

Reconsidering the Trade-off between Speed and Accuracy:  
The Role of Perceived Goal Progress Velocity

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### Abstract

Previous research has found a consistent trade-off between speed and accuracy. Whereas completing work tasks quickly is generally associated with increased mistakes, slowing down allows individuals to work in a more careful and accurate manner. However, this previous work has not considered the implications that subjective speed perceptions have for accuracy. To this end, we draw on control theory accounts of goal progress velocity, which predict that *feeling* slow is associated with negative emotional experiences. We argue that slow perceived progress is frustrating, and that this frustration can hinder accuracy. We tested our hypotheses using an experiment in which participants (N = 92) completed a work simulation. Importantly, actual speed was held constant across conditions, and instead we manipulated participants' subjective interpretations of their rate of progress. As expected, feeling slow was associated with increased frustration, which in turn was negatively associated with accuracy. The results of this study imply that, contrary to the typical finding of a trade-off between speed and accuracy, there are situations in which slowing down can actually hinder accuracy. Therefore, the current research adds important nuance to the literature on speed-accuracy trade-offs. Additionally, this research provides the most direct test of control theory predictions regarding velocity to date. We conclude with a discussion of the implications of these results for both theory and practice.

*Keywords:* speed-accuracy trade-off, velocity, frustration, effort, control theory

Work tasks often must be completed quickly and within stringent deadlines (Mitchell et al., 2008). However, working quickly can lead to mistakes; there is a well-documented trade-off between *speed* and *accuracy* (Gilliland & Landis, 1992; Locke et al., 1994). Yet, previous speed-accuracy trade-off research has not accounted for subjective emotional experiences. In particular, how quickly a person works on a task affects the way it *feels* to work on that task (Johnson et al., 2013), and emotions can have important implications for accuracy. As such, we argue that in some cases, slowing down may actually *hurt* accuracy. Given the high cost of mistakes (Frese & Keith, 2015; Lei et al., 2016), a more nuanced account of speed and accuracy is warranted.

The primary purpose of this article is to provide this nuance. We do so by drawing on Carver and Scheier's (1990, 1998) control theory. A key element of this theory is *velocity*, which is defined as the rate at which goal progress is made (i.e., speed). Carver and Scheier argued that individuals possess referents for desired velocity, and that progressing toward a goal at below-referent velocity results in emotions like frustration, anger, and irritability (Carver, 2004; Carver & Scheier, 2011). Downstream, these emotions can narrow attention (Gable & Harmon-Jones, 2010; Harmon-Jones et al., 2013), leading to a focus on the problem at hand (speed) at the expense of competing demands (accuracy). Therefore, by integrating speed-accuracy trade-off research with Carver and Scheier's control theory, the central contribution of the current research is to demonstrate that although *going slow* in an objective sense is typically associated with fewer mistakes and inaccuracies, *feeling slow* in a subjective sense may have the opposite effect.

The current research also contributes to the broader motivation literature. Whereas previous velocity research provides initial support for relationships between velocity and emotions (e.g., Beck et al., 2017a; Phan et al., 2023), this work has not sufficiently disentangled the effects of *actual* velocity from the effects of *discrepancies* between actual- and referent-

velocity. Thus, from a theoretical perspective, the empirical data collected up to this point do not provide a complete test of Carver and Scheier's (1990, 1998) claims that velocity discrepancies drive emotional reactions, rather than velocity itself. This distinction has practical implications for managers. If emotional reactions are indeed driven by velocity discrepancies as theorized, then velocity referents must be carefully considered when engaging in managerial behaviors like goal setting and establishing deadlines. Failure to do so may inadvertently result in frustration and anger, with adverse implications for numerous work outcomes, including accuracy.

We tested our predictions with an experiment in which participants completed a work simulation. Importantly, *actual* velocity was held constant across conditions. Instead, we manipulated velocity *referents*. Half the participants experienced below-referent velocity while performing the task, and the other half experienced no such discrepancy. Using this paradigm, we demonstrate that slow perceived velocity can actually *increase* mistakes. Additionally, we do so while also disentangling actual velocity from the subjective experience of velocity, thereby providing a direct test of Carver and Scheier's (1990, 1998) control theory.

### **A Trade-off Between Speed and Accuracy**

Completing tasks quickly often requires a sacrifice in terms of accuracy. In work contexts, this is typically described as a trade-off between quantity and quality (Gilliland & Landis, 1992; Locke et al., 1994). For example, increasing the number of products produced in a period of time (speed/quantity) is associated with increased defects (accuracy/quality). Likewise, speed-accuracy trade-offs also manifest as an exchange of safety for productivity (Wallace & Chen, 2006). Safety procedures may be skipped to speed the flow of work, yet this increases the likelihood of accidents (i.e., mistakes). Although individual differences affect the tendency to prioritize speed versus accuracy in a given situation (Förster et al., 2003), the trade-off itself is

fundamental to goal pursuit. Indeed, bees, guppies, and various other non-human animals balance speed and accuracy to meet the demands of their environments (Chittka et al., 2009).

Speed and accuracy are negatively yoked because they compete for the same finite resources. Prioritizing speed typically means time, energy, and attention must be diverted from accuracy, and vice versa. For instance, individuals assigned quality-goals tend to prioritize quality over quantity, whereas the opposite pattern is observed for individuals assigned quantity-goals (Locke et al., 1994). Likewise, because difficult goals require more resources than easy goals, the trade-off between quality and quantity is accentuated by goal difficulty (Gilliland & Landis, 1992). Also, individuals are most likely to sacrifice safety for productivity when they are faced with high workloads (Beck et al., 2017b). Thus, there is considerable empirical evidence of a trade-off between speed and accuracy that is driven by resource scarcity.

However, this previous research considered the objective trade-off between *actual* speed and accuracy. Yet, Carver and Scheier (1990, 1998) argued that subjective, emotional reactions to goal pursuit are a function of *discrepancies* between actual velocity (i.e., speed) and internal velocity referents. We expect these emotional experiences to impact accuracy, and thus, that velocity-referent discrepancies influence speed-accuracy trade-offs. To this end, we review Carver and Scheier's theory in greater detail in the following section.

### **Control Theory Account of Velocity**

According to control theories, discrepancies between a person's goals and their perception of progress motivate goal-striving behaviors (Carver & Scheier, 1998; Lord & Levy, 1994; Powers, 1978; Vancouver, 2005). Yet, goals are not achieved instantaneously, but instead are pursued over time. Thus, Carver and Scheier's version of control theory emphasizes that the *rate* at which progress is made (i.e., velocity) drives motivational and emotional experiences.

Specifically, Carver and Scheier (e.g., 1990, 1998, 2011) theorized that individuals possess internal velocity referents for desired rates of progress. They argued that the degree to which actual velocity deviates from the referent is associated with the subjective experience of goal pursuit. According to this theory, above-referent velocity is associated with positive emotions, such as eagerness and enthusiasm, and below-referent velocity is associated with negative emotions like frustration, anger, and irritability. Thus, it is not the *actual* speed at which a person completes a task that drives the way it feels to pursue a goal, but the *discrepancy* between actual- and referent-velocity. As an analogy: travelling at 40 mph may feel quite pleasant for a person who is used to travelling by bicycle, yet this same speed can be exceedingly frustrating on a congested highway with a posted speed limit of 65 mph.

