Words could be between two and five characters long and each letter could only be used once. We used the letters "AENOPSR" which produces 192 possible solutions. Performance was incentivized with a 1-cent bonus for each solution generated.

Non-creative task: Math Problems. Math problems are a commonly used non-creative task (Metcalfe & Wiebe, 1987). In our task participants were presented with 50 story-based math problems. Each problem was about 70 words long. Problems could be solved with simple math operations (i.e. addition, subtraction, multiplication, division) and typically involved multiple steps. All math problems were presented on a single page and participants could solve them in any order they wanted. To incentivize performance, participants earned a raffle ticket into a $10 lottery for each problem they solved.

Non-creative task: Value-of-words. This task involved calculating the numeric value of words based on the alphanumeric position of the letters that make up the word. For example, the value of the word *bat* is 23 [(*b*=2) + (*a*=1) + (*t*=20) = 23]. Participants were presented with 50 eight-letter words. All words were presented on a single page and

participants could solve them in any order they wanted. A diagram of a letter-value conversion chart appeared after every fifth word. To incentivize performance, participants earned a raffle ticket into a $10 lottery for each problem they solved.

Non-creative task: Word Search. In this task participants were presented with a 20 x 20 character letter matrix and were asked to find as many words as they could. The matrix was created using a random puzzle generator and included 100 words between two and five characters long, which were generated using a random word generator. Participants were instructed that words must be at least two letters long and that words could appear in any direction. Performance was incentivized with a 1-cent bonus for each word found.

Results

We predicted people would significantly underestimate the value of persistence in the creative tasks and that this effect would be attenuated in the non-creative tasks. First we compared the three creative tasks with the three non-creative tasks. A 2(performance: predicted, actual) x 2(task: creative, non-creative) mixed-factor analysis of variance (ANOVA) revealed the predicted performance x task interaction, $F_{(1,645)}$=46.55, p<.001. Predicted performance while persisting was significantly lower than actual performance while persisting for both the creative tasks, t(342)=-6.68, p<.001, and the non-creative tasks, t(304)=-3.40, p=.001 (Table 1), however an effect size comparison revealed that the effect size of the creative tasks, d=.58, was significantly larger than that of the non-creative tasks, d=.19, p<.001, as indicated by the non-overlapping confidence intervals (Table 1). The main effect of performance was significant, $F_{(1,645)}$=111.85, p<.001, and the main effect of task was non-significant, $F_{(1,645)}$=.026, p=.872. As a visual aid and to

further explore the data, Figure 1 displays paired-samples t-tests comparing predicted to actual performance for each task.

Finally, we looked at idea quality. In the unusual uses task, ideas generated while persisting (M=2.15, SD=.73) were significantly more original than ideas generated initially (M=1.93, SD=.48), $t(106)=4.30$, $p<.001$, d=.43, CI[.12,.32], and in the advertisement slogan task, slogans generated while persisting (M=1.83, SD=.14) were of significantly higher quality than slogans generated initially (M=1.80, SD=.12), $t(100)=2.57$, p=.012, d=.26, CI[.01,.06].

[Insert Figure 1 About Here]

Discussion

Study 2 found further evidence that people underestimate the value of persistence for performance in creative tasks. Across three creative tasks, people underestimated how productive they would be while persisting and, as predicted, this effect was significantly attenuated in the non-creative tasks. It is notable that, overall, the non-creative tasks also showed a small but significant persistence undervaluation effect. It suggests that, to some extent, persistence undervaluation may generalize beyond the creative domain. Given that the effect size of the creative tasks was stronger than that of the non-creative tasks, and that many non-creative tasks involve some elements of creativity, we would not see this as incompatible with our theorizing. It is an interesting question for future research.

We again found that the quality of ideas generated while persisting was higher than ideas generated initially, providing further evidence against a fatigue account in

which idea quality diminishes over time. Studies 1 and 2 provide a robust demonstration that people underestimate how productive they can be while persisting on a creative task and, in doing so, they underestimate their own ability to generate ideas that are at least of the same quality, if not higher, as those generated initially. In Study 3 we shift the investigation to focus on the mechanism underlying this effect.

