Interpretation of Difficulty's Impact on Shifting and Inhibition Ability

by

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Abstract

Past research on identity-based motivation theory (Oyserman, 2007; 2009) has shown that people given an interpretation of difficulty as importance outperform those given an interpretation of difficulty as impossibility or those given no interpretation on school tasks (Smith, Novin, Elmore, & Oyserman, *under review*). Paul, Smith, and Oyserman (2013) suggested that working memory may be a mechanism underlying these effects. The current research aims to explore whether other components of executive functioning, namely shifting and inhibition, act as additional contributors to interpretation of difficulty effects. College students were randomized to one of three conditions (interpretation of difficulty as importance, interpretation of difficulty as impossibility, or no interpretation control) and worked on a measure of shifting (Study 1) and a measure of inhibition (Study 2). Across studies, we found no significant differences on our measures. Implications are discussed.

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Interpretation of Difficulty's Impact on Shifting and Inhibition Ability

Aspirations play a crucial role in individual development and achievement. Once students begin their university studies, the autonomy and onus to properly manage their time becomes primarily their own. But it is important that university students not only have aspirations to succeed, but are motivated to take the necessary steps to achieve their academic and professional goals and ultimately realize their possible selves, or who they hope to become (Oyserman & James, 2009). Unfortunately, successfully completing all of one's self-goals can be difficult. Some students have aspirations and are able to motivate themselves to achieve their goals, while others have aspirations but fail to attain what they want. Past research has shown that one way to motivate goal-focused action is by providing students with an interpretation of the difficulty they are likely to encounter. When difficulty is framed as a sign that effort on a particular goal is important (rather than pointless), action increased. The current research focuses on exploration of potential mechanisms behind these effects. Helping to understand the mechanism can help to understand other possible methods for addressing and reducing aspiration-attainment gaps.

Identity-Based Motivation and Interpretation of Difficulty

To understand the relationship between aspiration, motivation, and achievement, identity-based motivation theory suggests that people act in line with their accessible identities (Oyserman, 2007) and makes the prediction that immediate contexts can influence which identities are accessible in the moment (Oyserman, 2007, 2009). Moreover, the gap between people's aspiration and achievement may be partially due to how people interpret the difficulties they meet (Smith, Novin, Elmore & Oyserman, *under review*). According to Oyserman (2013), people interpret difficulty in two possible ways: people might think the task is hard and impossible, and thus give up, or people might think the task is hard but important, so they keep trying. Which interpretation people choose when they face difficulties is affected by what is accessible in the moment, and different interpretations contribute to different motivation and achievement outcomes.

Researchers have conducted a series of studies to test these predictions. In one experiment with low-income minority children, Oyserman, Gant, and Ager (1995) examined the relationship between participants' identity and academic achievement. Children were randomly assigned to do math problems before or after they were reminded of their racial-ethnic identity, which was described to be associated with academic achievement. Children performed better if their identity was made salient before completing the math task, which implies that identity can positively affect performance if it is accessible, relevant, and believed to be linked to positive outcomes. In the same way, a large body of research on stereotype threat (Steele, 1997) can be explained using similar logic; if the identity made accessible is not linked to likelihood of success and importance of a domain but instead the unlikelihood and impossibility of success, then performance will likely suffer. For example, having Black students indicate their race before taking a standardized test made negative stereotypes about their group's performance in that domain salient, negatively impacting performance (Steele & Aronson, 1995). Similarly, positive stereotypes can boost performance. In other words, when a salient identity is linked to the likelihood of and importance of success, performance should be positively impacted. For instance, when female engineering majors were alerted to a positive stereotype about their ability to do math, their performance on a subsequent math test was enhanced (Crisp, Bache, & Maitner, 2009).

Identity-based motivation also has implications for other domains as well, such as health. Oyserman, Smith, and Elmore (2013) focused on the effects of identity-based motivation on health. The authors suggested that how motivated people were to become healthy depended on how people interpreted the difficulty of attaining a healthy future identity. If they thought the difficulty was important for them to go through to become healthy, they should be more motivated than people who thought difficulty pursuing the goal of being healthy meant impossibility.

Recent evidence focuses directly on difficulty and suggests that interpretation of difficulty can be directly manipulated to increase motivation and performance. In set of studies, Smith et al. (*under review*) explored the interaction between interpretation of difficulty and performance on academic tasks. In Study 1, children who were given the framing of difficulty as importance reported more school focused possible selves and strategies to attain them than children who were given no framing. The groups did not differ in the number of non-school identities that were salient, showing effects were targeted. Additionally, children provided an importance framing of their difficulty performed better on a change-making task. In Study 2, participants given the framing of difficulty as importance performed better on a set of hard problems from Raven's Progressive Matrices Test than participants given the framing of difficulty as impossibility and control condition participants given no framing. A third study replicated these effects, with students who interpreted difficulty as importance writing better quality essays than children in the other two conditions. These studies demonstrated the effectiveness of the interpretation of difficulty primes and the benefits of interpreting difficulty as importance.

