THE PERCEPTION OF MULTITASKING

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ABSTRACT

THE PERCEPTION OF MULTITASKING

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Multitasking is pervasive. With technological advancements, the desire, ability, and often necessity to engage in multiple activities concurrently are paramount. Although multitasking refers to the simultaneous execution of multiple tasks, most activities that require active attention cannot actually be done simultaneously. Therefore, multitasking is often a matter of perception. Unlike previous literature, I study how the exact same activity can be perceived as multitasking or single-tasking. This work is important because many activities in our lives can be perceived as multitasking or single-tasking and this has implications for performance and engagement. The first chapter of this dissertation demonstrates the malleability of people's multitasking perceptions. That is, I explore different factors that make individuals perceive the same activity as multitasking or single-tasking. In seven studies, I identify different ways of separating an activity into its components to make people feel like they are multitasking. The second, focal chapter of this dissertation explores how the mere perception of multitasking impacts performance across many domains. Across 29 studies ($N = 7{,}880$), I find that the perception of multitasking improves performance compared to the perception of single-tasking, holding the activity constant. The third chapter of this dissertation identifies the mechanism underlying this effect, engagement, using a physiological measure of engagement. In seven studies, I show this increase in engagement is a result of the perceived difficulty of multitasking and rule out rival accounts. The fourth chapter presents an internal meta-analysis in addition to examining key moderators. I conclude with implications and next steps.

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INTRODUCTION AND OVERVIEW

In today's society, multitasking is an integral part of daily life (e.g., Ophir, Nass, & Wagner, 2009). People frequently engage in two or more tasks simultaneously, like switching between tabs on computers and smartphones, checking email and social media, and surfing the web. A recent survey of consumers' mobile habits reported that individuals frequently use their smartphones while watching a movie, during a dinner date, and even at church (Jumio, 2013). Multitasking is also prevalent in the workplace, where most environments necessitate working under time pressure on several tasks simultaneously (Kreckler et al., 2008). Additionally, workers' attention is frequently torn between their primary task and interruptions and distractions (Goes et al., 2017; O'Conaill & Frohlich, 1995).

Aside from the prevalence of multitasking, the ability to multitask is seen as a highly desirable trait (Wang & Tchernev, 2012). In a survey I conducted, with 434 participants (sampled on age, income, and gender to reflect the US population), I found that 84% of participants reported that the ability to multitask is an important trait to have, and 93% said they could multitask better than or as well as the average person (see Table 1).

Table 1: Survey results from representative sample are broken down by gender, age, and income. Percentages represent the number of participants who selected a certain response within a specific demographic category.

	% of sample	How capable do you think you are at multitasking compared to an average person? (1 Much worse, 4 About the same, 7 Much better) **% chose ≥ 4**	To what extent do you believe that the ability to multitask is an important trait to have? (1 Not at all important, 4 Neither important nor unimportant, 7 Extremely important) **% chose > 4**	In your day-to-day life, on average, how frequently do you multitask? (1 Never, 4 Sometimes, 7 Always) **% chose 6 or 7**
Overall	100%	93.32%	84.10%	47.00%
Gender				
male	49.77%	92.59%	80.09%	39.35%
female	50.23%	94.04%	88.07%	54.59%
Age				
18-24 years[1]	4.84%	95.24%	100.00%	61.90%
25-34 years	20.51%	94.38%	89.89%	60.67%
35-44 years	18.20%	97.47%	93.67%	60.76%
45-54 years	20.05%	93.10%	82.76%	49.43%
55-64 years	16.82%	95.89%	80.82%	35.62%
65+ years	19.59%	85.88%	69.41%	23.53%
Income				
under $15k	12.21%	92.45%	83.02%	33.96%
$15k-$25k	11.29%	87.76%	81.63%	55.10%
$25k-$35k	10.60%	93.48%	91.30%	41.30%
$35k-$50k	13.13%	92.98%	85.96%	45.61%
$50k-$75k	22.58%	91.84%	78.57%	46.94%
$75k-$100k	11.52%	98.00%	84.00%	58.00%
$100k-$150k	11.75%	96.08%	84.31%	47.06%
$150k+	6.91%	96.67%	93.33%	50.00%

Given the ubiquity and desirability of multitasking, it is unsurprising that multitasking has been studied extensively. Early research on multitasking studied how working concurrently on two or more tasks affects human performance on various

[1]Although 11% of the US population is between 18 and 24 years old, due to sampling error, this group is underrepresented in the sample.

activities (Borger, 1963; Creamer, 1963). This research found that, when working on multiple non-automatic tasks, individuals cannot actually perform the tasks simultaneously but rather alternate between different activities, engaging only in a single task at a time (Kieras et al., 2000; Pashler, 1994). The literature proposes several reasons for human's inability to multitask. On a neurological level, there are cognitive processing and working memory limitations on the number of thoughts that can be held at once (Miller & Buschman, 2015; Tombu et al., 2011). From a psychological perspective, people's attention is limited and they can only focus on one task at a time without experiencing some slowing in behavior and thinking (Leroy, 2009; Levy & Pashler, 2001; Pashler, 1994).