Study 3: The Role of Fluency

Study 3 investigated whether fluency experienced during initial work accounts for the undervaluation of persistence. We proposed that people underestimate the value of persistence because the attributes of creative work (i.e. associative, non-linear, limited conscious access) lead it to feel disfluent (Nijstad et al., 2006). Participants worked on a creative task or a non-creative task, reported the fluency experienced during the initial work period, and then estimated how many solutions they could generate during an additional work period. We predicted that fluency would account for the undervaluation of persistence.

Method

Participants. One-hundred and sixty-one participants (M_{age}=33.91, SD_{age}=11.59; 70 women) were recruited from Mturk and compensated $0.51. Our recruitment goal was 80 per condition. Twelve failed the attention check (7% of sample), leaving 149 for analysis.

Procedure. Participants received the survey through an online portal provided by MTurk. In the first stage of the survey, participants received instructions for a creative task or a non-creative task. The *creative task* was the remote associates task (RAT), a

common measure of convergent thinking and creative problem solving (Mednick, 1962). In this task participant view a triad of three words that can be logically associated by a fourth word. For example, one triad consists of the words “manners”, “round”, and “tennis”. For this triad, the solution is “table” because the word table logically associates with each of the three words in the triad, i.e. “table manners”, “round table”, and “table tennis”. Participants solve the problem by providing the fourth word. The *non-creative* task was the math problems task used in Study 2.

Participants worked on the task for 4 minutes and then reported the number of solutions they generated. Next participants reported how fluently they experienced the task. Participants indicated their agreement with three questions on seven-point scales (1=disagree completely, 7=agree completely): “It was difficult to generate solutions during the 4 minutes”, “Solutions came easily to me during the 4 minutes”, and “I had a tough time generating solutions during the 4 minutes”. The first and third questions were reverse scored so that higher scores reflect greater fluency (α=.82). In the second stage of the survey participants estimated how many solutions they could generate during an additional 4 minutes and then they persisted on the task for 4 minutes.

Results

On the RAT people initially solved an average of 8.71 triads (*SD*=4.45) and on the math task people initially solved an average of 4.51 problems (*SD*=2.74).

First we looked for persistence undervaluation. A 2(task: creative, non-creative) x 2(performance: predicted, actual) mixed-factor ANOVA revealed the predicted performance x task interaction, $F_{(1,147)}$=20.03, p<.001. On the creative task, predicted performance while persisting (*M*=5.87, *SD*=3.89) was significantly lower than actual

performance while persisting (M=7.95, SD=4.34), t(74)=-4.84, p<.001, d=1.12, CI[-2.94,-1.22]. However, for the non-creative task, predicted (M=5.43, SD=3.03) and actual (M=5.09, SD=2.97) performance while persisting did not differ, t(73)=1.12, p=.270, d=.26, CI[-.27,.94]. The main effects of task, $F_{(1,147)}$=10.21, p=.002, and performance, $F_{(1,147)}$=10.92, p=.001, were significant.

Next we tested whether fluency predicted persistence undervaluation. To account for differences in raw performance across tasks, we computed a percentage of underestimation score [1 – (predicted performance ÷ actual performance)]. Thus, if a participant predicted they would solve 6 solutions and actually solved 10, the percentage of underestimation would be .40, or 40%. Simple mediation found that the creative task was experienced significantly less fluently, t(143)=-5.55, p<.001, and controlling for fluency, the significant effect of task condition on percentage of underestimation, t(143)=-3.12, p=.002, became non-significant, t(143)=-1.88, p=.063 (Figure 2). Bootstrap analysis with 5000 resamples confirmed the significant indirect effect, CI[-.37, -.02]. Fluency and initial task performance were uncorrelated in our sample, r(149)=.08, p=.346, however, one possible concern is that participants simply used fluency as a proxy for initial task performance. In a follow-up analysis controlling for initial performance, all links in the model remained statistically significant.

[Insert Figure 2 About Here]

Discussion

In Study 3 the fluency of initial work accounted for the undervaluation of persistence in a creative task. This was the case even when controlling for initial task performance. Having found evidence of the mechanism underlying persistence undervaluation, in Studies 4-5 we address alternative explanations.