Interpretation of Difficulty and Working Memory

Given the recent results demonstrating how interpretation of difficulty matters, researchers have begun to explore potential mechanisms behind the IBM difficulty effects. Paul, Smith, and Oyserman (2013) proposed that recruitment of executive functioning resources, specifically working memory, might play an important role in explaining the above effects. Working memory is people's process of storing and manipulating information over a short period of time. Working memory capacity has been found to have a strong positive relationship with intelligence in previous research. A study by Friedman et al. (2006) found that working memory capacity explained 37% to 45% of the variance in intelligence measures. Also, better performance on tasks that required working memory resources was related to better performance on intelligence tasks as well. At the same time, working memory capacity has been shown to be positively related to problem solving skills. Seyler, Kirk, and Ashcraft (2003) conducted a study to explore how one's problem solving ability (specifically, performing subtraction) interacted with working memory. Results showed that when people had a higher working memory capacity, the percentage of calculation errors decreased, indicating better problem solving skills. Thus, having better working memory in the moment could lead to a better ability to sustain effort and be successful on difficult tasks.

Paul et al. (2013) predicted just that – when people were cued to interpret difficulty in a certain way, their performance on given tasks might improve because of a better ability to recruit working memory resources in the moment and focus and sustain effort on a task. If difficulty is interpreted as importance, then more effort is deemed necessary, meaning more cognitive focus should be devoted to a given task. If difficulty is interpreted as impossibility, then effort is not necessary, and one should quickly revert to being a cognitive miser on a given task, not desiring to expend the effort to devote more cognitive focus. The researchers tested this hypothesis by randomly assigning participants to one of three conditions (interpretation of difficulty as importance, interpretation of difficulty as impossibility, or a no interpretation control condition) and requiring participants to complete an “N-back” working memory task (Paul et al., 2013). The responses on the task were recorded and weighted by difficulty (i. e., how taxing the problem was on working memory). After controlling for baseline working memory score, results showed that participants in the difficulty as importance condition had better scores on the N-back task than participants in the difficulty as impossibility or control conditions, and there was no significant difference between performance in these latter two conditions. This suggests that better recruitment of working memory resources in the moment could be one possible explanation underlying interpretation of difficulty effects, which lead to better performance outcomes. While interesting, several questions still remain. Since working memory is not an isolated process but an integral part of larger executive functioning, what is the role of executive functioning as a whole? Further, what (if any) is the role of the other key components of executive function, namely, shifting and inhibition? Is it likely that effects from different components are separable and each makes a unique contribution to interpretation of difficulty effects?

Executive Functioning: Shifting and Inhibition

Executive functioning consists of processes that control and regulate thought and action. Executive functioning (EF) is typically thought to have three separable components: updating, shifting, and inhibition (Miyake, Friedman, Emerson, Witzki, & Howerter, 2000; Friedman et al., 2006). While there is some overlap between these components, each one makes unique contributions to our thought and action and is separable from the others. The previously mentioned research by Paul et al. (2013) focused on the updating component of EF. Updating is the ability to add new and remove irrelevant information from working memory (i. e., to update working memory). Tasks that examine updating ability include the keep track task and the letter memory task (Miyake et al., 2000), as well as the previously mentioned N-back task (Shelton, Metzger, & Elliot, 2007), which require participants to organize short-term working memory by taking in new information and eliminating irrelevant information.

Shifting is the ability to change mental operations between tasks in order to respond appropriately to given situations; for example, one may shift from one mental operation such as making a mathematical calculation to another mental operation like letter recognition. Tasks to test the shifting ability include the plus-minus task (Jersild, 1927), the number-letter task (Rogers & Monsell, 1995), and the local-global task (Miyake et al., 2000). These tasks all require participants to shift between different mental operations, like shifting between adding 3 and subtracting 3 to a series of digits, or between reporting numbers and letters.

Inhibition is the ability to inhibit the dominant response to a stimulus in order to respond to another stimulus simultaneously. For example, when participants are presented the word “green” in a black font, one may be required to report the color of the word (black) and resist the dominant response of reporting what the word actually says (green). Example tasks to assess inhibition ability are the antisaccade task (Roberts, Hager, & Heron, 1994), the stop-signal task (Logan, 1994), and the Stroop task (Stroop, 1935). When participants complete these tasks, they are asked to pay attention to stimuli and make responses that would not be their gut-reaction response. The earlier task described was an example of the Stroop task, in which words are names of color words that are presented in a different color than what the word describes (for instance, the word ‘blue’ may be written in red ink). Participants are asked to respond to the color of words while overriding their proponent response to read the words. In the antisaccade task, participants are required to ignore an initial stimulus and look in the opposite direction so that they do not miss a brief secondary stimulus. Here, one's dominant response would be to look at the initial stimulus, which would mean the second stimulus would be missed.

Interpretation of Difficulty and Executive Functioning

Experimental evidence has suggested that executive functioning is associated with performance on tasks that measure intelligence and academic performance. Brydges, Reid, Fox, and Anderson (2012) examined the relationship between EF and intelligence. Nine different tasks were used to assess different EF components (working memory, shifting, and inhibition), and four tasks were used to evaluate fluid intelligence (gF, such as reasoning ability) and crystallized intelligence (gC, information acquired through culture or other experiences). Researchers combined people's performance on working memory, shifting, and inhibition tasks and formed an overall score for EF, and analyzed the relationship of this score with gF and gC. Results showed that EF was highly correlated with both fluid and crystallized intelligence, and "specifically, executive functions explained 80% and 69% of the variance in gF and gC in children" (Brydges et al., 2012, p. 467), and explained 43% and 51% of the variance in gF and gC in young adults (Friedman et al., 2006). Thus, the researchers looked at the overall contribution of EF rather than the specific contribution of one subcomponent.