Several studies have shown rapid goal progress to be associated with a general sense of pleasantness and satisfaction, whereas slow progress is associated with negative emotions and dissatisfaction with one's progress (Chang et al., 2009; Elicker et al., 2010; Lawrence et al., 2002; Wilt et al., 2017). Other research has demonstrated similar effects on discrete emotional states like frustration and enthusiasm (Beck et al., 2017a; Phan & Beck, 2020; Phan et al., 2023). Yet, for the most part, the disambiguation of actual velocity from velocity discrepancies has been insufficient. Specifically, some studies did not examine velocity discrepancies at all, but instead either manipulated or measured actual velocity. Other studies used velocity discrepancies as independent variables, yet the manipulations and measures also conveyed information about actual velocity, which confounds velocity with the likelihood that the goal can be achieved. Thus, whether emotions emerge as a function of velocity *discrepancies* (a la Carver and Scheier), or instead are a byproduct of *actual* velocity, remains unclear.

This ambiguity is not trivial. If the emotions associated with slow velocity are largely a function of the likelihood of achieving a goal, then within many work contexts velocity may have little bearing on emotions. For instance, negative emotions might be alleviated simply by extending the deadline. Likewise, some work tasks do not have concrete deadlines, meaning velocity has little bearing on whether or not the task can be completed. Yet, if below-referent velocity is unpleasant *in and of itself*, then velocity will drive emotional experiences, even in the absence of meaningful deadlines. This is because the minimum rate of progress required to meet a deadline is only one *potential* source of a velocity referent; other referents also exist, such as one's previous experience with the task. As long as velocity is below one of these referents, negative emotions are likely to persist. Thus, disambiguating the effects of velocity discrepancies from the effects of actual velocity is essential, especially if the negative emotions associated with slow velocity affect outcomes like accuracy.

The current research addresses these ambiguities, particularly with regard to the effects of below-referent velocity on negative emotions like frustration and anger. The focus on below-referent velocity is driven by our overall research objective: demonstrating the importance of subjective feelings associated with one's rate of progress when considering speed-accuracy trade-offs. Previous research demonstrates a clear association between working slowly and accuracy, yet slowing down to the point where velocity is below the referent may have the opposite effect. Likewise, we expect emotions like frustration and anger to provide the bridge between below-referent velocity and mistakes. These emotions are theorized as proximal outcomes of below-referent velocity (Carver, 2004; Carver & Scheier, 2011), and they have important implications for the allocation of attention (Gable & Harmon-Jones, 2010; Harmon-Jones et al., 2013). In the following sections we develop these arguments in greater detail.

### **Frustration in Response to Below-referent Velocity**

Carver and Scheier (2011) argued that within approach-goal contexts, which are characterized by movement *toward* some desired end-state, below-referent velocity produces negative emotions like frustration, anger, and irritability.<sup>1</sup> These emotions serve as internal signals of insufficient progress (Carver, 2004; Carver & Harmon-Jones, 2009). As such, they are part of an adaptive process, helping individuals to reprioritize resources as needed. Importantly, Carver and Scheier do not differentiate among frustration, anger, irritability, and other similar emotions in their predictions regarding below-referent velocity. Likewise, lay individuals often use these terms interchangeably (Barata et al., 2016). As such, in the remainder of this article, we use the term “frustration” to refer to this cluster of emotions. We believe this simplification is justified for two reasons. First, the term frustration is often associated with thwarted progress towards one’s work objectives (e.g., Spector, 1978). Second, we believe frustration reflects the modal level of emotional intensity in response to below-referent velocity. For instance, some individuals may be merely miffed by slow progress, whereas others may be enraged. Yet we believe the term frustration probably reflects the typical, “middle ground” response. Nonetheless, we acknowledge that reasonable cases can be made for alternative labels.

Importantly, there is evidence that below-referent velocity is inherently frustrating, independent of the likelihood of achieving the goal within a deadline. Beck et al. (2017a) presented two studies to disentangle these effects. In both studies, half the participants were assigned to a *velocity* setback condition, meaning there was a reduction in their rate of progress midway through a work simulation. Thus, these participants experienced below-referent velocity,

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<sup>1</sup> Conversely, these authors argued that within avoid-goal contexts, characterized by movement *away* from an undesired outcome, below-referent velocity is associated with emotions like tension and anxiety. Consideration of avoidance-goal contexts is largely outside the scope of the current article. Nonetheless, we return to this issue in the Discussion section.

as their post-setback velocity was slower than the velocity they had experienced previously. The remaining participants were assigned to a *distance* setback condition, meaning their rate of progress did not change, but instead they lost some of the progress accumulated up to that point. Importantly, the two types of setbacks were designed such that all participants were equally likely to achieve the goal within the deadline. Despite this objective equivalence, subjective emotional experiences differed across conditions. Whereas frustration attributed to the setback eventually returned to baseline for participants in the distance condition, frustration remained elevated for the remainder of the experiment for participants in the velocity condition.

Additional evidence comes from an experiment and a field study conducted by Phan et al. (2023). In the experiment, participants completed a work simulation in which velocity was manipulated relative to a normative referent using false feedback (e.g., slower than average). In the field study, velocity was measured using a self-report scale. Participants responded to three items, each of which asked about velocity relative to a different referent (a rate of progress that was “acceptable,” “expected,” and “wanted”). In both studies, below-referent velocity was associated with increased frustration. Importantly, variance due to participants’ perceived likelihood of finishing their tasks on time was statistically controlled in these analyses.

Nonetheless, these studies have important limitations. Although objective likelihood of success was equated in the Beck et al. (2017a) studies, actual velocity varied across conditions, meaning subjective expectancies may have accounted for observed differences in frustration. Similarly, in the Phan et al. (2023) studies, both the experimental manipulation (Study 1) and the velocity measure (Study 2) contained information about actual velocity. With regard to the manipulation, “below average velocity” may have been interpreted as there being little chance to achieve the goal within the deadline. Likewise, although in the field study velocity was measured

relative to a referent, higher scores may have represented higher actual velocity, particularly if the referents (e.g., expected velocity) did not vary much from day to day. Thus, although expectancy was included as a control variable, there is still ambiguity regarding whether the effects on frustration are driven by velocity *discrepancies*, rather than actual velocity.

Therefore, we seek to replicate the effect of below-referent velocity on frustration, yet do so in a manner that addresses these limitations. To isolate the effects of *feeling* slow (below-referent velocity) from the effects of actually *being* slow (actual velocity), we held velocity constant across conditions. Instead, we manipulated whether or not this velocity represented a discrepancy from a referent. Furthermore, participants were paid a piece rate, and could stop the task at any time. Thus, participants were free to set their own goals and deadlines, meaning our velocity manipulation was not confounded with any need to achieve a given level of progress, nor to do so within a specified period of time. As such, this study provides the most direct test of Carver and Scheier's (1990, 1998, 2011) predictions regarding velocity discrepancies to date.

