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The Effect of Psychological Momentum on
Performance Expectations Versus Performance Outcomes

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Abstract

People believe that momentum is a force that accounts for success, but does the power of momentum reside mostly in performers' minds? Field data from an Ultimate Frisbee tournament ($N = 519$) and six experiments ($n = 2,533$) examined the effects of experiencing psychological momentum on players' *beliefs* about their performance as well as their *actual* performance. In Experiments 1a-d, individuals who completed a competitive task that became progressively easier perceived that they had more psychological momentum and believed that they were more likely to win, but did not win more often. In Experiment 2, individuals who experienced positive momentum were more likely to incorrectly predict that they would win a competition, whereas participants who experienced negative momentum were more likely to incorrectly predict that they would lose. These discrepancies in predicted and actual outcomes occurred despite financial incentives to make accurate predictions and to win the competition, and with full knowledge of the competition task. Finally, individuals in Experiment 3 who experienced positive momentum were more likely to bet on their future performance, yet they did not perform better. Experiment 3 further examines two possible moderators of the effect of momentum on expected performance: players' growth mindset about their skills, and whether they were an underdog in the competition. These results indicate that psychological momentum may influence performance expectations more than it influences performance outcomes.

Keywords: momentum; competition; misprediction; performance; efficacy; hot hand

“People who succeed have momentum. The more they succeed, the more they want to succeed, and the more they find a way to succeed.” - Tony Robbins

"We lost the momentum when we missed the field goal. They came back, and scored, and we never got back into it. It was all about momentum." - Dan Hinds

From hitting free throws to pitching strikes, athletes swear by the power of momentum. Commentators, coaches, fans, and players alike believe that momentum can determine the outcome of a game. Yet, the exact mechanisms by which momentum might actually influence performance are complex (for relevant theories, see Cornelius, Silva, Conroy, & Petersen, 1997; Taylor & Demick, 1994; Vallerand, Colavecchio, & Pelletier, 1998; Vancouver & Purl, 2017), and momentum's actual effect on performance is hotly debated among academics and statisticians (see Arkes, 2013; Miller & Sanjurjo, 2014). Does momentum matter as much as people think it does? The present work examines how psychological momentum – the perception that one “has” momentum – compares with reality.

Defining Psychological Momentum

To understand momentum's consequences, it is first necessary to define it. Metaphors describing the experience of psychological momentum abound—momentum is the “wind at one's back,” a “hot streak,” or “being on a roll.” These metaphors highlight how psychological momentum is a phenomenological experience, something that people feel at a specific point in time. It can have a transient quality, existing in one moment and then gone in the next. But does psychological momentum exist *only* in a person's mind, or is it also grounded in physical reality?

Scholars appear to be split on this question even in their definitions of momentum. Iso-Ahola & Mobily (1980; see also Iso-Ahola & Dotson, 2014), for instance, define momentum as “an added or gained psychological power which changes interpersonal perceptions and influences an individual's mental and *physical* performance” (emphasis added; p. 392). This

definition assumes that momentum *directly influences* performance and performance outcomes (see also Adler, 1981; Taylor & Demick, 1994, for other definitions with this property). On the opposite end of the spectrum, others define psychological momentum as a “perception” rather than a real force (e.g., Vallerand et al. 1988 defines momentum as the “perception that an actor is moving towards his/her goal”, p. 94). Taking a convergent position, Markman and Guenther (2007) propose that momentum is a psychological experience that need not affect performance but must involve perceived movement toward a goal (e.g., a string of successes or failures). They write: “a precipitating event provides a target (e.g., an attitude object, person, or group of persons) with velocity, and additional precipitating events can increase velocity” (p. 801). Similarly, Taylor and Demick (1994) define psychological momentum as “a positive or negative change in cognition, affect, and/or physiology caused by an event or series of events” (p. 54).

Consistent with these latter definitions, here we define psychological momentum as the *perceived progress of moving toward or away from a goal that is preceded by experiencing a change in upward or downward trajectory in pursuit of that goal, often in a competitive context* (e.g., Carver & Scheier, 1990; Gernigon, Briki, & Eykens, 2010; Hubbard, 2015). Our conceptualization of momentum aligns with lay participants’ reported understanding of the phenomenon (see Briki, Den Hartigh, Hauw, & Gernigon, 2012; Markman & Guenther, 2007). Momentum perceptions, then, require that actors and observers first experience or observe a change in trajectory toward some goal, which is often a competitive goal. For example, experiencing a series of successes or failures in a competition setting would elicit feelings of gaining or losing momentum (Iso-Ahola & Dotson, 2014; Markman & Guenther, 2007; Shaw, Dzewaltowski, & McElroy, 1992). In one nice demonstration of this, Vallerand et al. (1988) showed that participants rated players as having more momentum when they had won five out of

ten tennis games in a pattern of three losses, then one win, then two losses, then four wins (i.e., “0001001111”) than those who had won the same number of games in a pattern of one loss, one win, two losses, two wins, one loss, one win, one loss, and one win (i.e., “0100110101”).

Importantly, Vallerand et al.’s paradigm highlights that people can experience psychological momentum due to the order in which they encounter sequences of events, even when their actual skills are not changing. Expanding on this clever operationalization, in the current paper we use an incidental feature of the competition environment—manipulating the order of the same sequence of tasks so that they become either harder or easier—to make performers feel as though they are gaining or losing momentum. This differentiates the feeling of gaining momentum, for instance, from actual improvements in learning or task-related skill.¹ We expect that even when performers notice that tasks are increasing or decreasing in difficulty, they will experience psychological momentum. We then test how this feeling, in and of itself, can influence expected and actual performance.

Momentum, Expected Performance, and Actual Performance

A robust finding in psychology is that momentum positively correlates with confidence, efficacy, and even expected future performance. Unfortunately, most studies examining the relationship between momentum and expected performance are correlational (Attali, 2013; Cornelius et al., 1997; Gilovich, Vallone, & Tversky, 1985). Because momentum is often confounded with actual skill or efficacy, it is unclear from these correlational studies alone whether momentum can causally impact expectations. However, at least three sets of experiments demonstrate that the mere belief that an actor has positive momentum can in fact

¹ Of course, the ordering of tasks may sometimes influence actual skill development; on novel tasks, more learning may occur when tasks are completed in an increasing difficulty (vs. decreasing difficulty) order (Feltz & Weiss, 1982; Robinson, 2001). In our view, however, the ordering of short sequences of familiar tasks is unlikely to meaningfully influence skill levels, and should instead only create the phenomenological *experience* of momentum.

cause observers to revise their estimates of future performance (Markman & Guenther, 2007; Vallerand et al., 1988) or performance-related outcomes (Briki, Den Hartigh, Markman, & Gernigon, 2014).² Furthermore, the effect sizes reported in these studies were relatively large (i.e., *ds* ranging from 0.60-1.13; Cohen, 1992). Although these experiments examined only observers' expectations, they suggest that a similar effect would exist among actors themselves.

But does momentum really affect performance outcomes, or is its effect limited to expectations? On the one hand, several experimental manipulations of momentum demonstrate null or even reverse effects on performance outcomes (Perreault, Vallerand, Montgomery, & Provencher, 1998; Shaw, Dzewaltowski, & McElroy, 1992; Silva, Hardy, & Crace, 1988). Furthermore, although correlational findings link winning the first game of a racquetball or tennis match (Iso-Ahola & Mobily, 1980; Silva, Hardy, & Crace, 1988) to winning the entire match, these correlations tend to diminish when skill level is taken into account (Miller & Weinberg, 1991; Ransom & Weinberg, 1985). On the other hand, a number of studies indicate that the occurrence of a short spurt of successful outcomes within a *single* game (eliminating the conflation between momentum and skill level) can increase the likelihood of subsequent successful outcomes within that game (i.e., the "hot hand" effect; Dorsey-Palmateer & Smith, 2004; Mace, Lalli, Shea, & Nevin, 1992; Raab, Gula, & Gigerenzer, 2012; Yaari & David, 2012), although the associated effect sizes are relatively small and not always robust (e.g., Gilovich et al., 1985; Miller & Sanjurjo, 2014). If momentum does not directly influence performance levels, another possibility is that it influences behaviors that are relevant for performance, thereby *indirectly* enhancing performance levels. For instance, NBA players are

² We disregarded experiments that included fewer than 10 participants per condition.

significantly more likely to take the team's next shot after making a shot (Attali, 2013), and they tend to take more difficult shots after making a three-point shot (Neiman & Loewenstein, 2011).

These prior findings indicate that although momentum may play a role in shaping both performance expectations and performance levels, there may be a discrepancy between the magnitudes of these effects. In other words, the effect of momentum on expectations seems to be fairly large and robust, whereas the effect of momentum on actual performance appears to be more tenuous. Comparing effect sizes across studies is problematic for many reasons, but a handful of studies have examined expectations and performance within the same study. For instance, in one study participants believed that there would be a positive correlation between their prior free-throw successes and their next free-throw shot ($r = 0.40$), when in reality they were uncorrelated ($r = 0.02$) (Gilovich et al., 1985). In another study, participants who competed in multiple rounds of a basketball shot competition against a trained confederate who shot poorly (versus shot well) became increasingly confident about winning the next round but actually performed no better (or slightly worse; Shaw et al., 1992). Finally, and in a different sports domain, participants who fell behind a (virtual) competitor while cycling believed that they had less momentum and felt less positively about winning, but actually increased their effort (Perreault et al., 1998). Expanding on these earlier findings that suggest that momentum perceptions may influence performance expectations more than outcomes, the current paper seeks to more clearly understand the extent to which psychological momentum alone—and not real changes in skill—*causally* influences expected and actual performance, as well as downstream consequences and moderators of the effects of momentum.

Overview of Studies

All of our experiments manipulate psychological momentum by changing the order by which performers complete practice tasks (increasing-difficulty or decreasing-difficulty order) prior to a competition task. In each experiment, players complete practice tasks in one order or the other, report their momentum, and then make predictions about their competition performance (which we also measure). We selected a discrete task that all players could conceivably complete and for which we could empirically vary the difficulty level: a word search task.

First, Experiments 1a-d test how gaining or losing psychological momentum affects expected and actual performance, using multiple variations in the final performance task to deliberately test the conditions that we believed would be optimal to create an effect of momentum on real performance, if such an effect exists. Experiment 2 adds financial incentives to incentivize accuracy in players' predictions about their performance and to incentivize players' actual performance. Experiment 2 also tests whether psychological momentum influences the likelihood of making an inaccurate estimate of one's own performance (i.e., a false alarm or miss) versus an accurate estimate (i.e., a correct rejection or hit). Finally, Experiment 3 tests a potential consequence of experiencing psychological momentum. We give players an opportunity to bet on their performance, hypothesizing that those who believe they are gaining momentum would be more likely to bet on themselves despite being no more likely to actually win.