Study 4: Ruling Out Goal-Setting

Study 4 addressed an alternative explanation. The goal-setting literature finds that performance predictions sometimes act as performance goals that then motivate higher performance (Heath, Larrick, & Wu, 1999), which would artificially produce an undervaluation effect. In the current study some participants persisted on a creative task after making performance predictions (*prediction* condition) and others persisted on the task without making performance predictions (*no prediction* condition). If making a prediction inflates performance while persisting, then those in the prediction condition should perform better than those in the no prediction condition. Alternatively, if both groups perform similarly, it will suggest that goal-setting does not account for persistence undervaluation.

Method

Participants. One-hundred and nine participants (M_{age}=34.70, SD_{age}=11.29; 48 women) were recruited from Mturk and compensated $0.51. Given the moderate-to-large effect size for this task found in Study 2 (d=.80), our recruitment goal for this study was reduced to 50 per condition. Eight participants failed the attention check (7% of sample), leaving 101 for analysis.

Procedure. In this study all participants completed the unusual uses task, as described in Study 2, and we manipulated whether participants made performance predictions. In the *prediction* condition participants worked on the task for 4 minutes, made predictions about their performance during an additional 4 minutes, and then persisted for 4 minutes. In the *no prediction* condition participants worked on the task for 4 minutes and then persisted on the task for an additional 4 minutes without making a prediction.

Results/Discussion

In the prediction condition people initially generated 13.64 uses (*SD*=5.77) and in the no prediction condition people initially generated 13.65 uses (*SD*=8.98). Replicating Study 2, a paired samples t-test on those in the prediction condition found that predicted performance while persisting (*M*=5.58, *SD*=3.76) was significantly lower than actual performance while persisting (*M*=8.70, *SD*=4.56), $t(53)=-5.65$, $p<.001$, $d=.78$, *CI*[-4.23,-2.01].

Importantly, actual performance while persisting did not differ between the prediction and no prediction (*M*=8.65, *SD*=5.24) conditions, $t(99)=.05$, $p=.957$, $d=.01$, *CI*[-1.88,1.99]. This study failed to support an alternative explanation based on goal-setting. In Study 5 we address domain knowledge as a possible boundary condition.

Study 5: Domain Knowledge

Domain knowledge, or prior knowledge relevant to the domain in which the creative task occurs, is known to influence creative performance (Amabile, 1996). Because we did not assess domain knowledge in our prior studies, one could question

whether persistence undervaluation generalizes to people with prior knowledge in the creative domain. In Study 5 we recruited football fans to perform a creative task related to football and predicted they would undervalue persistence.

Participants. Ninety-nine participants (M_{age}=34.70, SD_{age}=11.29; 48 women) were recruited from Mturk and compensated $1. Our recruitment goal for this study was 100 participants. Six participants failed the attention check (6% of sample), leaving 93 for analysis.

NFL knowledge. All survey respondents were screened for knowledge of American Football (i.e. the NFL). Respondents passed the screen if they responded higher than a "1" to three questions about their knowledge of NFL rules (four-point scale; 1=no knowledge at all, 4=expert; *M*=3.08, *SD*=.58), teams in the NFL (four-point scale; 1=not familiar with any teams, 4=I can list all the teams; *M*=2.97, *SD*=.74), and how many NFL games they watch per season (six-point scale; 1=none, 6=fifteen or more; *M*=4.05, *SD*=1.39).

Procedure. The task in this study was an idea generation task in which participants generated solutions to the problem of how to increase safety for current players in the NFL. Participants were asked to think of as many solutions as they could, but with the caveat that ideas generated could not be impossible to implement. For example, participants were told that solutions could not involve technologies that do not exist. As an incentive, each solution participants generated earned them a raffle ticket into a lottery for a $10 bonus. Participants generated solutions for 5 minutes, estimated how many solutions they would generate during an additional 5 minutes, and then persisted for 5 minutes.