*H1*: Below-referent velocity will be associated with increased frustration, relative to at-referent velocity.

### **Indirect Effect of Velocity on Accuracy via Frustration**

Downstream, we expect frustration to predict accuracy. Intense emotions focus attention on the task at hand, and inhibit attention to competing demands (Finucane, 2011; Gable & Harmon-Jones, 2010; Harmon-Jones et al., 2013). Negative emotions like frustration function as feedback, indicating insufficient goal progress (Richard & Diefendorff, 2011; Seo et al., 2004). In turn, attention is focused on speed, and diverted from concerns for accuracy. Likewise, these emotions signal that higher-order goals, such as competence and well-being, require resource allocation (Johnson et al., 2006). This in turn hinders accuracy, as concern for these goals diverts attention from the task itself (Kluger & DeNisi, 1996; Vancouver & Tischner, 2004). Thus, we

hypothesize an indirect effect of velocity on accuracy via frustration. Contrary to the common finding that slower speeds are associated with increased accuracy, we argue that slow *perceived* velocity—such that velocity is below the referent—decreases accuracy.

To this end, previous research has demonstrated a link between below-referent velocity and accuracy. Specifically, Phan et al. (2023) found below-referent velocity to be associated with increased use of shortcut behaviors, which in turn were negatively related to accuracy. Yet, these shortcuts were a deliberate attempt to increase velocity; skipping rules and procedures allows individuals to speed their workflow. Conversely, in the current research we expect the indirect effect of velocity on accuracy to occur largely outside of conscious awareness. In contrast to the Phan et al. studies in which individuals made a *choice* to sacrifice accuracy in response to below-referent velocity, we are predicting that the frustration that accompanies below-referent velocity inhibits attention to the task, and thus, can lead to mistakes and inaccuracies.

*H2: There will be an indirect effect of velocity on accuracy via frustration. Below-referent velocity will be associated with lower accuracy, relative to at-referent velocity.*

### **Differentiating Accuracy and Effort**

Finally, there is an adage that a person who never makes mistakes never makes anything. In other words, one way to avoid mistakes is to simply disengage from the task. Therefore, it is critical to differentiate the effects of velocity on effort and accuracy. Effort is characterized by the direction, intensity, and persistence of behavior (Van Iddekinge et al., 2023). Carver and Scheier (2011) hypothesized that negative emotions like frustration are a signal that goal pursuit is in jeopardy, and thus, are likely to be associated with increased effort. However, this account seems to take a high level of commitment to the goal in question for granted. That is, if an individual is highly committed to a given goal, slower-than-referent velocity is a problem, and

one that may be solved by increasing effort. Yet, how might someone respond to below-referent velocity if achieving the goal is not all that important, particularly relative to other goals?

In the current research, the incentive for continuing with the task was a relatively modest cash payment. Yet, by discontinuing the task, participants could spend their effort on numerous competing goals (e.g., socializing), many of which likely had far greater subjective value than the experimental task. Individuals tend to prioritize goals with the highest relative value (Schmidt & DeShon, 2007), and goals with little chance of success are often abandoned outright (Beck et al., 2019; Schmidt & Dolis, 2009). Thus, for relatively inconsequential tasks, below-referent velocity, and the frustration associated with it, sets the stage for reduced effort. That is, frustration signals that goal pursuit is going poorly. Although in some cases that may lead a person to “double down,” it is just as likely to lead a person to disengage from the task, particularly if there are appealing alternative courses of action. Frustration is an unpleasant experience, and people tend to distance themselves from its source when possible (Berkowitz, 1989). Taken together, this means that in the current research below-referent velocity is likely to be associated with decreased effort.<sup>2</sup> Importantly, we are hypothesizing *incremental* indirect effects of velocity on both accuracy and effort via frustration, meaning velocity will account for unique variance in each dependent variable.

*H3:* There will be an indirect effect of velocity on effort via frustration. Below-referent velocity will be associated with lower effort, relative to at-referent velocity.

### Method

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<sup>2</sup> Beck et al. (2017a) made similar predictions, yet their results were mixed. Frustration was related to task performance (which was a function of effort) in Study 2, but not Study 1. Likewise, frustration was unrelated to self-reported effort (which was only measured in Study 2). However, in the Beck et al. studies, performance was operationalized as a function of both accuracy *and* effort, meaning velocity and frustration may have influenced either accuracy, effort, or both. Furthermore, it is possible that self-reported effort perceptions were affected by the differences in actual velocity across conditions that were noted above. The current study avoids these ambiguities.

The study was approved by the University of [masked for review]’s Office of Research Ethics (#30337, “Managerial Tasks in Organizational Settings”). We describe the sampling plan, all data exclusions, all manipulations, and all measures. Data and syntax are available via the Open Science Framework.<sup>3</sup> The experimental paradigm and materials can be requested from the first author. The study was not preregistered.

### **Participants**

Ninety-five undergraduate students completed the study in exchange for course credit and an opportunity to earn a cash reward. Three participants experienced technical difficulties and were excluded from analyses (final  $N = 92$ ). Most participants were White (40%) or Asian (36%). The sample was 73% female and had an average age of 20.06 ( $SD = 4.12$ ).

### **Procedure**

The study was conducted online. After signing on and providing consent, participants completed several individual difference measures.<sup>4</sup> Next, participants were given detailed instructions for completing the experimental task. Following these instructions, participants reported the degree to which they were frustrated “at the moment” (baseline). Participants then completed a practice trial, followed by the velocity referent manipulation, which is described in detail below. Following the manipulation, momentary frustration was measured for the second time (pre-trial). Participants then completed the experimental trial. Performance on this trial was used to determine the cash reward that participants received. Immediately after the experimental trial participants completed the same momentary frustration measure for the third time (post-trial). Next, participants completed an additional frustration item which explicitly referenced the

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<sup>3</sup> [https://osf.io/2xy8a/?view\\_only=84c79350337f4edd9c55bfc15e3e2eb7](https://osf.io/2xy8a/?view_only=84c79350337f4edd9c55bfc15e3e2eb7)

<sup>4</sup> These measures were included for exploratory purposes and are not included in our focal analyses. The supplemental online materials (SOM) contain a list of these measures.

task, as well as several additional items used to rule out alternative explanations. Finally, participants were debriefed and signed off. These procedures are summarized in Figure 1.

### ***Experimental Task***

We used a version of Beck et al.'s (2017a) work simulation. Participants combined four pieces of job performance information from fictional truck drivers (e.g., km driven) to determine each driver's salary using a series of simple rules. The rules were displayed on participants' computer screens at all times, meaning they did not need to be memorized.

Thirty minutes were allotted to the experimental trial, yet participants could choose how long to engage with the task. Specifically, participants were told that they would be paid \$0.05 for each correct salary (i.e., without mistakes), and they were free to quit at any time. It was emphasized that they would receive full participation credit regardless of the number of salaries completed, yet stopping early meant forgoing the opportunity to earn additional money. Although some participants worked the entire 30 minutes, most (85%) ended the experimental trial early. Finally, to discourage random responding, there was a \$0.025 penalty for each incorrect salary.<sup>5</sup> On average, participants spent 12.44 ( $SD = 10.29$ ,  $Min = .09$ ,  $Max = 30$ ) minutes on the experimental trial, completed 26.75 ( $SD = 24.14$ ,  $Min = 1$ ,  $Max = 97$ ) driver salaries, and were paid \$1.13 ( $SD = \$1.22$ ,  $Min = \$0.00$ ,  $Max = \$4.67$ ).