Executive functioning also matters for academic performance. In a study by Best, Miller, and Naglieri (2011), participants took part in the "Cognitive Assessment System", which was a standardized test that assessed children's cognitive function abilities, indicating executive functioning capabilities. Next, participants were given an achievement test to evaluate their reading, writing, and mathematical skills. Research found that there was a strong association between EF and academic achievement, and participants with higher EF capabilities reported higher academic achievement.

As a whole, executive functioning seems to be related to intelligence and performance on a variety of tasks. Similar results have been found looking just at the updating component of EF via working memory (Paul et al., 2013). This leads us to an important question: what is the role of shifting and inhibition in intelligence and academic performance? Research suggests that shifting is indeed related to intelligence and academic performance. Puric and Pavlovic (2012) showed that shifting ability was positively associated with fluid intelligence. Also, Yeniad, Malda, Mesman, van IJzendorn and Pieper (2013) conducted a meta-analysis of twenty studies to examine the relationship between shifting ability and children's performance on math and reading tasks, and found that there was a strong relation between shifting ability and performance. Additionally, evidence has shown that inhibition is associated with intelligence and school performance. Michel and Anderson (2009) found a correlation between inhibition ability and intelligence, such that as inhibitory processes became more efficient, intelligence increased as well. They further noted that the increase in intelligence over childhood can be explained at least in part by better inhibition ability, and that the antisaccade task, an inhibition task, can be used for intelligence training. Another study by Vuontela, et al. (2013) showed that inhibition was related to school performance such that children with more inhibition ability had better academic performance, less behavioral problems, and were happier. These studies above imply that shifting and inhibition play an important role in executive functioning and can lead to higher intelligence and better academic performance, just like working memory. Thus, it is very much possible that in addition to working memory, differences in shifting and inhibition may underlie differences in interpretation of difficulty effects, linking identity-based motivation and academic performance. In the current research, we directly test this idea, exploring whether shifting and inhibition are potential mechanisms that help explain the interpretation of difficulty effects.

For tasks to measure shifting and inhibition, we looked to the existing literature. Miyake et al. (2000) tested 3 measures of each of the 3 components of EF. Through structural equation modeling, Miyake and colleagues found loadings for each task on the underlying EF component it was designed to measure. According to Miyake et al. (2000), the plus-minus task had the highest loading on the underlying shifting component, in addition to the lowest error term compared to other shifting tasks. Similarly, the antisaccade task had the highest loading on the underlying inhibition component, and the lowest error term compared to other inhibition tasks. As a result, we decided to use the plus-minus and the antisaccade task as our measures of shifting and inhibition, respectively.

Current Studies

To test the relationship between the executive functioning components of shifting and inhibition and the identity-based motivation interpretation of difficulty effects, we conducted two studies to examine if different interpretations of difficulty can affect shifting and inhibition. In both studies, we manipulated participants' interpretation of difficulty. In Study 1, we use the plus-minus task to test interpretation of difficulty's effects on shifting ability. In Study 2, we use the antisaccade task to test interpretation of difficulty's effects on inhibition. In both cases, we predict that interpreting difficulty as importance will lead to better performance than no interpretation of difficulty or an interpretation of difficulty as impossibility.

Study 1

We predicted that different interpretations of difficulty would lead to performance differences on the plus-minus task, evidence for interpretation of difficulty's impact on the underlying 'shifting' component of executive functioning. Participants in the difficulty as importance condition should perform better (lower shift cost) on a shifting task versus those in the difficulty as impossibility and control conditions.

Methods

Sample and Procedure

Participants were from the University of Michigan Introductory Psychology Subject Pool (*N* = 198, 60% male, 62% freshman, 58% White, 16% Asian, 12% Black, 14% other), and earned course credit for their participation. Students came to the lab in groups of six for a study on problem solving and completed study materials on separate computers with large dividers between them. The study was run using Qualtrics software, which was programmed to randomize participants to one of three conditions, difficulty-as-importance (*n* = 67), difficulty-as-impossibility (*n* = 66), and no prime control (*n* = 65). After reading an informed consent, participants were exposed to an initial difficulty prime, followed by the first part of the plus-minus task. Next, participants saw another difficulty prime consistent with the one they previously saw followed by the second part of the plus-minus task, demographic questions, and debriefing.

Manipulation

Participants in the experimental conditions first read *Experiencing difficulty working on school goals can be thought of as signaling importance (impossibility). In other words, the school task you are working on is (not) worth your effort because it is important (impossible), and this can be a common occurrence for UM students. What about you? How many times have you had the feeling of difficulty as importance (impossibility) when it comes to school tasks or studying in the past month?* This prompt was followed by a 6-point scale (1-2 times to more than 11 times) for participants to respond. By using a scale with low frequencies, participants should feel that they frequently experience difficulty as importance (impossibility) more than others (Rothman, Haddock, and Schwarz, 2001).