Results/Discussion

A paired samples t-test found that participants' predicted performance while persisting (M=1.83, SD=1.42) was significantly lower than their actual performance while persisting (M=2.75, SD=1.85), $t(92)=-5.98$, $p<.001$, $d=.62$, $CI[-1.23,-.62]$. Follow-up analyses revealed that none of the three football knowledge questions moderated the persistence underestimation effect; interaction term statistics: NFL rules, $F=.18$, $p=.838$; NFL teams, $F=.37$, $p=.328$; games watched, $F=2.01$, $p=.100$.

This study found that people underestimate the value of persistence in a creative domain in which they have prior knowledge. This speaks to the robustness of persistence undervaluation and demonstrates it is not limited to novel domains. In our final study we test a consequence of undervaluing persistence. Specifically, we look at whether people underinvest in opportunities to persist.

Study 6: Investing in Persistence

The decision to persist is an investment that incurs the opportunity cost of not being able to allocate one's resources elsewhere. In Study 6 we simulated this investment decision by giving participants the choice of whether to invest in additional time to persist on an incentivized creative task. We predicted that those who chose not to invest in persistence would earn less money than those who chose to invest and those in a control condition. We also predicted that fluency would predict participants' decisions to persist.

Method

Participants. One hundred participants (M_{age}=33.42, *SD*=10.96; 46 women) were recruited from Mturk and compensated $0.51. Our recruitment goal was 50 participants per condition. Nine participants (9% of sample) failed the attention check and were excluded, leaving 91 for analysis.

Procedure. Participants received the survey through an online portal provided by Mturk. Participants were first introduced to the creative problem-solving task. In this task participants imagined that they work for a cancer-related charity organization whose task was to think of ways to increase charitable donations from members of the local community. Participants were instructed to generate as many solutions as they could but that the solutions could not be impossible to implementable. Further, participants learned that they would receive a 2-cent bonus for each solution they generated and were instructed to make as much money as they could. Examples of solutions participants generated were *organize a charity sports league, develop an iPhone app,* and *sponsor a casino night*.

In the first stage of the survey participants generated solutions for 4 minutes. Then they reported the fluency they experienced while working on the task using the same questions as in Study 3 (α=.92). In the second stage of the survey participants were presented with the decision of whether to invest in an additional 4 minutes to work on the task. Participants who chose to invest in persistence ("investors") continued generating ideas for 4 minutes and those who did not ("non-investors") worked 4 minutes on an unrelated, non-incentivized task.

Study conditions. We included two investment conditions. To inform participants' investment decisions they learned that in a previous survey another group of participants

generated an average of 5 solutions while persisting, which amounts to a 10-cent bonus. In the *high-cost* investment condition, investing cost 6-cents (60% of the average expected return) and in the *low-cost* investment condition investing cost 1-cent (10% of the average expected return). Thus, in both conditions participants could expect to make a profit if they performed on par with previous participants.

Decision to persist. The decision to persist was measured on a binomial response scale (1=switch tasks, 2=persist).

Results

As expected, more participants persisted in the low-investment condition (32 of 46, 70%) compared to the high-investment condition (17 of 45, 38%), X^2=9.25, p=.002, suggesting that investment cost was a salient decision factor.

Our main analysis compared the total earnings of non-investors (coded as "1") and investors (coded as "2"). For this analysis we collected a *control* condition[5] (N=49) in which participants persisted without the option to switch tasks (coded as "3"). This provided a performance comparison group free from self-selection effects. A one-way ANOVA found that total earnings significantly differed by condition, $F_{(2,137)}$=20.19, p<.001, η^2=.23 (see Figure 3). As predicted, non-investors (M=17-cents, SD=6.94) earned significantly less than investors (M=37-cents, SD=18.89), t(62.24)=6.91, p<.001, d=1.45, and significantly less than controls (M=30-cents, SD=16.19), t(66.86)=5.32, p<.001, d=1.12. Investors and the controls did not significantly differ, t(93.80)=1.83, p=.070,

[5] For this condition, 52 participants (M_{age}=35.00, SD=10.38; 36 women) were recruited from Mturk. Three failed the attention check (6% of sample), leaving 49 for analysis. The two samples did not differ by age, p=.392. They did significantly differ by gender, p=.006. Controlling for gender did not change the statistical conclusions of any analyses in this study.

d=.38. The fact that non-investors underperformed the control group suggests that non-investors would have done better by investing. Thus, 30% and 62% of participants in the low- and high-investment conditions, respectively, likely underinvested in persistence.