An important feature of the simulation is that velocity is controlled by the experimenter. Specifically, participants requested the information required to compute driver salaries by clicking buttons on the screen. Velocity is controlled via the delay between when a button is clicked and when the information is displayed. During the experimental trial this delay was two seconds. Importantly, this delay was present for all participants, regardless of condition. Thus,

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<sup>5</sup> Because of this penalty, 14 participants finished the experimental trial having earned negative values ( $Min = \$-.025$ ,  $Max = \$-.825$ ). These participants were paid \$0.00.

*actual velocity* was held constant. Instead, we manipulated *velocity referents* by varying the delay during the practice trial across conditions. This is described in detail below.

### ***Velocity Referent Manipulation***

Participants were randomly assigned to one of two conditions: below-referent velocity vs. control. In the below-referent velocity condition, participants performed the practice trial with no delay. The logic of this manipulation is that these participants would establish a referent for the velocity at which the task could be performed during the practice trial. This referent would be higher than the velocity that could be achieved during the experimental trial, thereby resulting in a discrepancy between actual- and referent-velocity. Immediately following the practice trial, participants in the below-referent condition were shown this message:

*“Attention! There is a problem with the program used to retrieve the driver information. From this point onward there will be a delay between the time when driver information is requested (i.e., when the button is clicked” and when the information is displayed.”*

This messaging was intended to be consistent with common workplace obstacles, such as malfunctioning equipment, slow internet access, or computer glitches. These participants were then given two sample drivers for which to compute salaries, and thus, experience the delay before reporting momentary frustration and beginning the experimental trial. On the other hand, in the control condition the two second delay was present during the practice trial. Therefore, these participants experienced the same maximum velocity during the practice and experimental trial, meaning they did not experience an actual- versus referent-velocity discrepancy.

## **Measures**

### ***Frustration***

*Momentary frustration* was measured using four items. Participants responded to the statement “At the moment I feel...” for each of the following: frustrated, angry, irritable, and

hostile.<sup>6</sup> These were the same items used to operationalize frustration in the Beck et al. (2017a) studies. The response scale ranged from 1 (not at all) to 5 (extremely). Alpha was .89, .89, and .91 at the baseline, pre-trial, and post-trial measurement periods, respectively. We also measured *task-related frustration* immediately after the experimental trial using the item: “Overall, how frustrating did you find the task?” Participants responded from 1 (not at all) to 7 (very much).

### ***Accuracy***

The percentage of incorrect salary submissions (i.e., mistakes) was used to operationalize accuracy. This number was then subtracted from 100 to reflect accuracy (rather than inaccuracy).

### ***Effort***

We operationalized effort as a composite of the amount of time participants spent on the experimental trial (persistence), as well as the total number of salary submissions they made (intensity). These variables were converted to z-scores, and the effort variable was computed as the mean. Alpha for this composite was .94.

### ***Alternative Explanatory Variables***

It is possible that the velocity-referent manipulation had unintended consequences for participants which might influence frustration, accuracy, or effort. Therefore, we included several measures of potential alternative explanations for observed differences across conditions. For instance, participants in the below-referent condition may find the task to be less enjoyable, relative to participants in the control condition. Likewise, the manipulation may be perceived as a source of difficulty. It is also possible that the manipulation may lead participants to decide the financial incentives are “not worth it.” Finally, working slower than one would like to might be

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<sup>6</sup> Participants also responded to 25 additional affective items (e.g., happy, anxious, guilty) at each measurement period. We included these items to obscure our interest in measuring frustration from participants, as this may have influenced the results. After applying a Bonferroni correct ( $.05 / 25 = .002$ ), there were no significant differences in these affective indicators across conditions at any measurement period. These results are available in the SOM.

fatiguing. Importantly, all of these factors might influence participants experience of frustration, and in turn, decreased accuracy and effort. Yet, a core purpose of the current study is to demonstrate that velocity-referent discrepancies are inherently frustrating. To this end, following the experimental trial we measured several variables to rule out these explanations.

*Task enjoyment* (“Overall, how much did you enjoy the task?”) and *perceived task difficulty* (“Overall, how difficult did you find the task?”) were measured with one item each. Participants responded on a scale from 1 (not at all) to 7 (very much). We also measured participants’ *desire to earn money* with two items: “How much did you care about earning the money for this task?” (1 = not at all, 7 = very much) and “How important to you was it to earn the money for completing this task?” (1 = not at all important, 7 = very important). These items were averaged into a composite variable ( $\alpha = .92$ ). Finally, we measured the degree to which participants felt *fatigued* following the experimental trial using Ciarocco et al.’s (2004) 10-item measure (e.g., “I feel drained”). Alpha was .84.

## Results

### Internal Validity Checks

Before testing the hypotheses, we first demonstrate that actual velocity did not differ by condition. Velocity was computed as the number of submissions per minute. As expected, there was no significant difference in velocity across conditions ( $t(90) = -.06$ ,  $SE = .41$ ,  $p = .949$ ), meaning actual velocity cannot account for the results reported below. Yet, although actual velocity did not vary *between* conditions, there was variance in actual velocity *within* each condition. Along these lines, there was a trade-off between speed and accuracy, as these variables were negatively correlated ( $r = -.49$ ,  $p < .001$ ). Nonetheless, including actual velocity

as a control variable did not change the interpretations of the hypothesis tests (these results are available in the SOM). Thus, below we report the results without controlling for actual velocity.

### **Descriptive Statistics**

Means, standard deviations, and intercorrelations are presented in Table 1. The momentary frustration (pre/post) variable is the mean of the pre- and post-trial momentary frustration variables. This composite variable is explained in the following section.

### **Hypothesis 1: The Effect of Perceived Velocity on Frustration**

#### ***Momentary Frustration***

H1 stated that below-referent velocity would be associated with increased frustration. We began by testing this hypothesis using momentary frustration. Specifically, we computed a 3 (time: baseline, pre-trial, post-trial)  $\times$  2 (condition: below-referent vs. control) mixed analysis of variance.<sup>7</sup> Although there was no significant main effect of the velocity condition on momentary frustration ( $F(1, 90) = 2.12$ ,  $MSE = 1.60$ ,  $p = .149$ ,  $\eta^2_{\text{partial}} = .02$ ), there was a significant time  $\times$  condition interaction ( $F(2, 180) = 5.15$ ,  $MSE = .28$ ,  $p = .007$ ,  $\eta^2_{\text{partial}} = .06$ ; see Figure 2).