Since people cannot actually perform two or more non-automatic tasks at the same time, when people believe that they are multitasking, they are in fact switching back and forth between tasks. Thus, while the definition of multitasking (which originated in the computer engineering field; Witt & Lambert, 1965) is the simultaneous performance of more than one task, multitasking in humans has more to do with subjective perceptions. Therefore, even though people might be working on exactly the same task, they can perceive this activity as multitasking or single-tasking.

This dissertation studies the *perception* of multitasking, holding the actual activity people work on constant. I argue that in some situations shifting back and forth between two tasks may be perceived as multitasking but in other situations the same activity is associated with a single task. Furthermore, I argue that many complex activities can be broken down into their components to feel like multitasking. Chapter 1 explores and demonstrates the malleability of peoples' perceptions of how they construe their activity.

Specifically, I explore different factors that make people construe a certain activity as either multitasking or single-tasking. Chapter 2 examines how the mere perceptions of multi- and single-tasking influence actual performance on the activity, which is the central finding of this dissertation. Unlike previous literature that found that trying to multitask was detrimental to performance, I hold the workload constant across conditions and find that the perception of multitasking improves performance. Chapter 3 examines engagement as the underlying mechanism of this improvement in performance. Additionally, I explore different psychological drivers of how and why the perception of multitasking increases engagement. Finally, Chapter 4 presents an internal meta-analysis of the effect of the perception of multitasking on performance. This dissertation concludes with implications and future directions for this work.

CHAPTER 1: FACTORS INFLUENCING THE PERCEPTION OF MULTITASKING

Multitasking is traditionally defined as the performance of multiple tasks at one time; Merriam-Webster's Dictionary, 2018). Based on this definition, I argue that an activity may be construed as multitasking if individuals feel (i) they are working on more than one task, and (ii) that the tasks are done simultaneously. That is, in order for a person to perceive their activity as multitasking they must think that they are working on multiple tasks simultaneously. Even if an individual construes their activity as composed of multiple tasks, they still can perceive it as single-tasking if, for example, they feel they are working on the tasks sequentially. I term these conditions for the perception of multitasking the principles of separation and simultaneity, respectively.

In this chapter, I identify several factors that make people perceive that they are working on two tasks simultaneously. In Studies 1 and 2, I test the principle of separation by examining factors that create separation in the components of an activity such as different topics and sources (i.e., where content is coming from). In Study 3, I test the principle of simultaneity by examining how switching frequency can make people feel like they are engaging in two tasks simultaneously. Finally, in Study 4, I apply both principles to illustrate how they can shift the perception of paradigms that will be employed later in this dissertation.

STUDIES 1A AND 1B: RELATEDNESS OF TOPICS INFLUENCE THE PERCEPTION OF MULTITASKING

As discussed above, I hypothesize that, if a person is working on two tasks at the same time, making them feel as if those two tasks are distinct will trigger the perception of multitasking. Inversely, if a person is working on two tasks at the same time, making them feel as if they are not distinct will trigger the perception of single-tasking. One way to make two tasks feel distinct is by manipulating how related the topics are. For example, imagine you are shopping online and are searching for a kitchen appliance by switching back and forth between multiple tabs on your computer. If the tabs all have content relating to the same product category (e.g., coffee makers), then you probably would feel like you are engaging in a single-task. However, if the tabs have products that relate to different categories (e.g., coffee makers and blenders), then you would probably feel more like you are engaging in multitasking. Studies 1a and 1b establish that the relatedness of two tasks' topics can affect one's perception of an activity as multitasking or single-tasking. Importantly, I hold constant information about the simultaneity of the activity in order to isolate the principle of separation.

Study 1a: Method

One hundred and seven participants (43% female, age= 36.35 years) were recruited from Amazon's Mechanical Turk. Participants in this study, and all subsequent studies, provided informed consent and were aware that participation was voluntary. Participants were assigned to one of two framing conditions in order to assess the impact of topic on the perception of multitasking. In the multitasking condition, participants read the following:

> *Imagine you have two tabs open on your web browser. In one tab, you're emailing your friend a list of restaurants you want to try with them. In the other tab, you're reading reviews about movies. You switch back and forth between the two tabs*.