To be thorough, Experiment 3 also examines two possible moderators of the effect of momentum on expectations or performance: players' favorite or underdog status, and their growth mindset about their performance. Players' underdog status could influence the effect of momentum because, at least under certain circumstances, fans prefer underdogs to favorites,

even believing they will win despite their lower status (Ceci & Kain, 1982; Frazier & Snyder, 1991; Vandello, Goldschmied, & Richards, 2007). It may be possible that the perceived presence of momentum could increase expected (vs. actual) success particularly among underdogs. Performers' mindset could influence momentum's effects because growth-oriented mindsets are associated with improved performance (at least in academic domains; e.g., Dweck, 2000; Paunesku et al., 2015). Experiment 3 therefore tests whether any interactions exist between performers' status, their growth mindset, and their experienced momentum on their expected and actual performance.

For all studies, we report how we determined our sample size, all data exclusions, and all measures (Simmons, Nelson, & Simonsohn, 2011). All data, code, and survey materials are available in the Open Science Framework (OSF) repository for this project (https://osf.io/qqng5/?view_only=04e2e3ec43b747c7a86754ca0d0482a8).

Field Data from an Ultimate Frisbee Tournament

Before conducting experiments, we first examined our hypothesis that perceived momentum will be more strongly associated with performance expectations than it will be with performance outcomes in a competitive, real-world setting. To do so, we predetermined to collect as many survey responses as possible from players attending the USA Ultimate Southwest Club Regionals Ultimate Frisbee Tournament. In total, we collected 519 survey responses from 107 Frisbee players (93 female, $M_{age} = 27.40$, 95% CI [26.36, 28.44]) who played 42 games at the tournament. Players completed a survey before ($N = 204$) and after ($N = 315$) every game at the tournament; some players completed multiple surveys but not all players completed every survey.

Before each game, players reported their pre-game momentum (“How much momentum does your team have, entering this game?,” $-50 = \text{negative momentum}$; $50 = \text{positive momentum}$) and their confidence about winning (“I am confident about this game,” $1 = \text{strongly agree}$; $7 = \text{strongly disagree}$; reverse-coded for analysis). A subset of these players ($N = 179$ pre-game and $N = 266$ post-game) also completed an intake survey in which they reported their tenure (“How many years have you been on the team?”), the number of hours they practice per week, and their enjoyment with being on the team (“Are you pleased with your decision to play on this team this season?” $1 = \text{Yes, I love this team}$; $5 = \text{No, I wish I hadn't played}$). We also collected each team’s ranking before the tournament to control for skill level.

Because this data is nested, with multiple responses from single individuals, individuals nested within teams and ratings nested within games, we ran a cross-classified multilevel model to analyze the results. Level 1 units were ratings of momentum ($N = 204$), with individuals as Level 2 units ($N = 85$) and teams as Level 3 units ($N = 8$). Ratings are also nested within games ($N = 33$; Level 2 unit). Ratings were person-mean centered. To test whether ratings of momentum predicted confidence in winning, we ran a model with person-mean ratings of momentum before the game predicting confidence in winning, including random intercepts for games and for individuals nested within teams.

Consistent with our prediction, pre-game momentum perceptions and winning confidence were positively correlated, $\beta = 0.16$, 95% CI $[0.07, 0.25]$. This relationship remained statistically significant after controlling for tenure, practice hours, enjoyment, and ranking, $\beta = 0.16$, 95% CI $[0.06, 0.26]$.

We next examined whether pre-game momentum perceptions would correlate with actual performance levels. To control for teams’ prior performance, we computed a performance score

by using an algorithm created and maintained by USA Ultimate³ that takes into account every game played during the season prior to the regional tournament and predicts the number of goals the losing team should score in each game. We subtracted the number of goals actually scored from the number of predicted goals to compute a relative performance score ($M = -0.52$, 95% CI $[-1.05, 0.02]$). This metric is more informative than a binary win-loss measure because it accounts for teams' skill. Pre-game momentum perceptions did not correlate with performance scores, $\beta = 0.11$, 95% CI $[-0.03, 0.24]$. This null result remained unchanged after controlling for tenure, practice hours, enjoyment, and ranking in a simple linear model, $\beta = 0.14$, 95% CI $[-0.01, 0.29]$.

Finally, we examined whether post-game momentum perceptions ("How much momentum does your team have, after playing that game?" $-50 = \textit{negative momentum}$; $50 = \textit{positive momentum}$) correlated with performance scores. We ran the same model as above, substituting post-game momentum ratings for pre-game momentum ratings. The two variables were correlated, $\beta = 0.51$, 95% CI $[0.43, 0.60]$, suggesting that performers may infer momentum perceptions from prior performance outcomes, and the relationship remained statistically significant after controlling for age, gender, tenure, practice hours, enjoyment, and ranking, $\beta = 0.52$, 95% CI $[0.43, 0.61]$. Overall, these field data provide preliminary evidence to suggest that momentum perceptions better predict performance expectations than performance outcomes.

Experiments 1a-d: Perceived Momentum, Expectations, and Performance

To examine how momentum perceptions causally influence expected and actual performance levels on a competition task, participants in Experiments 1a-d completed three

³ <https://play.usultimate.org/teams/events/rankings/#algorithm>

practice rounds of a task that varied in order from either difficult to easy (positive momentum) or easy to difficult (negative momentum) and then engaged in a competition.

Common methods across Experiments 1a-d

Experiments 1a-d each employed two experimental conditions (between-subjects): *positive momentum* and *negative momentum*. All four experiments began the same way. After signing a consent form and before beginning the task, participants read that they would “see twelve letters” and then have “one and a half minutes to write down as many 4+ letter words as possible using those letters.” The word-find task had four rules: 1) each word could only be submitted once; 2) each letter could only be used once per word; 3) each word had to be at least four letters long; and 4) the words had to be real words that could be found in a dictionary. Participants’ goal was to find as many words as possible following the four rules in the time allotted for each practice round and competition. For example, if their letter string was “XHWYNEAJRTMF,” they could write words such as: “near,” “meat,” “fret,” “wart,” “wharf,” and so on. We told participants that they would be completing three practice rounds of the task before the competition, and they responded to several attention check items to ensure that they had read and understood the rules (see Supplemental Materials).

Manipulating psychological momentum via task ordering. To classify the difficulty level of the word-find tasks, we pre-tested seven letter sets to determine the average number of words found in 1.5 minutes. The pre-test results are reported in Supplemental Materials. We selected three letter sets: easy (“AEITFMNLPRYG”; M words found = 15.10, SD = 7.54), medium (“AEIBTJNCKYDH”; M words found = 10.60, SD = 5.31), and hard (“EIOBTJNCMYRP”; M words found = 8.08, SD = 4.74). In the *positive momentum* condition, we showed participants the hard letter set, then the medium letter set, and then the easy letter set.

In the *negative momentum* condition, conversely, they received the same letter sets in the opposite order – easy, then medium, then hard. Importantly, both conditions contained the same tasks, therefore giving participants the same set of experiences in aggregate. To further test whether participants' skill levels did not change more in one condition than the other, we computed the actual scores for each practice round.⁴

Perceived momentum. To measure *momentum perceptions*, we asked, “How much momentum do you think you have right now, headed into [Practice Round 3]?” To respond, participants moved a slider that was anchored at 0 (“No momentum”) and 100 (“A lot of momentum”), and was initially set at 0. Perceived momentum was measured three times: prior to Practice Round 3, prior to the competition, and after the competition.⁵

Although our primary intention was to examine how momentum condition influences performance expectations and outcomes, we speculated that participants' beliefs about their momentum might also influence self-efficacy levels, as self-efficacy has long been linked to performance outcomes (Bandura, 1977; Dziewaltowski & McElroy, 1992). To assess *self-efficacy* we asked three questions – 1) “How skilled do you think you will be at finding words?”; 2) “How confident do you feel about finding words?”; and 3) “How much do you trust your ability to find words?” (1 = Not at all [confident/skilled/]; 7 = Very [confident/skilled/much]) ($\alpha \geq .97$) – at five time points throughout the experiment: before the first practice round, after each practice round, and after the competition.

⁴ In all experiments, we additionally measure whether participants noticed their changing performance across rounds: “How do you think your performance is changing over time?” (-3 = “I’m getting a lot worse”; 3 = “I’m getting a lot better”) prior to Practice Round 3 and prior to the competition. We report these results in the Supplemental Materials.

⁵ We did not ask this question in earlier practice rounds because the initial perception of momentum also requires a perceived change in trajectory, and thus we reasoned that momentum perceptions could only be measured once participants had completed at least two rounds of word-find tasks. We expected that momentum perceptions would change as a function of momentum condition, but we made no *a priori* predictions regarding how momentum perceptions might change after the competition was over.

Expected performance measures. After completing Practice Round 3 and responding to the manipulation check, momentum, and self-efficacy items, participants learned about their opponent for the competition round: “The opponent has already been selected. Your opponent has consistently found X words in their practice rounds. In order to win, you will probably need to find more than X words,” where X was participants’ own average score from practice rounds 1-3 rounded to the nearest integer.⁶ We used participants’ average score in the description of their (ostensible) opponent for two reasons: first, using this score made it seem feasible that participants could either win or lose, thereby creating some potential for variability in expectations, and second, it standardized participants’ beliefs about their opponent across conditions, ensuring that different beliefs about the competition or one’s opposition could not be driving our results. We also reminded participants of their own scores in each practice round. We then asked two measures of *expected performance* just after Practice Round 3 and prior to the competition: 1) “How likely are you to win the competition?” (1 = Not at all likely; 10 = Very likely) and 2) “Who do you expect to win the competition?” (You; Your opponent).

Actual performance measures. Participants then completed the competition, which was a novel set of letters that we selected from our pre-test (“AEODTSNCPYRK”). For reasons described in the separate Method sections below, we varied the timing of the competition in each experiment. The competition was untimed in Experiments 1a and 1b, 3 minutes long in Experiment 1c, and 1.5 minutes long in Experiment 1d. Participants’ competition score (number of words found) was the primary measure of actual performance.

Post-competition feelings. Following the competition, participants completed several exploratory measures. In Experiments 1a-c, in addition to recording their self-efficacy levels for

⁶ We changed the framing of the competition slightly for Experiment 1d; see Experiment 1d Method section.

the fifth time and their momentum perceptions for the third time, they reported their *performance feelings* (“Overall, how did you feel about your performance in the competition?” 1 = Not at all good; 10 = Excellent) and *performance effort* (“How much effort did you put into the competition?” 1 = No effort; 10 = A lot of effort). In Experiment 1d, we included two more measures to examine alternative possibilities for how experimental condition might affect performance expectations: *task evaluation* (“How fun did you think this game was?” Not at all fun; A little fun; Somewhat fun; Very fun; Extremely fun) and *mood* (“How are you feeling right now?” Extremely unhappy; Moderately unhappy; Slightly unhappy; Neither happy nor unhappy; Slightly happy; Moderately happy; Extremely happy).