As expected, between-subjects follow-up tests indicated that the two conditions did not significantly differ in momentary frustration during the baseline measurement period ( $t(155) = -.39$ ,  $SE = .18$ ,  $p = .700$ ,  $d = -.08$ ). Conversely, during the pre-trial ( $t(155) = 2.05$ ,  $SE = .18$ ,  $p = .042$ ,  $d = .43$ ) and post-trial ( $t(155) = 2.10$ ,  $SE = .18$ ,  $p = .038$ ,  $d = .44$ ) measurement periods, participants in the below-referent velocity condition experienced higher frustration, relative to participants in the control condition. Likewise, within-subjects probing of this interaction indicated that in the control condition, momentary frustration did not change across the three measurement periods ( $F(2, 180) = .38$ ,  $MSE = .28$ ,  $p = .683$ ). Yet, there was a significant change

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<sup>7</sup> Mauchly's test of compound sphericity was non-significant ( $\chi^2(2) = .39$ ,  $p = .821$ ).

in momentary frustration among participants in the below-referent velocity condition ( $F(2, 180) = 7.21$ ,  $MSE = .28$ ,  $p = .001$ ). Relative to the baseline measurement period, momentary frustration was higher during the pre-trial ( $t(180) = 3.47$ ,  $SE = .11$ ,  $p = .001$ ,  $d = .73$ ) and the post-trial ( $t(180) = 3.07$ ,  $SE = .11$ ,  $p = .002$ ,  $d = .65$ ) measurement periods. There was no significant difference in momentary frustration across the pre-trial and post-trial measurement periods for these participants ( $t(180) = .40$ ,  $SE = .11$ ,  $p = .692$ ,  $d = .08$ ).

These results support H1. Although all participants completed the experimental trial at the same velocity, participants who had previously established a faster velocity referent experienced greater frustration, relative to individuals for whom velocity matched expectations. Furthermore, momentary frustration increased from baseline for these participants. However, measurements taken immediately *before* and *after* the trial did not significantly differ, meaning a composite of these variables provides the best estimate of frustration *during* the trial. Therefore, we used the mean of pre- and post-trial momentary frustration in our tests of H2 and H3.

### ***Task-related Frustration***

We also tested H1 using task-related frustration. Because this item was only measured once (immediately following the experimental trial), we used a between-groups t-test. In line with H1, participants in the below-referent condition reported significantly higher task-related frustration ( $M = 3.71$ ,  $SD = 2.19$ ) relative to participants in the control condition ( $M = 2.81$ ,  $SD = 1.96$ ,  $t(90) = 2.08$ ,  $SE = .43$ ,  $p = .040$ ,  $d = .43$ ). These results provide additional support for H1.

### **Hypotheses 2 and 3: Indirect Effects of Perceived Velocity on Accuracy and Effort**

H2 predicted an indirect effect of the velocity referent manipulation on accuracy via frustration. Likewise, H3 predicted a similar indirect effect on effort. We tested these hypotheses simultaneously using structural equation modeling. Specifically, we tested a model in which

frustration was regressed on a dummy variable representing the manipulation (0 = below referent velocity; 1 = control) at Stage 1, and the two dependent variables (accuracy and effort) were regressed on frustration at Stage 2. Indirect effects were computed as the product of the Stage 1 and Stage 2 regression coefficients, and the significance was tested by constructing 95% confidence intervals based on the results of 5,000 bias corrected bootstrapped samples. Similar to our test of H1, we tested H2 and H3 using both operationalizations of frustration.

### ***Momentary Frustration***

We used the pre/post momentary frustration variable to test H2 and H3. As noted above, this composite variable provides the best estimate of momentary frustration during the experimental trial. The regression coefficients are presented in Figure 3A, and the tests of the indirect effects are presented in the top half of Table 2. The model fit the data well ( $\chi^2(2) = .32$ ,  $p = .852$ , CFI = 1.00, RMSEA = .00, SRMR = .02).<sup>8</sup> H2 was supported. Specifically, there was a significant effect of the manipulation on momentary frustration, indicating that below-referent velocity was associated with increased momentary frustration (this is analogous to the test of H1). Likewise, there was a significant relationship between momentary frustration and accuracy, and the indirect effect of the velocity referent manipulation on accuracy via momentary frustration was significant. Conversely, H3 was not supported. The relationship between

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<sup>8</sup> A reviewer expressed concern that the fit statistics reported in this section may be misleadingly favorable due to the sample size. We acknowledge that our sample size ( $N = 92$ ) and ratio of sample size to free parameters (9.2 to 1) are smaller than typical rules of thumb (e.g.,  $N = 200$ , 10 to 1; Kline, 2005). However, to the extent that model  $\chi^2$  (upon which RMSEA and CFI are based) is biased within relatively small samples, it is in the direction of *poor* model fit (McNeish, 2020). Furthermore, H2 and H3 are primarily evaluated via the tests of the indirect effects, rather than overall model fit. Likewise, in Figure 3 we report  $R^2$  as an alternative goodness-of-fit measure. Thus, we do not believe that our sample size is ultimately of great concern for interpreting the tests of H2 and H3.

momentary frustration and effort was non-significant, and as such, there was no significant indirect effect of the velocity referent manipulation on effort via momentary frustration.<sup>9</sup>

### ***Task-related Frustration***

Next, we tested H2 and H3 using the task-related frustration variable. This model also fit the data well ( $\chi^2(2) = 1.50$ ,  $p = .474$ ,  $CFI = 1.00$ ,  $RMSEA = .00$ ,  $SRMR = .03$ ). Regression coefficients are presented in Figure 3B, and the tests of the indirect effects are presented in the bottom half of Table 2. As expected, below-referent velocity was associated with increased task-related frustration (again, this is analogous to H1), and task-related frustration was negatively related to both accuracy and effort. More so, the velocity referent manipulation had significant indirect effects on both accuracy and effort via task-related frustration. Therefore, both H2 and H3 were supported when task-related frustration was used as the mediating variable.

### **Ruling Out Alternative Explanations**

Finally, we tested the degree to which the velocity referent manipulation resulted in different levels of task enjoyment, perceived task difficulty, desire to earn the cash rewards, and fatigue. As shown in Table 3, none of these variables differed significantly across the conditions. Therefore, these alternative explanations cannot account for the observed results.

## **Discussion**

### **Theoretical Implications**

The current study provides important theoretical nuance to the speed-accuracy trade-off literature. Specifically, beyond *actual* speed, whether or not progress *feels* slow is an important driver of accuracy. This distinction is illustrated in Figure 4. Here Person A is working faster than Person B in an absolute sense. Based on the bulk of the speed-accuracy trade-off literature,

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<sup>9</sup> Controlling for baseline momentary frustration has no influence on the interpretation of the results reported in this section (see SOM). Therefore, for simplicity we have presented the results without including this control variable.

Person B would be expected to make fewer mistakes than Person A. Yet the current research indicates that this may not necessarily be the case. Because Person B is working at a rate that is *below* their velocity referent, the resulting frustration is likely to hinder Person B's accuracy. Thus, to fully understand the relationship between speed and accuracy, the current research highlights the importance of considering not only how quickly a person is working, but also how quickly that person *wants* to be working.