After the first part of the plus-minus task, participants were exposed to a second prime congruent with the first. Experimental condition participants rated their agreement to a set of 4 biased statements that led participants to endorse an interpretation of difficulty as importance or impossibility, depending on condition (Smith et al., *under review*). Participants in the difficulty as importance condition rated agreement to statements such as *Sometimes, you have to work really hard in order to be successful at a school task and there's nothing wrong with that. Having to work hard at a task means it is important* (1 being strongly disagree, 5 being strongly agree). Participants in the difficulty as impossibility condition were asked to rate their agreement with statements such as *When you're stuck on a school task, it is a sign that your effort is better spent elsewhere* on a 5-point scale (1 = strongly disagree to 5 = strongly agree). Control condition participants proceeded directly to the dependent variable without interruption.

Measures

To assess participants shifting ability under different interpretations of difficulty, we examined shift cost as our dependent variable via the plus-minus task. To measure participants' shift cost, they completed three sets of arithmetic problems. On the first set, participants were given a list of 30 two-digit numbers (10-99, pre-randomized without replacement) and had to add 3 to each number and input their answers next to the original. On the second set, participants were given a different list of two-digit numbers and were instructed to subtract 3 from each number and input their answers. Time to completion on both of these sets was recorded separately. Finally, on the third set, participants were required to alternate between adding 3 to and subtracting 3 from the numbers (i.e., add 3 to the first number, subtract 3 from the second number, and so on) and time data was recorded. The change from addition to subtraction and back constituted a mental 'shift'. In order to calculate the cost of shifting between the operations of addition and subtraction, we averaged the time on the first two sets and subtracted from it time on the final set of problems (time on set 3 minus average time on set 1 and 2). We removed one participant in the difficulty as impossibility condition who failed to effortfully complete the measures (the participant answered "1" or "4" for all arithmetic problems).

We also asked participants at the end of the study *On the last set of problems, you were asked to alternate between addition and subtraction. Did you follow directions and alternate, or did you do all the addition problems by skipping every other problem and then go back and fill in the subtraction problems (or vice versa)?* Fifteen participants (four in the difficulty as importance condition, seven in the difficulty as impossibility condition, and four in the control condition) reported not following directions by not alternating between addition and subtraction on the final set of problems, so they were removed from the final analyses ($N = 182$). We first looked at accuracy. Participants' accuracy on the addition block ($M = 98\%$, $SD = .03$) was not different from the accuracy on the subtraction block ($M = 98\%$, $SD = .04$), $t(181) = -1.464$, $p > .1$. Participants' accuracy on the switching block ($M = 89\%$, $SD = .22$) was significantly lower than the accuracy on the addition block, $t(181) = -4.678$, $p < .001$, and the subtraction block, $t(181) = -5.724$, $p < .001$. Average time in seconds on the addition ($M = 76.17$, $SD = 21.90$) and subtraction ($M = 76.42$, $SD = 23.50$) blocks were not different from each other, $t(181) = -.225$, $p > .8$. Average time on the first 2 blocks ($M = 76.30$, $SD = 21.42$) involved no shift in mental processes but time on the third block ($M = 88.13$, $SD = 26.12$) did. Participants did take longer on the final set than the initial sets, indicating the final set was more difficult and likely did indeed involve an effortful mental shift of operations $t(181) = -29.41$, $p < .001$. Finally, we computed shift cost by subtracting the shift time from the average time on the first 2 blocks from response time on the third block (*M* = -11.84, *SD* = 15.54, the more negative the number, the worse participants were at shifting). Also, we were able to assess accuracy on each set. We ultimately decided to remove participants whose accuracy was less than one standard deviation from the mean (*n* = 23). Time spent on each block was similar after removing theses participants (addition block time *M* = 75.62, *SD* = 21.42; subtraction block time *M* = 76.07, *SD* = 23.30; switch block time *M* = 85.84, *SD* = 23.89; shift time *M* = -9.99, *SD* = 14.37). In addition, we asked participants to indicate how easy they found the task to be (1 = very easy to 7 = very hard, *M* = 3.58, *SD* = 1.58) and how hard they tried to answer the problems correctly (1 = I did not try at all to 7 = I tried very hard, *M* = 6.43, *SD* =.87).

Analyses

As mentioned, shift cost was calculated for each participant. We looked for differences on our dependent measure based on gender, year in school, race, how easy or hard the participants felt the task was, how hard they tried, and their total accuracy on the three blocks. According to an analyses of variance (ANOVA), gender ($F(1, 157) = .037$, $p = .847$) and year in school (coded as freshman vs. other, $F(1, 157) = .018$, $p = .895$) did not significantly influence our shift cost results. However, race had an effect, $F(1, 157) = 5.67$, $p = .018$, with Whites doing better than non-Whites. Also, the percentage of correct responses was not significantly different across conditions (difficulty as importance, *M* = 97.3%, *SD* = 3.5%; difficulty as impossibility, *M* = 97.6%, *SD* = 3.1%; control condition, *M* = 98.1%, *SD* = 2.2%; $F(1, 156) = .980$, $p = .378$). Using regression analyses, how hard the participants tried did not affect their shift time, (standardized $B = .095$, $p = .233$), while how easy or hard participants' found the task influenced shift cost (standardized $B = -.304$, $p < .001$, those who found the task easier had a higher shift cost).