Control variables. To control for participants’ experience with the task, in all experiments we asked about *task familiarity*: “How familiar are you with word-find tasks similar to the ones you completed today?” (I have never played a game like that before; I have played a game like that a few times; I sometimes play games like that; I frequently play games like that; I play games like that almost every day).

Methods unique to each experiment

Experiment 1a method. Based on three prior experiments that tested the effect of a different momentum manipulation on performance beliefs among observers ($ds = 1.00, 0.41$, and 1.13 ; see Supplemental Materials for details), we aimed for a sample size of 80 participants in each of the two experimental conditions.⁷ We recruited 159 participants (87 female, 1 gender non-binary, $M_{age} = 35.52$ years, 95% CI [33.66, 37.37]) through Amazon Mechanical Turk who

⁷ In retrospect, it may not have been ideal to use these experiments for our power analysis, since they relied on a substantially different paradigm. We increased the sample size in Experiments 1c and 1d to account for this possibility.

completed a survey in exchange for \$1.00. This experiment followed the procedure described above.

Experiment 1b method. In addition to testing our primary hypothesis, Experiment 1b also examined whether interrupting perceived momentum would diminish its effect on expectations. Consistent with Experiment 1a, we predetermined a sample size of 80 participants that were randomly assigned to each of the conditions in a 2 (momentum manipulation: positive momentum vs. negative momentum) $\times$ 2 (interruption: no interruption or interruption) between-participants design. In total, we recruited 339 participants (161 female, 5 gender non-binary, $M_{age} = 34.04$, 95% CI [33.00, 35.08]) through Amazon Mechanical Turk who completed the survey in exchange for \$1.00. To interrupt momentum, we randomly assigned half of our participants to see the following message prior to the competition task for one minute: “ERROR! QUALTRICS IS EXPERIENCING AN ERROR. PLEASE WAIT WHILE WE FIX THIS ERROR,” along with a moving image of a loading circle. After the page re-loaded, we measured perceived momentum and self-efficacy again to see whether they had been affected by the interruption manipulation. Participants then completed the competition task and survey items described in the Common Methods section.

Experiment 1c method. The purpose of Experiment 1c was to run a high-powered replication test of Experiment 1a (pre-registered at https://osf.io/bsdzu/?view_only=02878326ee764029b64839191343ee61), and we therefore predetermined to recruit about five times as many participants (i.e., 350/condition). We were concerned that we could be under-powered to detect actual performance differences. In total, through Amazon Mechanical Turk we recruited even more participants than expected due to a glitch in the survey that created a re-start ($N = 917$ participants; 491 female, 8 gender non-binary,

$M_{age} = 36.18$, 95% CI [35.42, 36.95]). All participants received \$1.00 in compensation. This experiment followed the same procedure as Experiment 1a with the exception that the competition task was timed for 3 minutes (instead of being allotted unlimited time). We made this change to examine whether time pressure would alter the effect of perceived momentum on performance.

Experiment 1d method. Experiment 1d examined whether perceived momentum would influence participants' willingness to compete (pre-registered at https://osf.io/7gvp6/?view_only=7b1b3de09c4e4094b879ac6c9d983663). Based on the effect sizes obtained in Experiments 1a-c, we predetermined a sample size of 200 participants in each of two experimental conditions. We recruited 407 participants in total (236 female, 1 gender non-binary, $M_{age} = 37.22$ years, 95% CI [36.03, 38.42]) through Amazon Mechanical Turk who completed a survey in exchange for \$0.75. The procedure was the same as Experiment 1a through the first three practice rounds, with the exception that we omitted the self-efficacy questions in order to shorten the survey. In this experiment, however, we made the competition round optional and explicitly told participants that they would be competing against a number and not a real opponent (to reduce deception). We told them, "Now that you are done with the first three rounds, you have the opportunity to play one more round if you would like to. In this round you will compete against the average of everyone who has played this set of letters before. The average for this set of letters is X. In order to win you will need to find more than X words in 1.5 minutes," where X was their own average score from the first three rounds. To increase the time pressure even more from Experiment 1c (3 minutes), we reduced the competition time to 1.5 minutes in Experiment 1d. This amount of time also matched the practice rounds, making the competition more similar to the practice rounds.

After providing participants with the competition information, we asked, “Do you want to enter the competition? If you choose yes, you will play the next round for 1.5 minutes, then you will find out your score (whether you won or lost), answer a few questions, and finish this experiment. If you choose no, you will not play the next round, and instead just answer a few questions and finish the experiment. Please make your selection below:” (Yes; No). Those participants who chose to compete learned their scores and whether they had won or lost after the competition task was over. All participants then saw the same set of final questions employed in Experiments 1a-c.

A sensitivity analysis of our statistical power across these experiments (GPower; Faul, Erdfelder, Lang, & Buchner, 2007) revealed that we have 80% power to detect an effect size of $d = 0.15$ (at $\alpha = .05$).

Results

Analysis plan. In all experiments, we removed participants from analyses who did not perform within one standard deviation below the mean on *either* their combined practice round average score or their competition score. We did this because we determined that participants who scored under these thresholds were either not trying very hard or were so deficient at the task that their results would not accurately reflect the effect of momentum condition. Including these participants in analyses does not significantly change our primary results, as described in the Supplemental Materials.

The results on the variables of interest in each experiment were so similar that we collapsed our analyses across all four experiments. In Experiment 1b, our interruption manipulation had no effect on any of our variables of interest, so we collapsed these conditions

into *positive momentum* and *negative momentum* for analysis.⁸ In Experiment 1d, 71.5% of participants decided to compete, and we only included these participants in our analyses of actual performance. In total, then, we included in analyses 1,386 participants across all four experiments prior to the competition (701 in the *positive momentum* condition, and 685 in the *negative momentum* condition). We also included a dummy variable in the analyses to control for the fixed effects of each experiment.

Practice round scores. First, actual practice round scores were not meaningfully different between the negative momentum ($M=11.45$, 95% CI [11.13, 11.76]) and positive momentum ($M=11.88$, 95% CI [11.53, 12.22]) conditions, $t(1384) = 1.80$, $p = .072$, $d = 0.10$, suggesting that our manipulation did not strongly influence actual skill levels.

Perceived momentum. Indicating that our manipulation was successful, participants in the *positive momentum* condition perceived that they had significantly more momentum immediately prior to the competition round ($M = 63.9$, 95% CI [62.24, 65.57]) than did participants in the *negative momentum* condition ($M = 44.7$, 95% CI [42.76, 46.58]), $t(1384) = 14.94$, $p < .001$, $d = 0.80$. Perceived momentum after Practice Round 2 followed a similar pattern but did not show as large a difference as perceived momentum just before the Competition Round ($M_{Positive} = 54.37$, 95% CI [52.67, 56.08]; $M_{Negative} = 51.95$, 95% CI [50.15, 53.75]), $t(1384) = 1.92$, $p = .055$, $d = 0.10$, likely because participants had not acquired an amount of experience with the task that would be sufficient to establish a sense of momentum. Self-efficacy followed a similar pattern across practice rounds (see Supplemental Materials).

⁸ 18 participants dropped out of the experiment after encountering the interruption, but we continued to collect data from participants until we had a relatively equal number in each condition and achieved our predetermined sample size of 320 participants. We only include participants in this analysis who completed the full experiment.

Expected performance. Momentum condition had a statistically significant effect on participants' performance expectations, $t(1384) = 4.70, p < .001, d = 0.25$, as participants in the *positive momentum* condition believed that they were more likely to win the competition (on the 1 to 10 Likert scale item; $M = 5.61, 95\% \text{ CI } [5.44, 5.78]$) than were participants in the *negative momentum* condition ($M = 5.03, 95\% \text{ CI } [4.86, 5.20]$). This effect also emerged in each experiment separately except for Experiment 1a ($p(1a) = .813, p(1b) = .039, p(1c) = .003, p(1d) < .001$). In a regression analysis that predicted the influence of condition on expectations, the effect remained statistically significant after controlling for average practice round score, age, gender, education, and task familiarity (see Models 1 and 2 in Table 1).⁹

Participants in the *positive momentum* condition were also more likely to expect that they were going to win the competition (on the dichotomous measure; win = 1, lose = 0) ($M = 0.61, 95\% \text{ CI } [0.57, 0.65]$) than were participants in the *negative momentum* condition ($M = 0.53, 95\% \text{ CI } [0.49, 0.57]$), $t(1147) = 2.59, p = .010, d = 0.14$. However, we note that this effect was weaker across studies and should be interpreted with caution (1a: $p = .28, 1b: p = .046, 1c: p = .12$). The aggregated effect remained robust after controlling for baseline self-efficacy levels, average practice round score, age, gender, education, and task familiarity.¹⁰

⁹ Removing experimental condition from the regression analysis revealed only a significant relationship between self-efficacy levels and expectations (see Models 3 and 4 in Table 1), indicating that participants' self-efficacy levels just before the competition positively correlated with their performance expectations even after controlling for momentum perceptions before the competition, baseline self-efficacy levels, practice round score, and demographics.

¹⁰ A 10,000 sample bootstrapping mediation model indicated that the effect of experimental condition on expectations was mediated by momentum perceptions (95% bias corrected CI = [0.79, 1.05]). It was also mediated by self-efficacy: 95% bias corrected CI = [0.08, 0.28], and we found support for a two-step model indicating that momentum perceptions and self-efficacy levels sequentially mediated the effect of condition on expectations, 95% bias corrected CI = [0.67, 0.95].