In the single-tasking condition, the description was identical except the second tab contained content relating to the first tab.

> *Imagine you have two tabs open on your web browser. In one tab, you're emailing your friend a list of restaurants you want to try with them. In the other tab, you're reading reviews about the same restaurants. You switch back and forth between the two tabs.*

After participants read one of the two scenarios, they responded to two items intended to capture the perception of multitasking. Specifically, participants indicated (i) whether they perceived this activity to be a single-task or multitasking activity? (Single-task activity, Multitask activity) (ii) the extent to which they perceived this activity as either single-tasking or multitasking activity (1 Definitely Single-tasking, 7 Definitely Multitasking).

Results

Of the participants in the multitasking condition, 96.2% felt like they were multitasking, while only 51.9% of particiants in the single-tasking condition felt they were multitasking ($\chi^2_{(1, N= 107)} = 27.26$, $p < .001$). Participants in the multitasking framing condition also reported that they felt like they were multitasking ($M = 6.04$, 95% CI = [5.60, 6.48]) to a greater extent than those in the single-tasking condition ($M = 4.19$, 95% CI = [3.75, 4.62]; $F(1, 105) = 35.69$, $p < .001$).

Study 1b: Method

Ninety-five participants (43% female, age = 37.06 years) were recruited from Amazon's Mechanical Turk and like Study 1a were assigned to one of two framing conditions. In the multitasking condition, participants read the following:

> *Imagine that you are at work. You have to prepare a written proposal for a new product and an unrelated presentation. You work quickly on both tasks to finish them in next hour.*

In the single-tasking condition, the description was identical except the two tasks were presented as one task with related components:

> *Imagine that you are at work. You have to prepare a written proposal and a presentation for a new product. You work quickly on the task to finish it in the next hour.*

After participants read one of the two scenarios, they responded to the same two items intended to capture whether they perceived the activity as multitasking as the previous study.

Results

Of the participants in the multitasking condition, 77.1% felt like they were multitasking, while only 44.7% of particiants in the single-tasking condition felt they were multitasking ($\chi^2_{(1, N= 95)} = 10.49$, $p = .001$). Participants in the multitasking framing condition also reported that they felt like they were multitasking (M = 5.33, 95% CI = [4.77, 5.90]) to a greater extent than those in the single-tasking condition (M = 3.57, 95% CI = [3.00, 4.14]; $F(1, 93) = 18.97$, $p < .001$).

Discussion

Together, Studies 1a and 1b show that the more distinct the components of an activity are, the more likely a person is to perceive it as multitasking. This provides evidence for the principle of separation. Although in these studies, I manipulated the actual task relatedness, it is plausible that relatedness could also be a subjective perception. For example, if an individual was online shopping for kitchen appliances using multiple browser tabs, they would most likely feel like they were engaging in single-tasking. However, if they thought of this activity as having two separate components (shopping for coffee makers on half the tabs and shopping for blenders on the other half), I argue that this individual would feel more like they were multitasking. I directly explore this in Studies 4a-4c.

STUDY 2: SOURCE OF TASKS INFLUENCES THE PERCEPTION OF MULTITASKING

In the previous study, I showed that the relatedness of topics can influence the perception of multitasking; however, in this study I examine another factor, the source of the content, which could create separation in the components of an activity. While there could be many different types of sources (e.g., who assigns you to do work), I focus on how one's perception of their activity might change if the content they are engaging with is displayed on one or two devices.

Method

One hundred and four participants (60% female, age = 36.17 years) were recruited from Amazon's Mechanical Turk. Participants were assigned to one of two framing conditions in order to assess the impact of source on the perception of multitasking. In the multitasking condition, participants saw and read the following:

Fig. 1: Study 2 multitasking stimuli

> *Please imagine that you decided to check two news providers' websites. You check one, called Morning News, on your computer, and the other, called Good News, on your phone.*
>
> *You catch up on the news by watching the video coverage on Morning News and scrolling the headlines on Good News at the same time.*

In the single-tasking condition, the content was displayed on a single device:

Fig. 2: Study 2 single-tasking stimuli

Please imagine that you decided to check a news provider's website, called Good Morning News, on your computer.

You catch up on the news by watching the video coverage and scrolling the headlines on Good Morning News at the same time.

The phrase “at the same time” was intended to hold constant the perceived simultaneity of the activity across conditions, similar to the previous studies, in order to isolate the principle of separation. After participants read one of the two scenarios, they responded to two items about multitasking perceptions as the previous studies.