[Insert Figure 3 About Here]

Next we tested whether idea generation fluency predicted the decision to persist. We tested two models with binomial logistic regression (Table 2). In the first model fluency significantly predicted the decision to persist, $b=.65$, $X^2(1)=6.86$, $p=.009$. In the second model, fluency remained a significant predictor, $b=.66$, $X^2(1)=4.77$, $p=.029$, when including initial performance, $b=.90$, $X^2(1)=3.49$, $p=.062$, and investment condition, $b=1.39$, $X^2(1)=10.65$, $p=.001$.

[Insert Table 2 About Here]

Discussion

Study 6 looked at participants' willingness to invest in an opportunity to persist. The fact that non-investors underperformed investors and the control group, that was instructed to persist, suggests that non-investors, 46% of participants, underinvested in persistence. Additionally, participants' decisions were predicted by the disfluency of initial creative work. Strikingly, this analysis found that people's investment decisions were driven more by their subjective feelings of disfluency at the time of the decision than on past performance, a more objective indicator.

General Discussion

The current research found evidence that people underestimate the value of persistence for their own creative performance and that the fluency experienced during initial creative work accounts for this effect. The persistence undervaluation effect was found across a variety of creative idea generation tasks (Studies 1, 2, 4, & 5) and creative problem solving tasks (Studies 2-3). We theorized that the attributes of creative thought lead working on creative tasks to feel inherently disfluent, which leads people to underestimate the value of persistence. Consistent with this theorizing, persistence undervaluation was significantly weaker in non-creative tasks (Studies 2-3). As more direct evidence, the fluency of creative work predicted persistence undervaluation (Study 3) and it predicted the decision to turn down a profitable opportunity to persist (Study 6).

Across our studies we addressed two alternative explanations and considered a boundary condition. The first alternative explanation is that fatigue leads idea quality to diminish over the course of idea generation, which would diminish the value of persisting. Contrary to this account, Studies 1-2 found that ideas generated while persisting were of higher quality than ideas generated initially. This is consistent with early brainstorming studies that find similar patterns of sustained idea quality over time (Christensen et al., 1957; Parnes, 1961). Furthermore, the notion that ideas get better over time amplifies the value of persisting on creative tasks. Another alternative explanation is that performance predictions serve as performance goals that motivate higher performance, which would artificially create an underestimation effect. Inconsistent with this explanation, Study 4 found no performance differences between a group who made

predictions and a group that did not. Finally, we tested whether domain knowledge would serve as a boundary condition of our effect, as it is possible that persistence undervaluation only occurs for people who lack knowledge in the relevant domain. Study 5 found that football fans undervalued persistence in a football-related creative task, suggesting that the effect is robust against prior domain knowledge. Although football knowledge did not moderate our effect, it may be an open question whether persistence undervaluation would occur under extreme levels of expertise.

We think these studies make theoretical contributions to the creativity and decision-making literatures. First, we demonstrate that people's valuations of persistence in creative tasks are significantly influenced by the cognitive fluency experienced at the time of judgment. Most theories of creativity treat motivation as a relatively static predictor of creativity (e.g. Amabile, 1985) . Our studies demonstrate how key elements of creative performance, like motivation, can interact with basic psychological processes over time to impact performance. Our studies also contribute to the judgments and decision-making literature in demonstrating the impact of fluency on judgments about the value of effort. While previous literature has looked at the impact of fluency on the valuation of objects or willingness to incorporate advice (Alter & Oppenheimer, 2008; Shah & Oppenheimer, 2007), our studies demonstrate that fluency also determines people's judgments about the value of effort and continuing to invest effort.