Table 1

Summary of Hierarchical Regression Analysis for Variables Predicting Perceived Likelihood to Win Controlling for Experiment Number (in Experiments 1a-d)

Variable	Model 1			Model 2			Model 3			Model 4		
	<i>B</i>	<i>SE B</i>	<i>t</i>	<i>B</i>	<i>SE B</i>	<i>T</i>	<i>B</i>	<i>SE B</i>	<i>T</i>	<i>B</i>	<i>SE B</i>	<i>t</i>
Experimental condition	0.54	0.12	4.46***	0.54	0.11	4.76***						
Average practice score	0.11	0.01	7.82***	0.07	0.01	5.40***	0.03	0.01	2.20*	0.02	0.01	1.57
Age				-0.01	0.01	-1.53				-0.02	0.01	-2.63**
Gender				-0.05	0.08	-0.56				-0.05	0.07	-0.75
Education				0.52	0.04	13.91***				0.28	0.03	8.16***
Familiarity with task				0.10	0.07	1.40				0.06	0.07	0.88
Perceived momentum							0.00	0.00	0.42	0.00	0.00	0.97
Perceived self-efficacy							0.60	0.04	15.59***	0.50	0.04	12.77***
Baseline self-efficacy							0.00	0.01	-0.57	0.00	0.01	-0.87
Adjusted <i>R</i> ²	0.06			0.18			0.39			0.43		
N	1385			1385			1148			1148		

Note: Models 1 and 2 include Experiment 1d but Models 3 and 4 do not because we did not measure self-efficacy in Experiment 1d. Perceived momentum and self-efficacy were measured immediately prior to the competition round. Baseline self-efficacy was measured before the first practice round. Experimental condition is coded as 1=positive momentum condition; 0=negative momentum condition. * $p < .05$. ** $p < .01$. *** $p < .001$

Actual performance. We next examined the effect of momentum condition on competition task performance. Despite the fact that momentum condition enhanced performance expectations, condition neither affected performance levels, $t(1384) = 1.06$, $p = .289$, $d = 0.06$ ($M_{Positive} = 24.75$, 95% CI [23.89, 25.61]; $M_{Negative} = 24.10$, 95% CI [23.26, 24.94]), nor the actual likelihood of winning, $\chi^2(1, N = 1386) = 1.23$, $p = .267$, and these null effects remained unchanged after controlling for average practice round score, age, gender, education, and task familiarity (see Models 1 and 2 in Table 2).

We further examined the effect of momentum condition on competition task performance within each separate experiment because we changed the competition rules in each experiment. In the untimed competition task in Experiment 1a, participants in the *positive momentum* condition found marginally more words ($M = 35.55$, 95% CI [32.39, 38.70]) than did those in the *negative momentum* condition, ($M = 31.41$, 95% CI [28.09, 34.73]), $t(125) = 1.80$, $p = .074$, $d = 0.32$, although they spent the same amount of time on the competition task ($M_{Positive} = 317.92$ sec, 95% CI [275.66, 360.18]; $M_{Negative} = 345.33$ sec, 95% CI [287.17, 403.49]), $t(125) = 0.77$, $p = .443$, $d = 0.14$. In Experiment 1b, which also used an untimed competition task, participants found *fewer* words in the *positive momentum* condition ($M = 26.39$, 95% CI [24.24, 28.55]) than they found in the *negative momentum* condition ($M = 29.01$, 95% CI [26.60, 31.41]), $t(269) = -1.60$, $p = .110$, $d = -0.20$, and participants spent the same amount of time on the competition task ($M_{Positive} = 277.72$ sec, 95% CI [240.51, 313.75]; $M_{Negative} = 277.13$ sec, 95% CI [245.61, 309.83]), $t(269) = 0.02$, $p = .981$, $d < 0.01$. In Experiment 1c, during which participants had three minutes to complete the competition task, we found no difference in performance scores between the *positive momentum* ($M = 25.35$, 95% CI [24.34, 26.36]) and *negative momentum* conditions ($M = 24.30$, 95% CI [23.42, 25.18]), $t(749) = 1.54$, $p = .125$, $d = 0.11$. In Experiment 1d, during which participants had only 1.5 minutes to complete the competition task, we once again found no difference between performance scores in the *positive momentum* ($M = 14.85$, 95% CI [13.94, 15.75]) and *negative momentum* conditions ($M = 14.23$, 95% CI [13.18, 15.27]), $t(235) = 0.89$, $p = .375$, $d = 0.12$. We also tested whether condition affected participants' desire to enter the competition, but it did not, $t(405) = 0.66$, $p = .511$, $d = 0.07$ (the competition task in Experiment

1d was optional, and thus only those participants who chose to compete (71.5%) were included in the analyses reported above).

Because we observed no effect of experimental condition on performance, we further conducted an exploratory analysis in which we tested correlational predictors of competition task performance in regression models (See Table 2). This revealed a significant relationship between momentum perceptions and performance levels that persisted after including all of our control variables (see Models 3 and 4 in Table 2). In other words, participants' momentum perceptions predicted their performance levels even after accounting for prior performance and self-efficacy. Interestingly, the relationship between perceived momentum and performance was meaningfully larger than the relationship between self-efficacy and performance, suggesting, perhaps, that momentum perceptions more closely align with performance outcomes than do self-efficacy levels.

Table 2

*Summary of Hierarchical Regression Analysis for Variables Predicting Competition**Performance Controlling for Experiment Number (in Experiments 1a-d)*

Variable	Model 1			Model 2			Model 3			Model 4		
	<i>B</i>	<i>SE B</i>	<i>t</i>	<i>B</i>	<i>SE B</i>	<i>t</i>	<i>B</i>	<i>SE B</i>	<i>t</i>	<i>B</i>	<i>SE B</i>	<i>t</i>
Experimental condition	-0.09	0.42	-0.21	-0.15	0.42	-0.35						
Average practice score	1.47	0.05	31.29***	1.42	0.05	28.79***	1.48	0.06	26.05***	1.43	0.06	24.42***
Age				0.04	0.03	1.54				0.10	0.04	2.56*
Gender				0.91	0.31	2.96**				0.95	0.35	2.72**
Education				0.07	0.14	0.51				-0.07	0.16	-0.40
Familiarity with task				0.45	0.27	1.66				0.63	0.33	1.93
Perceived momentum							0.04	0.02	2.55*	0.04	0.02	2.71**
Perceived efficacy							0.00	0.18	-0.02	-0.05	0.19	-0.25
Baseline self-efficacy							-0.01	0.03	-0.33	-0.01	0.03	-0.55
Adjusted <i>R</i> ²	0.53			0.54			0.44			0.43		
<i>N</i>	1385			1385			1148			1148		

Note: Models 1 and 2 include Experiment 1d but Models 3 and 4 do not because we did not measure self-efficacy in Experiment 1d. Perceived momentum and self-efficacy were measured immediately prior to the competition round. Baseline self-efficacy was measured before the first practice round. Experimental condition is coded as 1=positive momentum condition; 0= negative momentum condition. * $p < .05$. ** $p < .01$. *** $p < .001$

Post-competition feelings. Although we did not have *a priori* predictions, to be thorough we tested the effect of experimental condition on reported effort, competition feelings, post-competition self-efficacy and momentum, evaluation of task, and mood. In Experiments 1a-c, participants did not report expending differential levels of effort on the competition task ($M_{Positive}$

= 8.65, 95% CI [8.52, 8.78]; $M_{Negative}$ = 8.58, 95% CI [8.44, 8.72]), $t(1141) = 0.65$, $p = .515$, $d = 0.04$. However, they did report feeling better about their performance in the *positive momentum* condition ($M = 6.92$, 95% CI [6.74, 7.09]) than they did in the *negative momentum* condition ($M = 6.66$, 95% CI [6.48, 6.83]), $t(1145) = 2.04$, $p = .042$, $d = 0.12$. They also reported elevated momentum perceptions ($M_{Mom} = 68.83$, 95% CI [66.94, 70.73]) and higher self-efficacy levels ($M_{Eff} = 7.01$, 95% CI [6.83, 7.18]) in the *positive momentum* condition than in the *negative momentum* condition ($M_{Mom} = 63.75$, 95% CI [61.81, 65.69]; $M_{Eff} = 6.75$, 95% CI [6.58, 6.93]), $ts > 2.03$, $ps < .043$, $ds > 0.12$, despite performing equivalently well on the competition task. No statistical differences by condition emerged on participants' *moods* or beliefs about *how fun* the task was in Experiment 1d, $ts < 0.19$, $ps > .857$, $ds < 0.03$, and controlling for these variables did not change the null effect of momentum condition on competition task performance, $t(232) = 0.92$, $p = .358$, $d = 0.12$.

Discussion

Experiments 1a-d provide evidence that merely completing a set of practice tasks in a different difficulty order influences the perception of psychological momentum, which then exerts a causal effect on expected, albeit not actual, future performance. Notably, the effect on expectations occurred despite participants reporting similar skill levels and task experience across conditions. Despite the lack of observable causal effect of the momentum manipulation on actual performance, momentum perceptions did appear to be at least correlationally related to the competition performance scores after controlling for observable differences in skill and perceptions of self-efficacy. We return to the question of whether, and if so how, psychological momentum might potentially influence performance outcomes in other domains in our General Discussion section.

Experiment 2: Performance Incentives

Experiment 2 provides a more direct comparison between the effect of momentum on predicted performance and actual performance. We made a number of methodological changes to create a more conservative test. First, to make predictions as informed as possible, we let participants view the competition task before their predictions and selected a competition task that was representative of participants' practice round experiences (i.e., of average difficulty). To make predictions as accurate as possible, we added a monetary incentive for prediction accuracy. We also added a larger monetary incentive for performance, both a base bonus if individuals won the competition and extra pay for each additional word found beyond their target. The incentive for real performance was higher than the incentive for prediction accuracy so that participants would not be tempted to deliberately perform in line with their predictions.

Method

We pre-registered this experiment on the Open Science Framework (OSF). (https://osf.io/wut82/?view_only=e13d95eca1684b56bc5f7bd25d8ac1b1).¹¹

Participants. Based on the effect sizes obtained in Experiments 1a-d, we predetermined a sample size of 150 participants for each of two experimental conditions. We recruited 302 participants (174 female, 1 gender non-binary, $M_{age} = 36.6$ years, 95% CI [35.33, 37.93]) through Amazon Mechanical Turk who completed a survey in exchange for \$0.70 with the opportunity to earn a substantial bonus. A sensitivity power analysis revealed that we have 80% power to detect an effect size of $d = 0.35$ (at $\alpha = .05$) with this sample size (Gpower; Faul et al., 2007).

Pre-test. We recruited 53 participants on Amazon Mechanical Turk (32 female, 1 gender non-binary, $M_{age} = 35.4$, 95% CI [32.36, 38.24]) to pretest a new set of letters

¹¹ The final method and results reported in this paper involve some deviations from this pre-registration, which are described in the Supplemental Materials.

(EIOBTHNCMYRG) for the competition round that were designed to be closer to the medium-difficulty letter set that participants viewed in the practice rounds. Participants' average score on this letter set ($M = 9.29$, 95% CI [7.71, 10.89]) was similar to the pre-test results of the medium-difficulty letter set used during the practice rounds (see “manipulating psychological momentum” section in Experiments 1a-d), $M = 10.60$, 95% CI [9.09, 12.11].