Results

Of the participants in the multitasking framing condition, 83.0% felt like they were multitasking, while only 66.7% of particiants in the single-tasking framing condition felt they were multitasking ($\chi^2_{(1, N= 104)}$ = 3.701, p = .054). Participants in the multitasking condition also reported that they felt like they were multitasking (*M* = 5.62, 95% CI = [5.18, 6.06]) to a greater extent than those in the single-tasking condition (*M* = 4.69, 95% CI = [4.24, 5.14]; $F(1, 102) = 8.69$, $p = .004$).

Discussion

In this study, I identify another factor that demonstrates how the principle of separation can cause the perception of multitasking. I show that when content is displayed on two devices versus one it can make people feel like they are multitasking. Although in this study I control the size and location of this content, one can imagine that this effect might be different when people are actually holding a phone and looking at their computer.

STUDY 3: SWITCHING FREQUENCY INFLUENCES THE PERCEPTION OF MULTITASKING

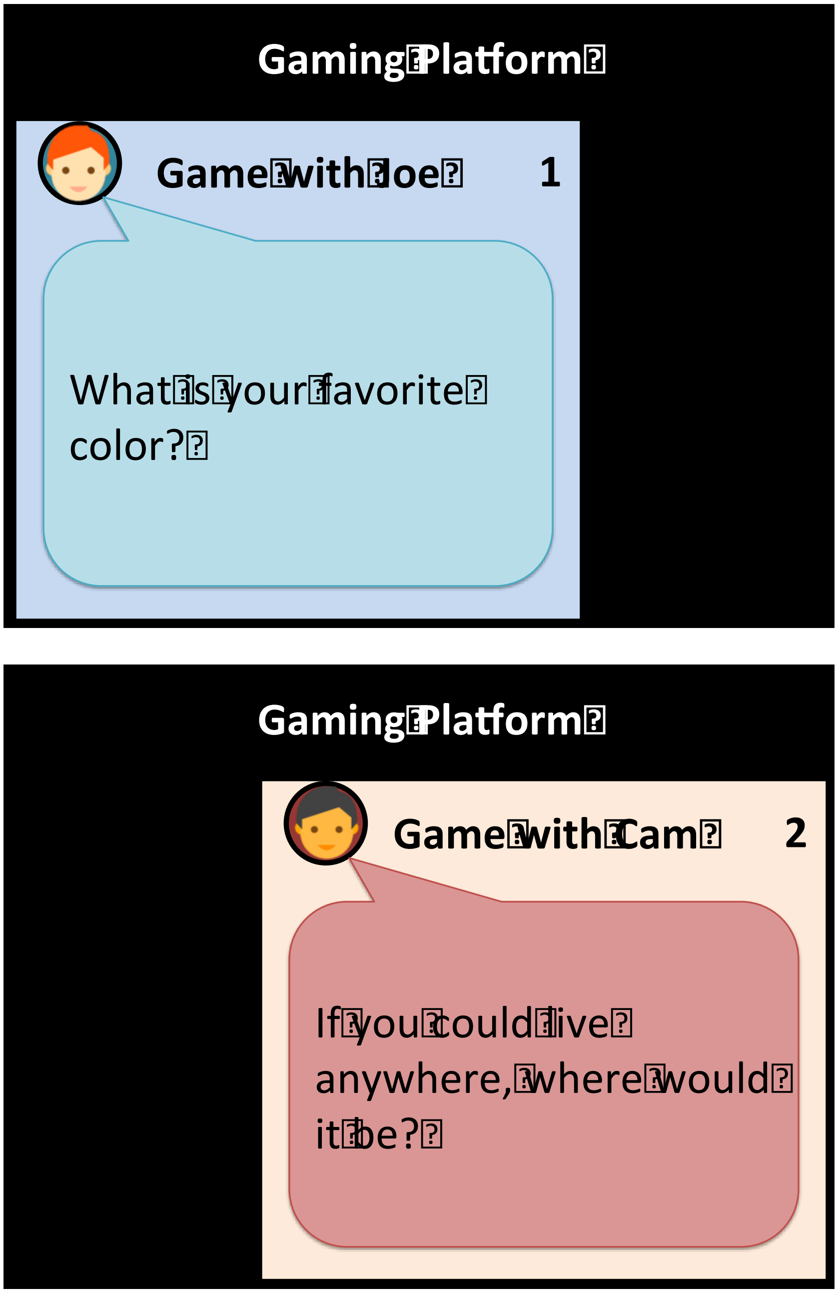
Unlike the last three studies that identify factors that separate a given activity to make it feel like multitasking, in Study 3 I focus on the principle of simultaneity. I posit that perceived switching between tasks will make people feel like they are multitasking more than working on the tasks sequentially.