This study also makes important contributions to motivational theory by providing a direct test of Carver and Scheier's (1990, 1998, 2011) predictions regarding velocity. Whereas previous studies provided initial evidence that below-referent velocity is unpleasant, no study has fully differentiated *actual* velocity and velocity-referent *discrepancies*. This distinction is important, because many (if not most) goals are accompanied by some deadline within which they must be accomplished. Thus, the faster a person works, the more likely they are to achieve the goal on time. As such, based on previous velocity research, it is difficult to know if below-referent velocity is inherently frustrating, or if negative emotions are a byproduct of mental projections of future failure. The current study provides clear support for the former explanation.

Distinguishing actual velocity and velocity discrepancies is critical, because individuals can possess multiple velocity referents simultaneously. The minimum speed *required* to meet a deadline is one potential velocity referent, yet there are additional referents as well. For instance, individuals form *expectations* about velocity based on previous experiences. Indeed, experience-based expectations were used to manipulate velocity referents in the current study. Additionally, individuals have *desired* velocities, which can be based on norms ("typical" or "exceptional" velocity), a desire to work on a competing goal (Phan & Beck, 2020), or numerous other factors. The important issue here is that even if one referent is adjusted, others may remain in place.

Referents based on required speed are relatively straightforward to adjust, as this can be done by extending deadlines, lowering quantity goals, or both. Yet doing so is likely to have little effect on frustration and accuracy if velocity remains less than what is expected or desired.

### **Practical Implications**

From a practical standpoint, the current research illustrates the importance of considering velocity referents when setting goals, establishing deadlines, and engaging in other performance management activities. The goals and deadlines that managers assign to their subordinates convey information about the rate at which work must be done; that is, a goal and deadline together inherently establish a velocity referent. Yet, individuals sometimes face unexpected constraints which hinder their rate of progress (O'Connor et al., 1984; Peters et al., 1982). As a result, these workers may experience below-referent velocity, as well as the frustration that typically accompanies it. Previous work indicates that the frustration associated with slower-than-referent velocity is associated with decreased goal commitment (Beck et al., 2017a) and deliberate attempts to circumvent rules and procedures (Phan et al., 2023). More so, the current research indicates that this frustration is also associated with unintentional errors. To this end, managers should be cognizant of their subordinates' velocity referents. This involves making sure these referents are realistic, and revising them as necessary.

In a similar vein, the current study has implications for introducing organizational changes. For example, although new technologies and systems may eventually speed up productivity, they can also be accompanied by short-term velocity reductions due to transition costs (Ahearne et al., 2010). When introducing new technologies and procedures, leaders may be tempted to emphasize the expected benefits. Yet, the current research indicates that it is also wise to acknowledge the potential for short-term decrements in velocity, and more so, establish

appropriate velocity referents during this time. Failure to do so could result in employees feeling frustrated with their perceived slow progress, which in turn may distract from work tasks, leading to mistakes. Although speculative, it is possible that employees could then attribute those mistakes to the new system, rather than to their own frustration, reducing buy-in to the change.

Lastly, as noted above, there are several sources of velocity referents. Whereas velocity *required* to meet a goal within a deadline is one source, the current research demonstrates that *expected* velocity, based on prior experiences, is another. This has implications for the training that individuals receive prior to beginning a new work role.<sup>10</sup> Work tasks often involve constraints, interruptions, and other problems that slow the pace of work (Leroy et al., 2020; Peters & O'Connor, 1980). Training that does not acknowledge this may inadvertently lead to unrealistic velocity referents. Indeed, this is similar to the concept of error management training, which is based on the logic that that mistakes are common and unavoidable (Frese & Keith, 2015). Error management training provides trainees with the tools needed to handle the mistakes they will inevitably encounter. We suggest expanding this approach to include simulated constraints and delays during training, thereby helping trainees form realistic velocity referents.

### **Future Directions**

Although it is clear that there are multiple velocity referents, many questions regarding these referents remain unanswered. Additional research is needed to identify which referents are most salient, for whom, under what conditions, and how to influence them. One fruitful direction for future research is to consider individual differences as antecedents of velocity referents. For instance, whereas individuals with a strong promotion focus may establish relatively high velocity referents because of their concern for productivity and speed, individuals with a strong

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<sup>10</sup> We'd like to thank an anonymous reviewer for this suggestion.

prevention focus may establish more modest velocity referents, given their inclination toward cautious, careful action (Higgins, 1997; Scholer et al., 2019). Additionally, situational cues may lead some referents to be more salient than others. For example, framing deadlines as an obligation that must be met at all costs is likely to make the velocity needed to reach the deadline highly salient (Beck et al., 2017b). Conversely, framing a task an opportunity to learn new skills may make individuals willing to accept relative low rates of progress (Hardy et al., 2019).

Additionally, future research should examine attributions about velocity. Indeed, differences in attributions for below-referent velocity may have been reflected in the two operationalizations of frustration used in this study. This, in turn, may have accounted for the different pattern of results regarding effort. Specifically, compared to task-related frustration, the source of momentary frustration may have been relatively ambiguous. Whereas some individuals may have attributed slow velocity to the task, others may have attributed it to their own skills or abilities. Furthermore, these attributions may have moderated the relationship between momentary frustration and effort. Participants who believed slow velocity was attributable to the task may have decreased their efforts as we hypothesized, yet individuals who attributed slow velocity to themselves may have increased their efforts to compensate. Together these offsetting effects would produce the null effect of momentary frustration on effort observed in the current research. Conversely, task-related frustration was likely to be attributed to the delay between when information was sought and when it was received. Because participants had no control over this delay, task-related frustration exhibited the hypothesized effect on effort. Of course, these post-hoc explanations are speculative, and additional research is needed to address the role attributions play in determining reactions to below-referent velocity.

Furthermore, the current study focused on below-referent velocity. Thus, future research should consider the effects of above-referent velocity on emotions and downstream behavioral outcomes. Carver and Scheier (1990, 1998, 2011) theorized that greater-than-referent velocity results in positive emotions, such as excitement and enthusiasm. To this end, there is empirical evidence that fast velocity is associated with satisfaction and positive affect (e.g., Chang et al., 2009; Elicker et al., 2010). Yet, as reviewed above, previous velocity research has not sufficiently differentiated actual velocity from velocity discrepancies. Furthermore, it is unclear what effects these emotions may have for outcomes like effort and accuracy. For instance, there is evidence of both positive and negative effects of positive affect on effort (Orehek et al., 2011). Likewise, the effect of positive affect on attention, and therefore accuracy, is likely to depend on the intensity of the specific emotion that is experienced (Gable & Harmon-Jones, 2013).

Finally, the current research was conducted within an approach-goal context, meaning participants strived *toward* a desired outcome (a completed driver salary with a \$0.05 incentive). In contrast, some work tasks are characterized by avoid-goals, meaning individuals exert effort to enlarge discrepancies between undesired outcomes and current their state. For example, wildfire fighters douse flames, cut fire lines, and apply foam suppressants to prevent fires from threatening lives and damaging property. In this example, the velocity referent is determined by the rate at which the fire spreads. Carver and Scheier (2011) hypothesized different negative emotions as a result of below-referent velocity across approach- and avoid-goal contexts. Whereas below-referent velocity in an approach-goal context is expected to yield frustration, anger, and irritability, these authors suggested that below-referent velocity in an avoid-goal context is associated with emotions like anxiety and tension. Importantly, similar to frustration, these emotions may be detrimental to accuracy, as they divert attention away from the task.