Procedure. We randomly assigned participants to one of two conditions: *positive momentum* and *negative momentum*. The word-find tasks employed in the practice rounds described in Experiments 1a-d were used again, and participants saw the same instructions and responded to the same attention check items employed in Experiments 1a-d. The procedure then followed Experiment 1a nearly identically through the three practice rounds, with the only difference being that the perceived momentum question was converted to a -50 (losing momentum) to +50 (gaining momentum) scale (with the slider bar starting at 0) because we believed that these scale labels would be more intuitive for participants.

After the third practice round, we told participants: “In this round you will compete against the average of everyone who has played this set of letters before. The average for this set of letters is X. In order to win you will need to find more than X words in 1.5 minutes,” where X was actually their own average score from the first three rounds.

Incentivized performance predictions. We incentivized participants' performance in the following way: “If you win, you will earn a \$0.30 bonus. On top of that, we will give you \$0.05 for every extra word you find beyond X.” We reminded participants of their scores in the first three rounds, and then showed them the actual set of letters that they would be seeing in the competition for 15 seconds prior to asking them to predict how many words they would find. We further incentivized participants' prediction accuracy by informing them: “To encourage you to

predict accurately, if your prediction is within 3 words of your final score, we will give you an extra \$0.03 bonus” (we chose a small sum so that participants would not stop finding words in order to win the bonus, but would at least be minimally incentivized to make accurate predictions). After seeing the competition set of letters and the score to beat, participants entered their prediction for the number of words they would find in the competition and then reported how likely it was that they were going to win the competition (1 = Not at all likely; 10 = Very likely), as well as whether they simply thought that they were going to win the competition (Yes; No).

Control variables. After the competition, we asked participants, “Overall, how did you feel about your performance in the competition?” (1 = Not at all good; 10 = Excellent) and “How much effort did you put into the competition?” (1 = No effort; 10 = A lot of effort), after which we revealed participants’ results to them. Finally, participants completed the same measures described in Experiment 1d: task familiarity, demographics, manipulation checks, how fun the game was, and mood.

Results

Analysis plan. As in Experiments 1a-d, we removed participants who did not score within one standard deviation below the mean on their average practice round or competition score. Including these participants in analyses does not significantly change our primary results, as described in the Supplemental Materials.

Practice round scores. Actual practice round scores were not meaningfully different between the negative momentum ($M=11.24$, 95% CI [10.20, 12.29]) and positive momentum ($M=10.91$, 95% CI [10.02, 11.80]) conditions, $t(258) = 0.48$, $p = .632$, $d = 0.06$, suggesting that our manipulation did not affect actual skill levels.

Perceived momentum. Momentum condition significantly affected momentum perceptions ($M_{Positive} = 20.73$, 95% CI [17.33, 24.12]; $M_{Negative} = 0.24$, 95% CI [-4.25, 4.74]), $t(258) = 7.22$, $p < .001$, $d = 0.90$. Self-efficacy ratings followed a similar pattern (see Supplemental Materials).

Expected performance. Replicating the findings of Experiments 1a-d, momentum condition significantly influenced participants' performance expectations, $t(258) = 3.67$, $p < .001$, $d = 0.46$, such that participants in the *positive momentum* condition were more likely to believe that they were going to win the competition ($M = 5.79$, 95% CI [5.39, 6.19]) than were participants in the *negative momentum* condition ($M = 4.73$, 95% CI [4.32, 5.14]). Likewise, participants in the *positive momentum* condition ($M = 0.58$, 95% CI [0.49, 0.66]) were more likely to believe that they would be the ultimate winner of the competition than were participants in the *negative momentum* competition ($M = 0.43$, 95% CI [0.34, 0.52]), $t(258) = 2.37$, $p = .018$, $d = 0.30$.

Performance predictions. We next examined participants' predicted performance scores. Despite reporting that they were going to be more likely to win, participants in the *positive momentum* condition did not predict a higher competition score ($M = 12.08$, 95% CI [10.87, 13.28]) than did participants in the *negative momentum* condition ($M = 11.46$, 95% CI [10.25, 12.67]), $t(258) = 0.71$, $p = .478$, $d = 0.09$.¹²

We additionally tested a metric more directly related to the criterion we set for winning the competition: the extent to which participants predicted that they were going to beat their target score and hence “win” the competition (i.e., the difference between participants' predicted

¹² We note that when controlling for average score in an ANOVA, participants in the *positive momentum* condition did predict a higher competition score than those in the *negative momentum* condition $F(1, 257) = 5.54$, $p = .019$, $\eta^2 = 0.01$. However, this was not a pre-registered analysis.

score and average score). On this metric there was an effect of momentum condition ($M_{Positive} = 1.17$, 95% CI [0.51, 1.83]; $M_{Negative} = 0.22$, 95% CI [-0.28, 0.72]), $t(258) = 2.26$, $p = .025$, $d = 0.28$, indicating that participants in the *positive momentum* condition predicted a larger margin of success than did participants in the *negative momentum* condition.

Actual performance. In reality, participants were similarly likely to win in both conditions ($M_{Positive} = 0.54$, 95% CI [0.45, 0.62]; $M_{Negative} = 0.60$, 95% CI [0.52, 0.69]), $t(258) = 1.03$, $p = .302$, $d = 0.13$. Furthermore, performance levels did not vary by condition, ($M_{Positive} = 12.76$, 95% CI [11.38, 14.14]; $M_{Negative} = 13.05$, 95% CI [11.78, 14.31]), $t(258) = 0.31$, $p = .760$, $d = 0.04$, even when controlling for average practice score. The actual number of words that participants found above their target score (i.e., the difference between their actual competition score and average practice round score) also did not differ by condition, ($M_{Positive} = 1.85$, 95% CI [0.70, 2.99]; $M_{Negative} = 1.80$, 95% CI [1.19, 2.42]), $t(258) = 0.07$, $p = .947$, $d = 0.01$, even when only participants who won the competition are included in the analysis, ($M_{Positive} = 5.14$, 95% CI [3.37, 6.91]; $M_{Negative} = 3.78$, 95% CI [3.10, 4.46]), $t(146) = 1.48$, $p = .142$, $d = 0.24$.

Comparing predicted and actual performance. The difference between participants' predicted competition scores and their actual competition scores was directionally but non-significantly higher in the *positive momentum* condition than in the *negative momentum* condition ($M_{Positive} = -0.68$, 95% CI [-1.58, 0.22]; $M_{Negative} = -1.59$, 95% CI [-2.19, -0.98]), $t(258) = 1.65$, $p = .100$, $d = 0.21$. Indeed, participants were unexpectedly *underconfident* in both conditions, believing that they would find fewer words than they actually did. An alternative analysis intended to control for competition score revealed similar results: In a one-way ANOVA of condition on prediction controlling for competition score, a very weak effect of condition emerged, $F(1, 257) = 2.79$, $p = .096$, $\eta^2 < 0.01$, suggesting that predictions were more highly

correlated with actual scores in the *positive momentum* condition than in the *negative momentum* condition.

We conducted a follow-up analysis that was not preregistered at the time of conducting this study, but we subsequently learned about and believed could be informative. Specifically, we relied on signal detection theory to compute values corresponding to four categories: 1) Hit (expect to win and win), 2) Miss (expect to win but lose), 3) Correct Rejection (expect to lose and lose), and 4) False Alarm (expect to lose but win). As depicted in Table 3, participants in the *positive momentum* condition (compared to participants in the *negative momentum* condition) were more likely to experience *misses* ($M_{Positive} = 0.24$, 95% CI [0.17, 0.32], $M_{Negative} = 0.14$, 95% CI [0.08, 0.20]), $t(258) = 2.09$, $p = .037$, $d = 0.26$, whereas participants in the *negative momentum* condition (compared to participants in the *positive momentum* condition) were more likely to experience *false alarms* ($M_{Positive} = 0.20$, 95% CI [0.13, 0.27], $M_{Negative} = 0.31$, CI [0.23, 0.39]), $t(258) = -2.00$, $p = .047$, $d = -0.25$. In other words, 10.18% of participants were more likely to incorrectly predict that they would *win* in the *positive momentum* condition, whereas 10.80% were more likely to incorrectly predict that they would *lose* in the *negative momentum* condition. The number of participants who correctly predicted that they would win (“hits”; $M_{Positive} = 0.33$, 95% CI [0.25, 0.41], $M_{Negative} = 0.29$, 95% CI [0.21, 0.37]), $t(258) = 0.77$, $p = .443$, $d = 0.10$ or lose (“correct rejections”; $M_{Positive} = 0.22$, 95% CI [0.15, 0.29], $M_{Negative} = 0.26$, 95% CI [0.18, 0.33]), $t(258) = -0.72$, $p = .473$, $d = -0.09$, did not differ by condition.

Table 3

Number and Percentage of Participants in each Experimental Condition who Correctly or Incorrectly Anticipated a Win or Loss in Experiment 2

	Positive Momentum Condition		Negative Momentum Condition		<i>t</i>	<i>p</i>	<i>d</i>
	Number of Participants in Condition	Percentage in Condition	Number of Participants in Condition	Percentage in Condition			
Expect to win but lose (Miss)	32	24.24%	18	14.06%	2.09	.037	0.26
Expect to lose but win (False Alarm)	27	20.45%	40	31.25%	-2.00	.047	-0.25
Expect to win and win (Hit)	44	33.33%	37	28.90%	0.77	.443	0.10
Expect to lose and lose (Correct Rejection)	29	21.97%	33	25.78%	-0.72	.473	-0.09
Total	132	100%	128	100%			

Control variables. We also tested whether momentum condition affected participants' moods or beliefs about whether the task was fun. There were no differences in mood across condition ($M_{Positive} = 4.62$, 95% CI[4.36, 4.89]; $M_{Negative} = 4.59$, 95% CI[4.33, 4.84]), $t(258) = 0.19$, $p = .850$, $d = 0.02$, but participants in the *positive momentum* condition did believe that the task was more fun ($M_{Positive} = 4.14$, 95% CI[3.89, 4.40]; $M_{Negative} = 3.75$, 95% CI[3.46, 4.04]), $t(258) = 2.03$, $p = .044$, $d = 0.25$. However, the aforementioned results on expectations, accuracy, and performance levels do not meaningfully change when we control for perceived fun, nor do they change when we control for participants' average practice score, task familiarity, education, age, or gender (see Supplemental Materials).

Discussion

Experiment 2 replicates the effect from Experiments 1a-d that momentum perceptions raise performance expectations without boosting performance levels. However, the effect of momentum on performance expectations did not translate into an effect on predicted performance. Players consistently underestimated their actual performance results, although this underestimation was slightly weaker when they experienced positive (vs. negative) momentum. A signal detection analysis provided more precision on the effect of momentum on actual and expected performance: performers who perceived they were gaining momentum were more likely to incorrectly predict that they would win a subsequent competition, whereas performers who perceived they were losing momentum were more likely to incorrectly predict that they would lose a subsequent competition.