Results

Looking solely at the effects of our prime on shift cost, as depicted in Figure 1, there was no significant influence of our interpretation of difficulty primes on participants' shift cost, $F(1, 156) = .621$, $p = .539$. Controlling for the influence of race and how easy or hard the participants felt about the task, the analysis still did not reach significance, $F(2, 154) = .384$, $p = .682$. Thus, the results do not support our hypothesis that priming different interpretations of difficulty results in different shifting performance.

Discussion

We hypothesized that participants in the difficulty as importance condition would perform the best (having the smallest shift cost) on the plus-minus task, participants in the difficulty as impossibility condition would perform the worst, and participants in the control condition would be somewhere in the middle. However, results showed that there was no significant effect of different interpretations of difficulty on performance on the plus-minus shifting task. While a number of factors might be at play in our non-significant results, one might have been the difficulty of the task itself. When asked how easy or hard the task was, participants on average responded that the task was "neither easy or hard". Without sufficient difficulty, interpretations of difficulty have little application. We return to this in the general discussion. Also, it is possible that the plus-minus task is not a very sensitive task to measure shifting ability. In the task, people switch between addition and subtraction, which are two mathematical operations that are not dramatically different from each other; a switch to something such as verbal ability might constitute more of a change from mental arithmetic calculations. The switch cost caused from switching between addition and subtraction may not have been a large enough "shift". Alternatively, it could just be the case that shifting, as one of the processes of executive functioning, is not part of the mechanism that explains the interpretation of difficulty effects. In Study 2, we further explored if inhibition, as another component of EF, would help shed some light on interpretation of difficulty effects. We hypothesized that interpretation of difficulty would affect people's inhibition ability.

Study 2

We predicted that interpreting difficulty as importance would lead to better performance on an antisaccade task, a measure of the executive functioning component of inhibition. We expected participants who were primed with difficulty as importance would outperform those primed with difficulty as impossibility and people who were in the control condition, showing faster reaction time because of a better ability to inhibit and refocus attention.

Methods

Sample and Procedure

Participants (*N* = 197, 72.1% female, 54.8% freshman, 60.4% White, 23.9% Asian, 4.5% Arab, and 11.2% other) were recruited from the University of Michigan Introductory Psychology Subject Pool, and earned course credit for their participation. Students came to the lab in groups of six and sat at separate computers to complete the study as in Study 1. Before the study started, the experimenter randomly assigned participants to one of three conditions, interpretation of difficulty as impossibility (*n* = 66), interpretation of difficulty as importance (*n* = 65), or a no prime control (*n* = 65). After reading informed consents, participants were asked to complete a problem-solving task on the computer using E-Prime software. Once they started the program, they were given instructions and practice trials of the antisaccade task (described below).

Following practice trials were the primes, followed by the actual trials of the antisaccade task. Finally, participants completed demographic questions and debriefing.

Manipulation

As in Study 1, experimental condition participants rated their agreement to a set of 4 biased statements. Prior work has shown these sets of questions effectively cue interpretations of experienced difficulty as importance or impossibility (Smith et al., *under review*). As before, control condition participants proceeded directly to the dependent measure without interruption.

Measures

Our dependent measure was the antisaccade task. Participants were asked to complete 5 antisaccade practice trials and 80 actual trials as quickly and accurately as they could. In each trial, a fixation point '+' first appeared in the middle of the computer screen for a set amount of time (randomized times between 1500 ms and 3500 ms in 250 ms intervals). A black square was then presented on one side of the screen for 225 ms. Then, a target stimulus, which was an arrow inside an open square, appeared on the opposite side of the screen for 150 ms before being covered by a larger gray square. The participants' task was to indicate the direction of the arrow (right, left, up, or down) using the arrow keys on the keyboard as quickly as possible. Since the arrow appeared for only 150 ms before being masked, participants would need to inhibit the dominant response of looking at the initial stimulus (a small black square) because doing so would make it difficult to identify the direction of the target stimulus correctly. The response time on each trial and total accuracy were recorded using the E-Prime software to indicate how well participants could inhibit.

We also asked participants at the end of the study *What did you think this study was about?* Four participants in the difficulty as impossibility condition effectively guessed the main purpose of the study, so they were removed from the final analyses (*N* = 193)[1]. Excluding these participants, we computed the participants' average response time in milliseconds on the 80 antisaccade trials (*M* = 383.14, *SD* = 76.71). In addition, we asked participants how easy or hard they found the task (1 = very easy to 7 = very hard, *M* = 1.79, *SD* = .96).

Analyses

As mentioned, total accuracy and average response time on actual antisaccade trials that participants responded correctly to were calculated for each participant. We looked for differences on our dependent measure based on gender, year in school, race, and how easy or hard the participants found the task. According to an analysis of variance (ANOVA), year in school (coded as freshman, others), $F(1, 190) = 1.45$, $p = .230$, and race (coded as White, other), $F(1, 191) = .75$, $p = .389$, did not significantly influence our response time results. However, gender had an effect, $F(1, 191) = 10.06$, $p = .002$, with females doing better than males. Using regression analyses, how easy or hard participants' found the task marginally influenced response time (standardized $B = .134$, $p = .079$)[2].