However, we are unaware of any empirical tests of Carver and Scheier's predictions regarding avoid-goals. Thus, future research should examine velocity within avoid-goal contexts, including the specific emotions evoked, and their influence on outcomes like accuracy.

### **Strengths and Limitations**

The experimental design used in the current research has important strengths. First and foremost, during the experimental trial all participants experienced the same conditions, and thus, the same maximum velocity. This is critically important, as it allows us to state that the observed effects on frustration (and downstream, accuracy and effort) across the conditions were a function of velocity *discrepancies*, and not *actual* velocity. Furthermore, the absence of assigned quantity goals and a deadline further strengthen this design, as differences in frustration across conditions could not be explained by beliefs or expectations regarding meeting these external demands. As such, this research provides a more direct and unambiguous test of Carver and Scheier's (1990, 1998) control theory than any previous velocity research.

Nonetheless, our use of a work simulation is a limitation of the current research. For many work tasks, the consequences for mistakes are far greater than the small financial penalties used in the current study. However, the effects that the consequences for inaccuracy may have on our results is an empirical question. On the one hand, very strong consequences for inaccuracies may lead individuals to "override" their frustrations, such that they make efforts to calm down and act in a careful and deliberate manner. On the other hand, if the relationship between frustration and accuracy is largely driven by a non-conscious diversion of attention, the effects of frustration on accuracy may persist, even if the consequences of inaccuracies are severe.

Another limitation of this design is that for many work tasks, individuals do not have the autonomy to decide how much effort to put forth, at least not to the degree present in the current

study. However, we believe this limitation is reasonable for two reasons. First, although many jobs are not characterized by this level of autonomy, many others are. Indeed, 43% of the occupations listed on the Occupational Information Network (O\*Net) have an importance rating of at least 4 out of 5 on the dimension “independence,” which is characterized by “...guiding oneself with little or no supervision, and depending on oneself to get things done.” Second, this design characteristic was necessary for making the inferences that we are able to draw from the current results. That is, it was critical to isolate the effects of velocity discrepancies from beliefs about the likelihood of success. In addition to keeping actual velocity constant across conditions, this was done by allowing participants to establish their own goals and deadlines.

### **Conclusion**

Taking the time to complete tasks in a deliberate and measured manner surely helps to prevent errors; indeed, there is ample evidence of a trade-off between speed and accuracy (Gilliland & Landis, 1992, Locke et al., 1994; Wallace & Chen, 2005). However, slowing down, in and of itself, may not be a panacea for accuracy. Instead, velocity referents must be taken into account. Without a commensurate downward adjustment in the velocity referent, slowing down may ultimately detract from accuracy via feelings of frustration.

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**Table 1***Means, Standard Deviations, and Correlations*

<i>Variable</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>8</i>	<i>9</i>	<i>10</i>	<i>11</i>	<i>12</i>	<i>13</i>
1. Velocity referent manipulation	1.00												
2. Momentary frustration (baseline)	.05	1.00											
3. Momentary frustration (pre-trial)	-.20 †	.57 ***	1.00										
4. Momentary frustration (post-trial)	-.20 †	.55 ***	.70 ***	1.00									
5. Momentary frustration (pre/post)	-.22 *	.61 ***	.92 ***	.92 ***	1.00								
6. Task-related frustration	-.21 *	.09	.47 ***	.41 ***	.48 ***	1.00							
7. Accuracy	.04	-.06	-.25 *	-.19 †	-.24 *	-.43 ***	1.00						
8. Effort	-.05	.03	-.07	.00	-.04	-.33 **	.51 ***	1.00					
9. Task enjoyment	.00	-.03	-.22 *	-.26 *	-.26 *	-.52 ***	.50 ***	.31 **	1.00				
10. Perceived task difficulty	-.09	.23 *	.27 **	.23 *	.27 **	.27 **	-.35 ***	-.21 *	-.17	1.00			
11. Desire to earn money	-.05	.07	.04	.07	.06	-.15	.20 †	.50 ***	.32 **	-.07	1.00		
12. Fatigue	-.09	.43 ***	.48 ***	.51 ***	.54 ***	.37 ***	-.19 †	-.03	-.34 ***	.22 *	.02	1.00	
13. Actual velocity	.01	-.06	-.01	.01	.00	.07	-.49 ***	-.17	-.25 *	-.02	.03	-.01	1.00
<i>Mean</i>	.51	1.42	1.59	1.54	1.57	3.25	74.31	.00	3.22	1.91	2.46	3.50	2.58
<i>SD</i>	.50	.71	.93	.92	.85	2.12	32.19	.97	1.73	1.38	1.72	1.21	1.94

*Notes:* N = 92. †p < .10, \*p < .05, \*\*p < .01, \*\*\*p < .001. Velocity referent manipulation is coded 0 = below-referent condition, 1 = control condition.

**Table 2***Indirect Effect Results for the Tests of H2 and H3*

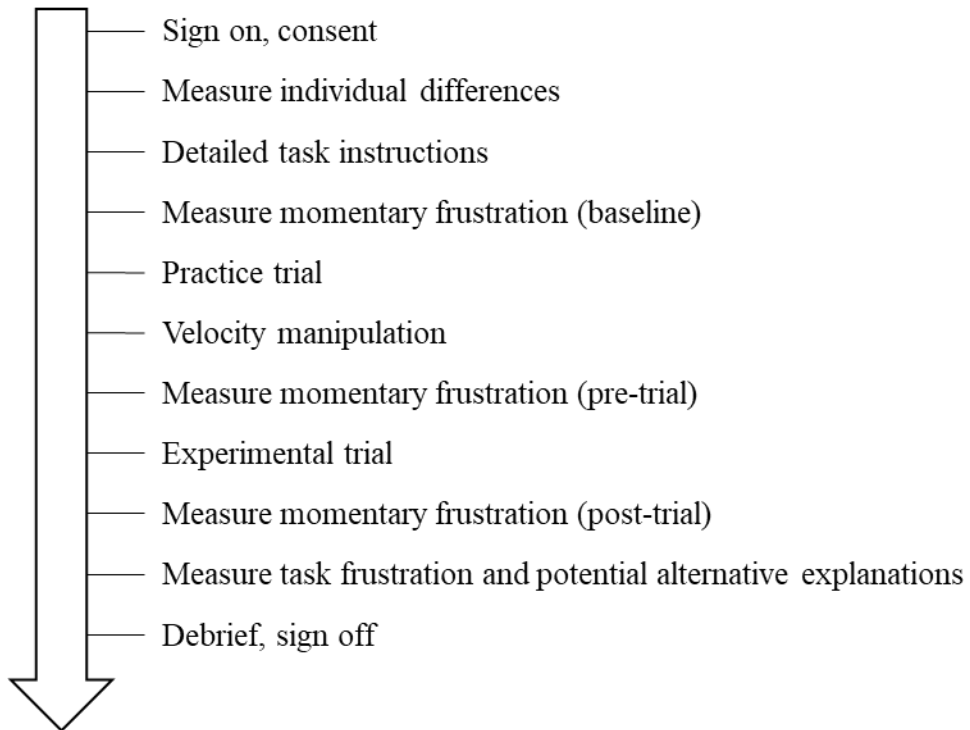
	Effect	95% Confidence Interval	
		LB	UB
Mediator: Momentary frustration			
DV: Accuracy	3.27	.05	9.46
DV: Effort	.02	-.09	.12
Mediator: Task-related frustration			
DV: Accuracy	5.87	.77	12.71
DV: Effort	.14	.02	.33

*Notes:* N = 92. DV = dependent variable. LB = lower bound. UB = upper bound.