Experiment 3: Betting on Momentum

Experiment 3 examines whether experiencing psychological momentum emboldens people to bet on themselves in a competition, even when performers know that the difficulty level of their tasks is changing. It also considers two possible moderators of the effect of psychological momentum on performance expectations: performer status and mindset. First, we examine how underdog (versus favorite) status influences performance expectations, as prior research suggests that observers sometimes have higher performance expectations for underdogs in a variety of contexts (e.g., Vandello, Goldschmied, & Richards, 2007). Second, we test whether performers who believe that their abilities are malleable will experience a more pronounced effect of psychological momentum on performance expectations than performers who believe that their abilities are fixed.

Method

Participants. Because we did not know exactly what effect size to expect with regard to betting behavior, we decided to collect 100 participants for each of four experimental conditions in the hope that a sample size of this magnitude would yield adequate statistical power to detect a small to medium-sized effect. In all, we recruited 409 participants (224 female, $M_{age} = 38.28$ years, 95% CI [37.07, 39.50]) through Amazon Mechanical Turk who completed a survey in exchange for \$0.60 with the opportunity to earn a \$0.40 bonus. A sensitivity power analysis revealed that we have 80% power to detect an effect size of $d = 0.30$ (at $\alpha = .05$) with this sample size (Gpower; Faul et al., 2007).

Procedure. The study employed a 2 (task order: negative momentum or positive momentum) $\times$ 2 (status: favorite or underdog) between-participants design. The procedure and survey followed Experiment 1d except for the following changes described below.

Growth mindset. Prior to completing the practice rounds, participants completed a growth mindset scale (eight items, modified to pertain to performance; De Castella & Byrne, 2015).

Favorite vs. underdog. After completing the practice rounds, we randomly assigned participants into a status condition (*favorite* or *underdog*) and told them: “You have the opportunity to play one more round and earn a bonus if you would like to. In this round you will compete against a set score.” Participants in the *underdog* condition learned that they needed to beat their average score *plus one* (thereby making it harder for them to win), whereas participants in the *favorite* condition learned that they needed to beat their average score *minus one* (thereby making it easier for them to win).

Betting on performance. To explain the choice to enter the competition, participants read:

“If you WIN the competition you will earn **an additional \$0.40**. If you LOSE the competition, you will earn **\$0**. You do not get ANY bonus money if you lose the competition. If you choose **not** to compete, you will not play the next round, and instead just answer a few questions and finish this experiment. If you do not choose to compete, you will earn **an additional \$0.20** which cannot be taken away. To summarize, your choices are: 1. Choose to compete: win the competition = \$0.40 extra, lose the competition = \$0.00 2. Choose not to compete = \$0.20 extra.”

We then reminded participants of their practice scores in each round and the score they needed to beat to win the competition, after which they reported how likely they believed it was going to be that they would win the competition (1 = Not at all likely; 10 = Very likely). For our key betting measure, participants selected whether or not they wanted to enter the competition (Yes; No).

Control variables. Following the competition, participants completed the same measures described in Experiment 1d: task familiarity, demographics, manipulation checks, whether the game was fun, and their mood.

Awareness of changing task difficulty. Finally, in addition to examining participants’ awareness of how their own performance was changing, this experiment also measured participants’ awareness that the task difficulty was changing (i.e., an external attribution for their momentum). To examine this, we asked: “Did you notice that the word sets were getting easier or harder during the first three rounds?” (Yes, they were getting easier (1); Yes, they were getting harder (2); No, I didn’t notice a change (3)).

Results

Analysis plan. As in Experiments 1a-d and 2, we removed participants who did not score within one standard deviation below the mean on their average practice round score or competition score. Including these participants in analyses does not significantly change our primary results, as described in the Supplemental Materials.

Practice round scores. Average practice scores were higher in the *positive momentum* condition ($M = 12.26$, 95% CI [11.52, 13.01]) than in the *negative momentum* condition ($M = 11.10$, 95% CI [10.40, 11.79]), $t(342) = 2.27$, $p = .024$, $d = 0.25$. This difference was driven solely by a difference in letters found on their easy set ($M_{Positive} = 15.88$, 95% CI [14.83, 16.93]; $M_{Negative} = 12.13$, 95% CI [11.29, 12.98]), $t(342) = 5.53$, $p < .001$, $d = 0.60$. The averages of the medium and hard sets of letters were the same across condition, $ts < 1.40$, $ps > 0.162$, $ds < 0.16$. Because the participants in the *positive momentum* condition saw the easy set of letters last, we believe this difference is a practice effect and not a skill effect.

Awareness of changing task difficulty. Those in the *negative momentum* condition recognized that the tasks were getting harder ($M = 1.17$, 95% CI [1.09, 1.25]), whereas those in the *positive momentum* condition recognized that the tasks were getting easier, ($M = 1.85$, 95% CI [1.79, 1.91]), $ps < .001$, and the two conditions reported significantly different assessments of task difficulty, $t(221) = 13.78$, $p < .001$, $d = 1.85$. Thus, participants were aware that the task difficulty was changing.

Perceived momentum. Perceived momentum measured prior to the competition task varied by momentum condition, ($M_{Positive} = 64.52$, 95% CI [60.85, 68.19]; $M_{Negative} = 45.21$, 95% CI [41.02, 49.40]), $t(342) = 6.80$, $p < .001$, $d = 0.74$. We did not analyze momentum scores by status because participants provided their momentum perceptions before we assigned them to different statuses.

Expected performance. Replicating the results of the prior experiments, a 2×2 ANOVA conducted on performance expectations indicated that participants in the *positive momentum* condition were more likely to believe that they were going to win ($M = 6.13$, 95% CI [5.80, 6.46]) than were participants in the *negative momentum* condition ($M = 5.38$, 95% CI [5.04,

5.73]), $F(1, 340) = 12.29, p < .001, \eta^2 = 0.03$. Unsurprisingly, *favorites* also believed that they were going to be more likely to win ($M = 6.27, 95\% \text{ CI } [5.92, 6.62]$) than did *underdogs* ($M = 5.25, 95\% \text{ CI } [4.93, 5.57]$), $F(1, 340) = 18.43, p < .001, \eta^2 = 0.06$, but there was no interaction, $F(1, 340) = 0.39, p = .531, \eta^2 < 0.01$.¹³

Betting on performance. Testing our hypothesis that task order would influence betting behavior, we found that participants were indeed more likely to choose to enter the competition in the *positive momentum* condition ($M = 0.78, 95\% \text{ CI } [0.72, 0.85]$) than they were in the *negative momentum* condition ($M = 0.67, 95\% \text{ CI } [0.60, 0.74]$), $F(1, 340) = 6.52, p = .011, \eta^2 = 0.02$. Participants were also more likely to choose to enter the competition in the *favorite* condition ($M = 0.80, 95\% \text{ CI } [0.74, 0.86]$) than in the *underdog* condition ($M = 0.66, 95\% \text{ CI } [0.59, 0.73]$), $F(1, 340) = 8.58, p = .004, \eta^2 = 0.03$. The interaction was non-significant, $F(1, 340) = 0.27, p = .607, \eta^2 < 0.01$.

Actual performance. We next examined competition performance, noting that because participants self-selected into the competition (78% of *positive momentum* participants and 67% of *negative momentum* participants chose to compete), random assignment to condition no longer holds in subsequent analyses. Despite clear differences in performance expectations, as well as an expressed willingness to *bet* on those expectations, neither momentum condition nor status condition affected performance levels ($M_{Neg-Fav} = 11.13, 95\% \text{ CI } [9.46, 12.80]$, $M_{Neg-Under} = 10.05, 95\% \text{ CI } [7.63, 12.46]$, $M_{Pos-Fav} = 13.50, 95\% \text{ CI } [11.48, 15.52]$, $M_{Pos-Under} = 11.39, 95\% \text{ CI } [9.43, 13.35]$) after controlling for average practice scores, $F(1, 339) = 0.13, p = .714, \eta^2 < 0.001$ and $F(1, 339) = 2.69, p = .102, \eta^2 < 0.008$, respectively, and there was no interaction, $F(1, 339) =$

¹³ As we found in Experiments 1a-d and Experiment 2 perceived momentum mediated the effect of momentum condition on performance expectations in a 10,000 bootstrapping mediation model, 95% bias-corrected CI [0.33, 0.69]. In a separate model, momentum perceptions did not mediate the effect of status condition on performance expectations, 95% bias-corrected CI [-0.21, 0.07].

1.16, $p = .282$, $\eta^2 < 0.004$. However, *favorites* actually “won” the competition more often ($M = 0.87$, 95% CI [0.81, 0.92]) than did *underdogs* ($M = 0.75$, 95% CI [0.67, 0.82]), $F(1, 246) = 5.33$, $p = .022$, $\eta^2 = 0.02$, presumably because they were competing against a lower score.

Growth mindset and performance expectations. To examine the relationship between growth mindset and performance expectations, we ran a regression analysis with expectations as the dependent variable that included the following predictors: momentum condition (0 or 1), status condition (0 or 1), growth mindset score, all interactions between these variables, and average practice score. The analysis revealed positive relationships between performance expectations and growth mindset, $\beta = 0.49$, 95% CI [0.10, 0.89], $p = .015$, indicating that a tendency to believe in the malleability of one’s performance abilities was associated with higher performance expectations, and between performance expectations and practice score, $\beta = 0.05$, 95% CI [0.00, 0.10], $p = .045$, but no other main effects or interactions. Removing the interaction variables from a second analysis revealed relationships between performance expectations and momentum condition ($\beta = 0.94$, 95% CI [0.49, 1.39], $p < .001$), status condition ($\beta = 1.18$, 95% CI [0.74, 1.63], $p < .001$), growth mindset ($\beta = 0.58$, 95% CI [0.38, 0.78], $p < .001$), and, marginally, practice score ($\beta = 0.04$, 95% CI [-0.01, 0.09], $p = .082$).

Growth mindset and actual performance. To examine the relationship between growth mindset and performance levels, we ran two regression analyses that substituted performance levels for performance expectations as the dependent variable. The first analysis included the following predictors: momentum condition (0 or 1), status condition (0 or 1), growth mindset score, all interactions between these variables, and average practice score. In this analysis, none of the variables predicted performance levels except for average practice score ($\beta = 1.31$, 95% CI [1.16, 1.47], $p < .001$). Removing the interaction variables in a second analysis revealed a

relationship between growth mindset and performance, indicating that the more malleability participants perceived in their performance abilities, the better they performed in the competition ($\beta = 1.12$, 95% CI [0.46, 1.78], $p < .001$), as well as a (marginal) effect of status on performance ($\beta = 1.46$, 95% CI [0.02, 2.93], $p = .053$), indicating that *favorites* ($M = 12.17$, 95% CI [10.89, 13.46]) scored higher in the competition than did *underdogs* ($M = 10.75$, 95% CI [9.22, 12.28]).