Judgments and Beliefs About Creativity

In an discussion of how people view creativity, Staw asserted that most people hold misguided beliefs about what truly creative work necessitates (Staw, 1995). For

instance, he anecdotally described how the average person does not appreciate the risk-taking, non-conformity, and persistence, involved in truly creative work. We view these speculations as a lucrative starting point for future research. The notion that people could improve their creative performance by simply adjusting their judgments and beliefs about creativity is enticing, particularly given the vast resources that organizations invest in promoting the creativity of their employees. We believe our studies contribute to the study of creativity judgments and beliefs by demonstrating how people's judgments about the value of persisting, a key determinant of creative performance, are miscalibrated. Our studies suggest that people may underestimate their creative potential in everyday creative tasks and that people may leave creative ideas on the table by failing to invest in persistence. A better understanding of these judgments and beliefs may help people better navigate the creative process and improve their performance.

Conclusion

Scholars and practitioners alike have long been interested in factors that improve creative performance, creating long lists of prescribed and proscribed behaviors. Rather than searching for new creative remedies, our results suggest the value of understanding whether people's beliefs about creativity and creative performance are calibrated. We found that people consistently underestimate the value of persisting on creative tasks and provided evidence that the disfluency of creative work accounts for this undervaluation. This suggests that recalibrating beliefs about the value of persistence may promote creativity by reducing the possibility that people quit too early, leaving their best ideas undiscovered.

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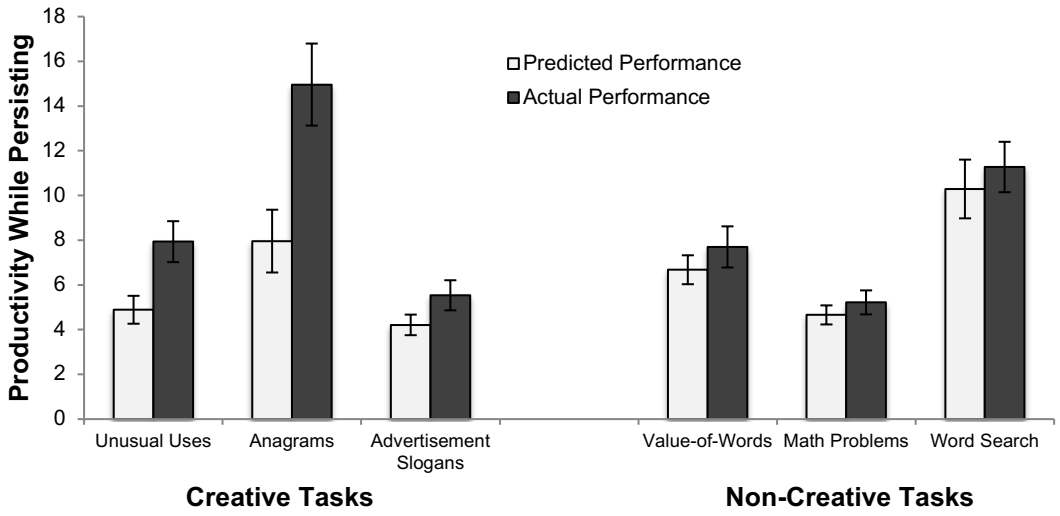
	Initial Effort	Persistence					
	Actual	Predicted	Actual	*t*	*d*	CI_{low}	CI_{high}
Creative Task Composite (*N*=342)		5.82 (5.70)	10.40 (13.40)	**-6.68*** **	.58	-4.73	-3.27
Non-Creative Task Composite (*N*=305)		7.47 (5.58)	8.33 (5.48)	**-3.40** **	.19	-1.36	-.36
Creative Tasks:							
Unusual Uses (N=109)	12.83 (5.74)	4.89 (3.32)	7.94 (4.88)	**-8.38*** **	.80	-3.77	-2.33
Anagrams (N=128)	29.65 (15.66)	7.96 (8.10)	14.96 (10.59)	**-8.34*** **	.74	-8.66	-5.34
Ad Slogans (N=105)	7.79 (3.87)	4.21 (2.40)	5.54 (3.52)	**-4.58*** **	.45	-1.91	-.75
Non-Creative Tasks:							
Value-of-Words (N=90)	5.98 (2.98)	6.68 (3.15)	7.70 (4.43)	**-3.65*** **	.38	-1.58	-.46
Math Problems (N=95)	4.32 (2.62)	4.66 (2.12)	5.22 (2.67)	**-2.43** *	.25	-1.02	-.10
Word Search (N=120)	15.95 (7.61)	10.29 (7.34)	11.28 (6.30)	-1.70	.15	-2.15	.17