Results

Looking just at the effect of our experimental manipulation, there was no significant influence of our interpretation of difficulty primes on participants' response time on the antisaccade trials, $F(2, 190) = .045$, $p = .956$[3] (see Figure 2). Controlling for gender and how easy or hard participants thought the task was improved the analysis, but results were still not

[1] The same pattern of result is observed leaving these participants in the analysis.
[2] Twenty-one people did not respond to this measure, so cannot be included in the analysis that used this variable as control.
[3] In addition, we tried excluding the participants whose time was two standard deviations above the mean, indicating they may not have paid attention, but this did not affect the results, $F(2, 180) = .385$, $p = .681$.

significant, $F(2, 167) = .092$, $p = .912$. Thus, the results do not support our hypothesis that giving participants different interpretation of difficulty primes leads to different inhibition ability.

Discussion

We predicted that interpretation of difficulty matters for inhibition ability and performance on an inhibition task, the antisaccade task. However, results showed that there was no significant effect of our manipulation on people's inhibition ability. Similar to Study 1, it could be possible that the task used did not induce sufficient difficulty, and therefore the effect of our difficulty primes on performance was not seen. In Study 2, most people actually thought that the antisaccade task was fairly easy, with the average response being "easy". As a result, the interpretation of difficulty may not have affected performance because there was no difficulty to interpret. Also, the antisaccade task has been widely used with children (Aman, Roberts, & Pennington, 1994) and patients with prefrontal lesions (Guitton, Buchtel, and Douglas, 1985). It may not have been the best task to assess adults' inhibition ability because adults without impairment may find it too easy, and therefore the task is not sensitive enough to show changes in inhibition ability.

General Discussion

The goal of the current study was to examine the mechanism behind the identity-based motivation theory interpretation of difficulty effects. These effects demonstrate that different accessible interpretations of difficulty can lead to different future identities and different performance on relevant tasks (Smith et al., *under review*). In addition, these effects help shed light on a potential explanation for the gap between aspirations and achievement. Empirical evidence suggested that executive functioning was related to intelligence task performance and academic performance (Brydges et al., 2012; Puric & Pavlovic, 2012; Vuontela, et al., 2013), implying that executive functioning could be an explanation of performance differences under different interpretations of difficulty. Executive functioning includes three components: updating, shifting, and inhibition (Miyake et al., 2000; Friedman et al., 2006). Paul et al. (2013) found that updating ability was influenced by interpretation of difficulty manipulations. We predicted that the shifting and inhibition components of executive functioning would also be part of the mechanism that explains the gap between aspirations and achievement and contributes to interpretation of difficulty effects.

When people are primed with an interpretation of difficulty as importance, we predicted they should outperform people who were primed with an interpretation of difficulty as impossibility and those receiving no prime on tasks assessing their shifting and inhibition abilities. Unfortunately, our results did not support our hypotheses. In Study 1, there was no significance difference in the shifting performance among participants in the difficulty as importance, difficulty as impossibility, and the control conditions. Participants' shift time on the plus-minus task was not affected by different interpretations of difficulty. Results of Study 2 showed that our difficulty interpretation manipulation did not influence people's inhibition ability either. Participants' ability to inhibit, measured by averaging reaction times across 80 antisaccade trials, did not differ between our three conditions.

The current study did not support our prediction. This could be due to several potential issues. First, there may have been problems with the measures we chose in our studies to test our theory and hypotheses; second, our hypotheses might not have held true in these conditions; third, there may have been crucial study implementation issues. First, our measures might not have adequately tested our theory and hypothesis. In short, the tasks we chose, the plus-minus task and the antisaccade task, may not have induced a sufficient level of difficulty for participants. Smith et al. (*under review*) pointed out that interpretation of difficulty would make a difference only if the task is difficult. In their second study, they found effects of interpretation of difficulty on a difficult set of reasoning problems but not on an easy set of problems. When we asked participants how hard they felt the tasks were in Study 1 and Study 2, most participants thought the tasks were fairly easy. Additionally, accuracy in both studies was fairly high. If participants did not find the tasks difficult enough, interpretation of difficulty and identity-based motivation would not predict a change in their task performance, and therefore we would not be able to identify any significant changes in shifting and inhibition ability.

In support of the idea that the measures may not have induced a sufficient feeling of difficulty, some studies (Guitton et al., 1985) used the antisaccade task specifically with adult patients that had frontal lobe lesions. For this population, the antisaccade task was found to be sensitive in measuring their inhibition performance. Moreover, studies have also used the antisaccade task as an effective measure of inhibition with children who may also have other cognitive deficits, rather than adults (Aman et al., 1994). It is reasonable to assume that our college student sample surpassed both patients with brain lesions and children in terms of cognitive ability and inhibition skills. Rober et al. (1994) did successfully use the antisaccade task with college participants, but their participants performed a measure of working memory at the same time, making both tasks much more difficult. Thus, while this may be a good task for some populations, it may have simply been too easy for ours. In other words, since the participants in the current study are college students, the antisaccade task might not be sensitive enough to show performance differences.