**Table 3***Tests of Alternative Explanations for the Observed Results*

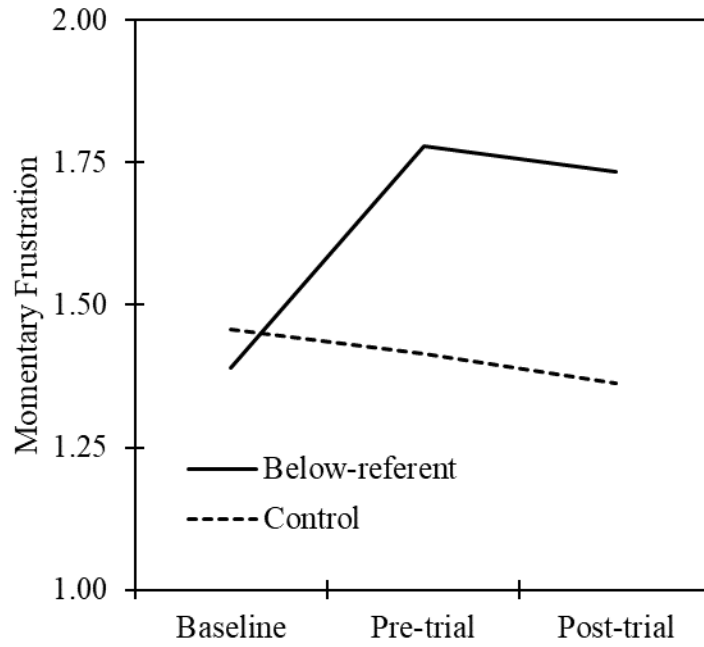
	Below-referent		Control		<i>t</i> (90)	<i>SE</i>	<i>p</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>			
Task enjoyment	3.22	1.72	3.21	1.77	.03	.36	.979
Perceived task difficulty	2.04	1.41	1.79	1.35	.89	.29	.374
Desire to earn money	2.54	1.73	2.38	1.71	.45	.36	.655
Fatigue	3.61	1.25	3.39	1.18	.85	.25	.396

*Note:* N = 92.

**Figure 1***Summary of Experimental Procedure Timeline*

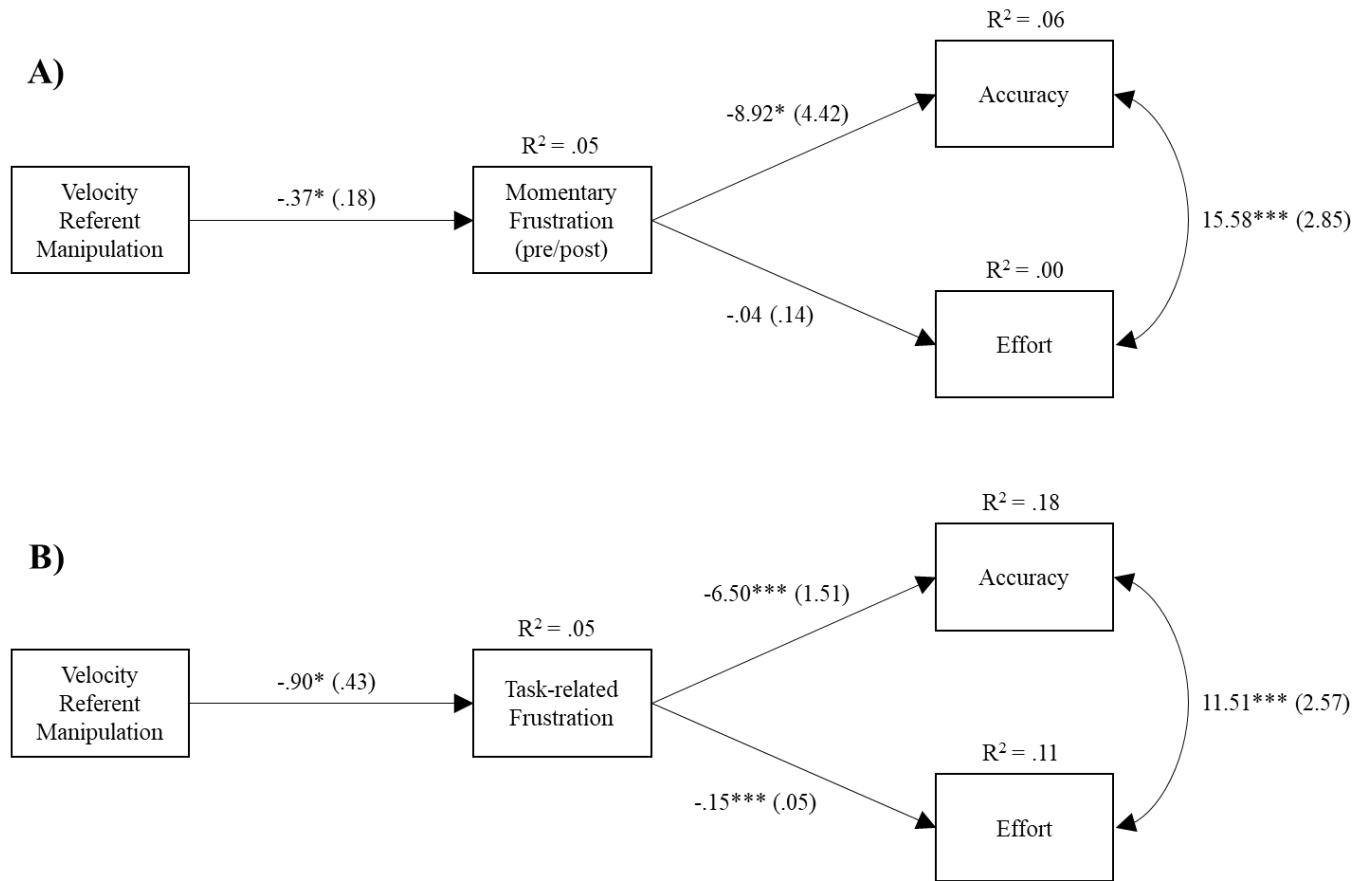
**Figure 2**

*Time by Condition Interaction on Momentary Frustration (Test of H1)*



**Figure 3**

*Regression Weights Used to Test (H2) and (H3)*



Notes:  $*p < .05$ ,  $***p < .001$ . Standard errors are reported in parentheses. Velocity referent manipulation coded: 0 = below-referent, 1 = control.

**Figure 4**

*Distinction between Actual Velocity and Velocity-Referent Discrepancies*