Discussion

Overall, Experiment 3 replicates the findings obtained in the previous experiments, and also shows that performers are more likely to bet on themselves when they believe they are gaining (versus losing) momentum, even though their objective performance did not differ between conditions. Thus, inaccurate financial gambles may be one potential consequence of psychological momentum.

We observed no interactions between the experience of gaining or losing momentum and performers' growth mindset or status (i.e., favorite or underdog) on either expected or actual performance. However, growth mindset and status both directly influenced expectations and real performance: participants who believed their performance was more malleable, and those who were actual favorites, had higher expectations and performed better.

Finally, this experiment provides more insight into people's beliefs about the changing difficulty-order of the practice tasks they completed. In this experiment, performers explicitly reported that they knew that the task difficulty level was changing, yet still reported having momentum. This suggests that although performers have at least some knowledge about the source of their experienced momentum, the feeling of momentum can still influence performance expectations, if not reality.

General Discussion

Momentum is a significant force at least in people's minds: our findings suggest that it exerts a stronger effect on people's performance expectations than it does on their performance outcomes. Six experiments ($N = 2,533$) revealed the remarkably consistent result that experiencing momentum in a competitive domain can enhance performance *expectations* without actually enhancing performance *outcomes*. Moreover, this effect of perceived momentum on expectations, as well as its corresponding null effect on performance, was robust to players' skill levels, task familiarity, self-efficacy levels, growth mindset, favorite versus underdog status, and various demographic variables. The current paper provides at least one quantifiable metric to compare the influence of momentum perceptions on expectations versus reality. In Experiment 2, performers who gained psychological momentum were 10.18% more likely than performers who lost psychological momentum to predict that they would *win* a competition that they eventually *lost*. Beyond only influencing performance expectations, psychological momentum can influence behaviors related to those expectations: in Experiment 3, performers with more momentum also bet more on their competition performance than they should have. In other words, players sacrificed their own earnings to bet on their performance if they believed that they were gaining momentum.

Theoretical Contributions

We believe that the present work makes at least four theoretical contributions. First, it marks an initial effort to understand the extent to which momentum perceptions change performance expectations compared to performance outcomes. Whereas prior research has provided hints about the nature of discrepancies between expectations and performance outcomes under conditions of perceived momentum (Gilovich et al., 1985; Perreault et al., 1998;

Shaw et al., 1992), none have examined or measured the magnitude of miscalibration under varying levels of (manipulated) momentum.

Second, we contribute to a growing body of research examining the consequences of momentum and momentum-like experiences on beliefs about the future. Most relevant is the prior finding that telling people to be optimistic or confident can enhance expectations about their future performance (Tenney et al., 2015). Similar results appear in research studying perceptions of status within groups and probability assessments. In one set of experiments, individuals who ascended through a hierarchy to reach their current rank—thus increasing their momentum in achieving their desired rank—were rated more positively and given more esteem than those who fell to that same rank (i.e., decreasing momentum; Pettit, Sivanathan, Gladstone, & Marr, 2013), suggesting that people expect changes in social hierarchy to continue linearly. In another set of experiments, when the probability of an event increased, the event felt less remote and more likely to occur than when the probability decreased (even when the final probability was exactly the same; Maglio & Polman, 2016). Extending this research, we find that not just observing but also *experiencing* momentum changes beliefs about the future.

Third, we provide an additional test of whether momentum can influence performance outcomes in a domain that is largely governed by effort more so than skill. Although a number of theories propose that momentum should influence performance outcomes under the very conditions we tested (Adler, 1981; Briki et al., 2014; Iso-Ahola & Dotson, 2016), we find no evidence for a causal effect of momentum on performance. However, as we note in the future directions section below, this is an important area that future research should explore.

Finally, we demonstrate that momentum perceptions not only inflate people's performance expectations, but also lead people to *act* on their inflated expectations. Whereas

prior research has examined correlations between momentum and betting behavior for other actors (Arkes & Martinez, 2011; Jegadeesh & Titman, 1993), we provide an initial demonstration that psychological momentum can causally increase betting on oneself.

Limitations and Future Directions

Our research contains limitations that future work could explore. One important remaining question is whether, and under what conditions, momentum actually influences performance. In the present work we found no clear evidence that momentum causally affects performance, and our null effect was appropriately statistically-powered. Of course, as with any null effect, our finding is not conclusive, although it is consistent with a number of other reported null findings (Gilovich et al., 1985; Mack & Stephens, 2000; Shaw et al., 1992; Silva, Cornelius, & Finch, 1992). On the other hand, our continuous measure of perceived momentum did *correlationally* positively predict performance levels in five out of six experiments while controlling for skill level and other relevant variables, indicating that perhaps momentum does play a role that we did not fully capture in our experimental paradigm.

It is also possible that we did not examine the performance domains or conditions under which momentum might actually influence performance. For instance, Taylor and Demick (1994) suggest that physiological arousal and positive affect are necessary for momentum to impact performance, and Vallerand et al. (1988) claim that some degree of control perceptions are necessary for the momentum-performance effect to appear. One recent paper (Shen & Hsee, 2017) demonstrated that viewing incidentally increasing numbers in increasing (vs. constant or decreasing) velocity made people perform more quickly when identifying words in a computer game and even step more quickly on a stepping machine, an effect that may be partly driven by the perception of momentum (although this perception was not measured in the reported studies).

Thus, future research might examine the momentum-performance link by creating conditions that incite physiological arousal and positive affect, and employ tasks that elicit control perceptions in order to more thoroughly test these theories.

Second, another direction for future research is to examine how experiencing momentum influences motivation more broadly, beyond competition settings. For instance, might ordering daily tasks from difficult to easy lead people to believe that they are gaining momentum throughout the day? Or, might people benefit from setting more challenging goals at first (and easier goals later) in order to establish and build momentum? This possibility diverges from predictions made by goal-setting theories, which posit that setting more challenging goals should lead people to perform better (Locke & Latham, 2002). Thus, researchers might benefit from integrating momentum and goal-setting theories in order to better understand how people experience progress versus setbacks when they are striving to attain their goals (e.g., Koo & Fishbach, 2014).

It might further be useful to explore possible individual differences in how people conceive of momentum and believe it will influence their future performance. For instance, novices might be more subject to the miscalibrating consequences of momentum than experts. Moreover, although our experiments drew from a wide sample of adults (with diversity across age, gender, race, and so on), they included primarily Americans. It is possible that Americans might be particularly likely to be overconfident about future performance, given that prior research has documented stronger self-enhancement tendencies in individualistic than collectivistic cultures (Heine & Hamamura, 2007; but see Moore, Dev, & Goncharova, 2018). Future research could examine how individual differences in knowledge or culture could affect the consequences of perceiving momentum.

Finally, there may be many more unexplored behavioral consequences of momentum. Experiencing or perceiving psychological momentum could influence decisions across a variety of domains. For example, momentum could lead individuals to purchase items that they might not necessarily need (e.g., impulse buying; Dhar, Huber, & Khan, 2007), fall prey to emotional contagion (e.g., “auction fever”; Ku, Malhotra, & Murnighan, 2005), and make risky choices in domains such as stock investing and gambling where control perceptions are mostly illusory (Guenther & Kokotajlo, 2017). But it may also be possible to counter such tendencies, for instance by reminding individuals of base-rate frequencies and prior probabilities, or perhaps by guiding people to attribute momentum externally (e.g., to a changing situation) instead of internally (e.g., to their own skill levels).

Open Practices

All data, code, and survey materials are available in the Open Science Framework (OSF) repository for this project

(https://osf.io/qqng5/?view_only=04e2e3ec43b747c7a86754ca0d0482a8).

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Supplemental Materials

Previous experiments used to determine sample size for Experiments 1a-d

We conducted three prior experiments whereby observers viewed the past performance rankings of two players or teams (e.g., tennis, basketball) who would actually compete in the future. Observers assessed the players' momentum moving into the competition and made predictions about the outcomes. We manipulated whether observers believed that players' rankings were staying the same (i.e., static), the favorite was falling in rankings, the underdog was rising in rankings, or both players were simultaneously moving in the rankings (i.e., favorite falling, underdog rising). When prior rankings were the same, the underdog was judged to have significantly less momentum than when both players were changing rankings ($ds = 1.00, 0.41$, and 1.13 for the three experiments run). We used these effect sizes to determine the sample sizes for the experiments in this paper.

Pre-test to select tasks for Experiments 1a-d

To identify a hard, medium, and easy set of letters for the word-find tasks, we recruited 307 participants (194 female, 1 gender non-binary, $M_{age} = 35.42$, 95% CI [34.13, 36.71]) on Amazon Mechanical Turk in exchange for \$0.20 and asked them to create words from one of six sets of letters (aiming for approximately 50 participants per set). We created these letter sets on the basis of our own experience playing similar word games. The letter sets were: AEODTSNCPYRK, AEITFMNLPRYG, EIOBTJNCMYRP, AEODTHNCPYRK, AEIDTSNHPYRM, and AEIBTJNCKYDH. Participants saw the same instructions and attention check items that participants saw in the main experiments and completed one of the word-find

tasks for 1.5 minutes. The average score on each of the six letter sets was: 14.98, 15.09, 8.08, 13.00, 14.23, and 10.60. We selected the hardest ($M = 8.08$, 95% CI [6.76, 9.40]), easiest ($M = 15.10$, 95% CI [13.00, 17.19]), and median-difficulty sets ($M = 10.60$, 95% CI [9.09, 12.11]) to use as stimuli in Experiments 1a-d. The average completion rates for each of these sets were statistically different from one another, $ts > 2.53$, $ps < .013$, $ds > 0.51$. Finally, for the competition we chose the second easiest set of letters ($M = 14.98$, 95% CI [12.38, 17.58]) in order to make the task more enjoyable for participants.

Results including all participants

Experiment 1a-d ($n=1,822$). The effect of experimental condition on perceived momentum ($M_{Positive} = 60.97$, 95% CI [59.42, 62.53]; $M_{Negative} = 42.31$, 95% CI [40.64, 43.98]), $t(1820) = 16.04$, $p < .001$, $d = 0.75$, and expected likelihood to win ($M_{Positive} = 5.32$, 95% CI [5.16, 5.48]; $M_{Negative} = 4.76$, 95% CI [4.61, 4.91]), $t(1820) = 4.97$, $p < .001$, $d = 0.23$, was statistically significant; the effect on performance was non-significant ($M_{Positive} = 20.51$, 95% CI [19.65, 21.38]; $M_{Negative} = 19.78$, 95% CI [18.95, 20.61]), $t(1820) = 1.21$, $p = .227$, $d = 0.06$.