There is also reason to cast doubt on previous research using the plus-minus task. These studies tend to be plagued by small sample sizes. For instance, several studies have used this task to test various topics relating to mental shifting, but all with small samples. Baddeley, Chincotta and Adlam (2001) had 12 to 36 participants in their experiments, Spector and Biederman (1976) recruited 12 to 48 participants, and Emerson & Miyake (2003) had 48 to 72 participants split across at least two conditions. Thus, the relationship between the plus-minus task and shifting ability in college students may not have as convincing support from the literature as it seemed to have initially.

In addition, our choice of the plus-minus and the antisaccade task may have been problematic because analyses in Study 1 and Study 2 showed that race and gender differences were present. In Study 1, there was a race difference on performance on the plus-minus task, with Whites outperforming non-Whites. In Study 2, gender influenced the performance on the antissacade task such that females did better than males. To our knowledge, race and gender differences were not observed in other studies that used these tasks. This indicates that previous studies likely used samples too homogenous to tease apart group differences that may have been present in our studies. Furthermore, it is likely that whatever group differences we did find in our study cannot be fully understood because even our samples were overwhelmingly White and female. Nonetheless, the existence of meaningful group differences may have helped mask any potential effect we could have found, undermining our observation of the effects of identity-based-motivation on shifting and inhibition.

Secondly, our predictions in the current studies were not supported possibly because shifting and inhibition, as parts of executive functioning, do not actually help explain the performance differences when college students have different interpretations of difficulty. In our study, the executive functioning tasks we chose may not be able to explain changes in performance since the relationship between executive functioning and intelligence is not as clear with this population. Brydges et al. (2012) pointed out that the relationship between executive functioning and intelligence changes with age. In children, executive functioning explained 80% and 69% of the variance in gF and gC (Brydges et al., 2012), while executive functioning explained only 43% and 51% of the variance in gF and gC in young adults (Friedman et al., 2006). Thus, as we get older, intelligence becomes less associated with executive functioning. The participants in our study were all college-aged, likely around 20 years old, and the relation between their executive functioning and intelligence was probably weaker than that of participants in the Smith et al. (*under review*) study, who focused on children in 4th to 8th grade. It is possible that the interpretation of difficulty primes affected our participants' executive functioning, but since the effect of executive functioning on intelligence was weaker, there was no significant change in our participants' task performance. If any potential effect was smaller than expected, we may not have had the power to detect meaningful differences.

It is also possible that shifting and inhibition may not be as important as working memory in explaining the effects of identity-based motivation theory on people's intelligence and task performance. Working memory has been shown to be closely associated with intelligence (Friedman et al., 2006; Salthouse, Atkinson, & Berish, 2003; Ackerman, Beier, & Boyle, 2005). However, findings on the relations between intelligence and shifting, and between intelligence and inhibition are a bit more mixed. Some studies show that intelligence is related to shifting (Puric & Pavlovic, 2012; Salthouse et al., 2003) and inhibition (Salthouse et al., 2003; Michel and Anderson, 2009), whereas some studies indicate that there is a much weaker association between shifting and intelligence (Friedman et al., 2006; Rockstroh & Schweizer, 2001) and between inhibition and intelligence (Friedman et al., 2006). We can reasonably conclude that all three components of executive functioning are related to intelligence and academic performance, but it is likely the relationship with working memory is much stronger and consistent than the relationship with shifting and inhibition. Again, if this is the case, this would make the likelihood of seeing significant results in our studies much smaller.

Moreover, as previously mentioned, previous studies have used the plus-minus task and the antisaccade task with college students to measure the change in shifting and inhibition abilities, and college students were the sample in our study. Yet the interpretation of difficulty effects we were testing were based on findings that different interpretations of difficulty affected children's task performance (Smith et al., *under review*). Since the sample of the current study was college students and the sample of previous study was children, it is possible that this disconnect hindered our ability to see significant results.

Finally, we made no prediction about the size of the effect we were looking for. It is very possible that the size of the effect was too small to identify with our sample size. Additionally, we ran the study in a room with six participants at the same time. Participants took different amounts of time to complete the study, and left the study room accordingly. Since these are sensitive measures of executive functioning components, people leaving earlier than other participants may have unknowingly hurt others' performance. The distraction and noise in the room created by participants leaving at different times may have negatively impacted the performance of those still working. We did not have a measure of total time spent on the study or who finished first or last in a study session, but these might prove to be useful factors to examine in the future.

Despite these limitations, our study adds value to the exploration of the mechanism behind the identity-based motivation theory interpretation of difficulty effects, and has several implications for future research. The current study did not support our hypothesis. This implies that updating is probably the main part of executive functioning that explains the performance effects behind the identity-based motivation theory (Paul et al., 2013). Still, we may not have seen significant results due to various factors. As we discussed earlier, interpretation of difficulty does not influence task performance unless the task is hard, and our tasks were easy for the participants. Future studies should consider harder tasks that ensure the interpretations of difficulty can have impact. In addition, the plus-minus and the antisaccade task had mixed results with college students, and people's performance on these tasks varied with gender and race. In order to further investigate the relation between the identity-based motivation theory effects and shifting and inhibition abilities, future research can improve upon the current studies namely by using tasks of shifting and inhibition that properly test the theory regarding difficulty with an appropriate age group and sample. Recruiting more participants could also be a good idea, as could tightening study implementation so as to reduce distraction among participants while performing the tasks.