	Model 1			Model 2		
	b	*SE*	X^2	*b*	*SE*	X^2
Fluency	0.43	0.16	**6.86****	0.41	0.19	**4.77***
Initial Performance				0.11	0.06	3.49
Investment Condition				-0.33	0.10	**10.65****


Productivity While Persisting
18
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Predicted Performance
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Anagrams
Advertisement Slogans
Value-of-Words
Math Problems
Word Search
Creative Tasks
Non-Creative Tasks

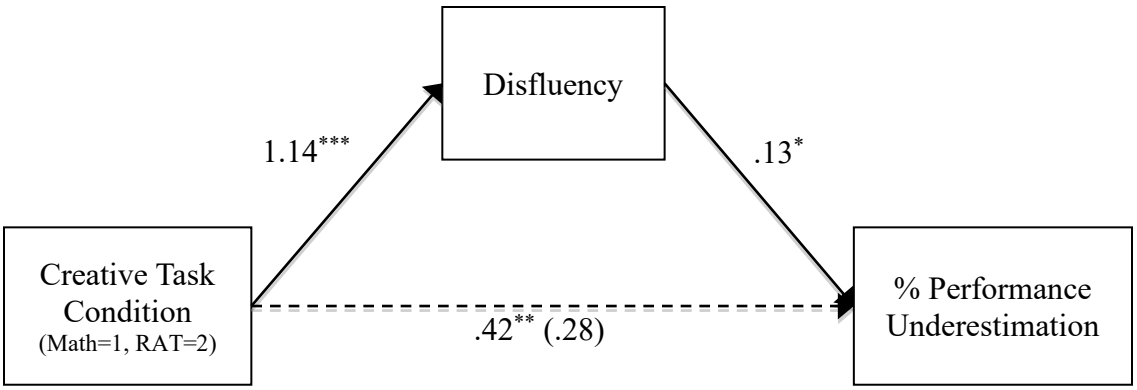

Fig. #2: Fluency mediates the relationship between task condition and percentage of performance underestimation, Study 3; $^{*}p<.05$, $^{**}p<.01$, $^{***}p<.001$.

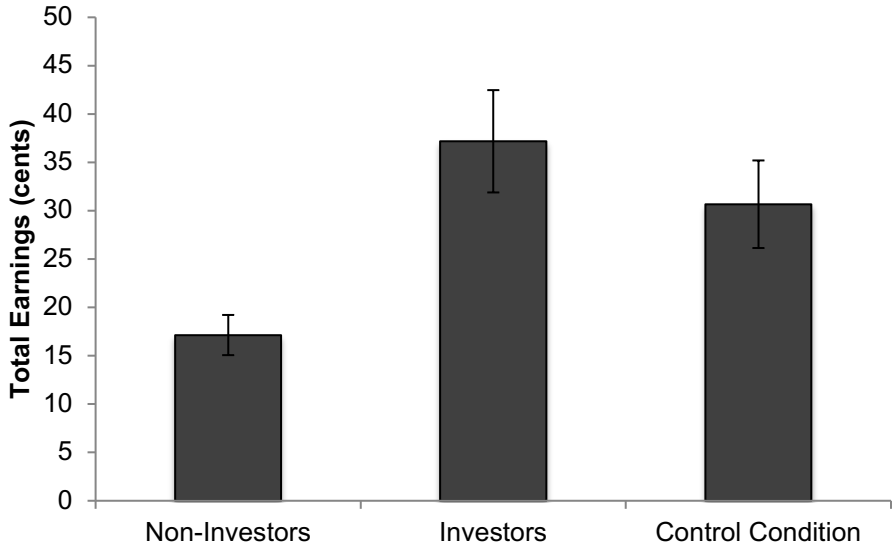

Fig. #3: Total earnings (±$CI_{95\%}$) as a function of whether participants switched tasks, persisted, or were instructed to persist in the no-decision control condition, Study 6.