Experiment 2 ($n=302$). The effect of experimental condition on perceived momentum ($M_{Positive} = 18.33$, 95% CI [14.94, 21.72]; $M_{Negative} = -1.96$, 95% CI [-6.11, 2.19]), $t(300) = 7.50$, $p < .001$, $d = 0.87$, and expected likelihood to win ($M_{Positive} = 5.63$, 95% CI [5.27, 6.00]; $M_{Negative} = 4.57$, 95% CI [4.18, 4.96]), $t(300) = 3.91$, $p < .001$, $d = 0.45$, was statistically significant; the effect on performance was non-significant ($M_{Positive} = 11.64$, 95% CI [10.40, 12.87]; $M_{Negative} = 11.65$, 95% CI [10.37, 12.92]), $t(300) = 0.01$, $p = .992$, $d < 0.01$.

Experiment 3 ($n=409$). The effect of experimental condition on perceived momentum was statistically significant ($M_{Positive} = 61.22$, 95% CI [57.68, 64.77]; $M_{Negative} = 44.47$, 95% CI

[40.50, 48.44]), $t(407) = 6.20, p < .001, d = 0.61$. A 2×2 ANOVA conducted on performance expectations indicated that participants in the *positive momentum* condition were more likely to believe that they were going to win ($M = 6.13, 95\% \text{ CI } [5.80, 6.46]$) than were participants in the *negative momentum* condition ($M = 5.95, 95\% \text{ CI } [5.63, 6.27]$), $F(1, 405) = 10.06, p = .002, \eta^2 = 0.02$. Unsurprisingly, *favorites* also believed that they were going to be more likely to win ($M = 6.10, 95\% \text{ CI } [5.77, 6.44]$) than did *underdogs* ($M = 5.17, 95\% \text{ CI } [4.87, 5.48]$), $F(1, 405) = 19.28, p < .001, \eta^2 = 0.04$, but there was no interaction, $F(1, 405) = 0.85, p = .357, \eta^2 < 0.01$. The experimental condition did not affect actual performance levels ($M_{\text{Negative-Favorite}} = 10.23, 95\% \text{ CI } [8.75, 11.71]$, $M_{\text{Negative-Underdog}} = 9.41, 95\% \text{ CI } [7.22, 11.61]$, $M_{\text{Positive-Favorite}} = 11.57, 95\% \text{ CI } [9.70, 13.45]$, $M_{\text{Positive-Underdog}} = 9.82, 95\% \text{ CI } [8.07, 11.57]$) after controlling for average practice scores, $F(1, 404) = 0.11, p = .741, \eta^2 < 0.01$, but participants in the favorite condition scored higher than those in the underdog condition, $F(1, 404) = 4.28, p = .039, \eta^2 < 0.01$. There was no interaction, $F(1, 404) = 1.23, p = .268, \eta^2 < 0.01$. There is no longer a main effect of momentum condition on entering the competition. Participants are no more likely to enter the competition in the *positive momentum* condition ($M = 0.72, 95\% \text{ CI } [0.66, 0.79]$) than in the *negative momentum* condition ($M = 0.68, 95\% \text{ CI } [0.62, 0.74]$), $F(1, 405) = 1.34, p = .201, \eta^2 < 0.01$.

Analysis of awareness of changing performance

Experiment 1a-d. Participants indeed noticed that their performance was changing across rounds; they reported improving more on the practice rounds in the *positive momentum* condition ($M = 1.05, 95\% \text{ CI } [0.95, 1.14]$) than in the *negative momentum* condition ($M = -0.47, 95\% \text{ CI } [-0.57, -0.36]$), $t(1384) = 21.44, p < .001, d = 1.15$.

Experiment 2. Indicating that participants were paying attention, they reported improving more on the practice rounds in the *positive momentum* condition ($M = 1.37$, 95% CI [1.17, 1.57]) than in the *negative momentum* condition ($M = -0.65$, 95% CI [-0.89, -0.41]), $t(258) = 12.79$, $p < .001$, $d = 1.59$.

Experiment 3. As in prior experiments, participants reported their performance was improving more on the practice rounds in the *positive momentum* condition ($M = 1.40$, 95% CI [1.23, 1.57]) than in the *negative momentum* condition ($M = -0.66$, 95% CI [-0.89, -0.41]), $t(342) = 13.97$, $p < .001$, $d = 1.51$.

Analysis of practice round scores

Experiment 1a-d. Average practice scores were marginally higher in the *positive momentum* condition ($M = 11.88$, 95% CI [11.53, 12.22]) than the *negative momentum* condition ($M = 11.45$, 95% CI [11.13, 11.76]), $t(1384) = 1.80$, $p = .072$, $d = 0.10$.

Experiment 2. Average practice scores were no different in the *positive momentum* condition ($M = 10.91$, 95% CI [10.02, 11.80]) from the *negative momentum* condition ($M = 11.24$, 95% CI [10.20, 12.29]), $t(258) = 0.48$, $p = .632$, $d = 0.06$.

Experiment 3. Average practice scores were higher in the *positive momentum* condition ($M = 12.26$, 95% CI [11.52, 13.01]) than in the *negative momentum* condition ($M = 11.10$, 95% CI [10.40, 11.79]), $t(342) = 2.27$, $p = .024$, $d = 0.25$. This difference was driven solely by a difference in letters found on their easy set ($M_{Positive} = 15.88$, 95% CI [14.83, 16.93]; $M_{Negative} = 12.13$, 95% CI [11.29, 12.98]), $t(342) = 5.53$, $p < .001$, $d = 0.60$. The averages of the medium and hard sets of letters were the same across condition, $ts < 1.40$, $ps > 0.162$, $ds < 0.16$. Because

the participants in the *positive momentum* condition saw the easy set of letters last, we believe this difference is a practice effect and not a skill effect.

Analysis of self-efficacy

Experiment 1a-d. Participants' self-efficacy was no different prior to completing the practice rounds in each condition, ($M_{Positive} = 6.37$, 95% CI [6.21, 6.53], $M_{Negative} = 6.48$, 95% CI [6.31, 6.65]), $t(1147) = 0.90$, $p = .370$, $d = 0.05$, but started to diverge immediately after the first practice round. Because participants in the *positive momentum* condition saw the hard set of letters first, they reported lower self-efficacy levels ($M = 4.82$, 95% CI [4.64, 5.01]) than those in the *negative momentum* condition ($M = 5.93$, 95% CI [5.75, 6.10]), $t(1147) = 8.44$, $p > .001$, $d = 0.50$. Just prior to the competition, however, participants' self-efficacy was significantly higher in the *positive momentum* condition ($M = 6.56$, 95% CI [6.40, 6.73]) than in the *negative momentum* condition ($M = 5.01$, 95% CI [4.82, 5.20]), $t(1147) = 12.24$, $p < .001$, $d = 0.72$ (see Figure S1).

Figure S1. Participants' self-efficacy ratings by experimental condition over time, starting before their first practice round ("Pre task") and continuing until after their final practice round ("Post PR3") in Experiments 1a-d.

Experiment 2. Participants' self-efficacy was no different prior to completing the practice rounds in each condition, ($M_{Positive} = 6.39$, 95% CI [6.02, 6.77], $M_{Negative} = 6.37$, 95% CI [6.01, 6.73]), $t(258) = 0.09$, $p = .928$, $d = 0.01$, but started to diverge immediately after the first practice round. Because participants in the *positive momentum* condition saw the hard set of letters first, they reported lower self-efficacy levels ($M = 4.84$, 95% CI [4.45, 5.24]) than those in the *negative momentum* condition ($M = 6.05$, 95% CI [5.70, 6.39]), $t(258) = 4.53$, $p > .001$, $d = 0.56$. Just prior to the competition, however, participants' self-efficacy was significantly higher in the *positive momentum* condition ($M = 6.56$, 95% CI [6.16, 6.96]) than in the *negative momentum* condition ($M = 4.91$, 95% CI [4.50, 5.33]), $t(258) = 5.61$, $p < .001$, $d = 0.70$.

Experiment 2 analysis with control variables included

Table S1

Summary of Hierarchical Regression Analysis Predicting Performance Expectations, Accuracy, and Competition Performance

Variable	Model 1 - Performance Expectations			Model 2 - Accuracy			Model 3 - Competition Performance		
	<i>B</i>	<i>SE B</i>	<i>t</i>	<i>B</i>	<i>SE B</i>	<i>t</i>	<i>B</i>	<i>SE B</i>	<i>t</i>
Experimental condition	0.89	0.25	3.52***	0.85	0.40	2.12*	0.16	0.65	0.24
Average practice score	0.12	0.02	5.21***	0.08	0.04	2.16*	0.91	0.06	14.79***
Age	0.01	0.01	0.69	-0.06	0.02	-3.49***	-0.05	0.02	-1.83
Gender	-0.27	0.26	-1.04	-1.39	0.41	-3.43***	-1.32	0.66	-2.00*
Education	0.02	0.19	0.12	0.34	0.30	1.15	0.52	0.49	1.07
Familiarity with task	-0.02	0.15	-0.12	-0.09	0.24	-0.38	0.89	0.39	2.29*
Fun	0.53	0.08	6.30***	0.27	0.13	2.05*	0.51	0.22	2.36*

Adjusted R^2	0.29	0.12	0.53
N	260	260	260

Experimental condition is coded as 1=decreasing difficulty; 0=increasing difficulty.
 $*p < .05$. $**p < .01$. $***p < .001$

Experiment 2 deviation from pre-registration

We arrived at the idea to conduct a signal detection analysis to quantify miscalibration after the study was completed (thanks to reviewer feedback); therefore, this analysis was not pre-registered.

Additional items

Attention check questions. We asked several attention check questions to make sure they had read and understood the rules: “How many practice rounds of finding words will you do today?” (“1 round”, “2 rounds”, “3 rounds”), “How long will you have to find words during each round?” (“2 minute”, “1.5 minutes”, “2 minutes”), “Can you repeat the same word?” (“Yes”, “No”), “Can you repeat a letter within a word?” (“Yes”, “No”) and “What is the minimum number of letters for each word?” (“2 letters”, “3 letters”, “4 letters”).

Other items in surveys. Most of our surveys conclude with three exploratory text box questions: “Do you think your performance in the practice rounds affected your competition performance? If so, how?”, “Do you have any thoughts about the competition?”, and “Do you have any other thoughts about the experiment?”