In conclusion, our prediction was not supported that interpreting difficulty as importance would lead to better performance on a shifting task and an inhibition task than no interpretation of difficulty or an interpretation of difficulty as impossibility. Thus, we did not find a significant relationship between different interpretations of difficulty and shifting and inhibition abilities. Previous research, though, has shown that at least one component of executive functioning, namely updating as measured by working memory, has yielded positive results in understanding interpretation of difficulty effects. Nonetheless, future studies are needed to solidify this relationship and further test the predictions suggested in this paper. Creating a complete picture of the relationship between executive functioning and interpretation of difficulty effects is an important step in indentifying ways to address the gap between aspirations and achievements, and help students to reach their goals.

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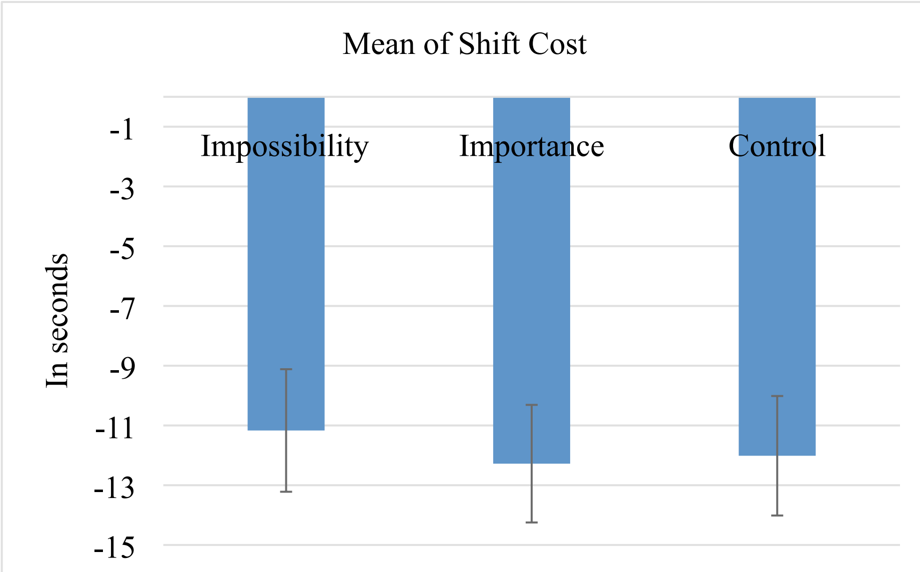

Figure 1. Study 1: Effects of Interpretation of Difficulty on Shifting Abilities
Participants were randomized to one of three conditions: difficulty means importance, difficulty means impossiblity, or a no difficulty control condition. Participants'shift cost in seconds was calculated by subtracting completion time on trials where there was no shift from a trial where a shift was required, with larger numbers indicating less shift cost and better shifting ability. No significant condition differences were found, $F(1, 156) = .621$, $p = .539$.

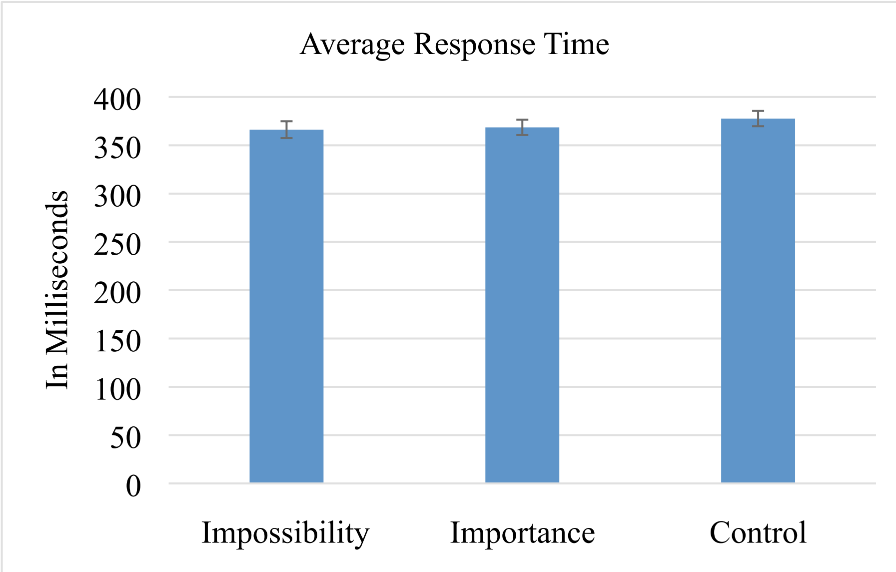

Figure 2. Study 2: Effects of Interpretation of Difficulty on Inhibition Abilities
Participants were randomized to one of three conditions: difficulty means importance, difficulty means impossiblity, or a no difficulty control condition. Participants' response time on the antisaccade task was measured in milliseconds, with longer response times indicating worse inhibition performance. No significant condition differences were found, $F(2, 190) = .045$, $p = .956$.