Method

One hundred and ninety-five participants (55% female, age = 37.43 years) were recruited from Amazon's Mechanical Turk. All participants were instructed that they would be playing two games with two different people, Joe and Cam. We held constant participants' perception of working on two tasks in order to isolate the principle of simultaneity. Each question for the games appeared in a pop-up window for 8 seconds, then would disappear and be replaced by a new pop-up window. During the time the question appeared on the screen, participants could write their responses in a text box allocated for the specific game they were working on. Both games involved answering questions about themselves (e.g., What is your favorite color?). In order to make the two games distinct, each game had a different color pop-up window with an image and the name of the person they were playing.

We manipulated the frequency in which participants felt they switched between the two games. There were four switching conditions. Across all conditions, I kept the 12 questions and the order of the questions constant and manipulated the visual frame surrounding the questions to make it appear as if it came from the game with Joe or Cam. In the first condition, participants switched games after every question. So they first answered a question from the game with Joe and then answered a question from the game with Cam (See Figure 3). In the second and third conditions, participants switched games after every two or three questions, respectively. In the fourth condition, participants first answered 6 questions from Joe and then answered 6 questions from Cam. Therefore, in this condition they answered the questions from Joe and Cam in a purely sequential manner.

Fig. 3: Study 3 game stimuli



After participants played the games, they responded to the same two items about multitasking perceptions as previous studies. I then asked them a manipulation check (To the best of your ability to recall, roughly, how often did you have to switch between answering to Joe and Cam? [Roughly, every one question, Roughly, every two questions, Roughly, every three questions, Roughly, every four questions, Roughly, every five questions])[2].

Results

93% of participants who switched after every question accurately recalled that they did so, 82% who switched every two questions accurately recalled this, and 72% who switched every three questions accurately recalled this. Finally, 85% of participants who worked on the tasks sequentially recalled switching roughly every five questions ($\chi^2_{(12, N= 195)} = 382.41$, $p < .001$).

There was an effect of condition on the proportion of people who felt they were multitasking ($\chi^2_{(3, N= 195)} = 28.52$, $p < .001$). Specifically, 54% of participants who switched after every question felt like they were multitasking, 66% of participants who switched after every two questions felt like they were multitasking, and 64% of participants who switched after every three questions felt like they were multitasking. However, only 20% of participants felt they were multitasking when they worked on the games sequentially. The effect of condition on the proportion of people who felt they were multitasking was driven by the contrast between participants who worked on the tasks sequentially and the rest of the conditions (all *p*'s < .001), while all other contrasts were not significant (*p*'s > .263).

A similar pattern was revealed when looking at the extent to which participants felt they were multitaksing, $F(3, 191) = 10.74$, $p < .001$. Specifically there was no difference

[2] I also asked them a reading check. I present the results including the 47 people who failed this item. Excluding people who failed this item does not change the results.

in multitasking perceptions when participants switched after every one question (*M* = 4.22, 95% CI = [3.65, 4.78]), every two questions (*M* = 4.68, 95% CI = [4.10, 5.26]), or three questions (*M* = 4.56, 95% CI = [4.02, 5.10]). However, participants assigned to work on the games sequentially reported feeling more like they were single-tasking (*M* = 2.76, 95% CI = [2.25, 3.28]) than all other conditions (all *p*'s < .001).

Discussion

Unlike Studies 1 and 2 where I find that the degree of separation of an activity's components can induce the perception of multitasking, in this study I show that switching can make people feel as if they are engaging in multitasking. Furthermore, I do not find any evidence that the exact frequency of switching substantially changes the perception of multitasking. However, future work could further explore this.

STUDIES 4A-4C: THE PRINCIPLES OF SEPARATION AND SIMULTANEITY

Building on the results reported in Studies 1-3, next I present studies that use both the principles of separation and simultaneity to trigger the perception of multitasking. In these studies, participants are asked to perform a certain activity. In the multitasking conditions the activity is separated into its components such that it highlights to participants that they are working on multiple tasks simultaneously. Conversely, in the single-tasking conditions the activity's different components are not highlighted. The paradigms reported and tested in Studies 4a-4c below are also used in later studies that I report throughout my dissertation.

Study 4a: Method

One hundred and seventy-eight participants were recruited from a behavioral lab at a northeastern university and asked to imagine engaging in an activity. They were then randomly assigned to one of two framing conditions. In the multitasking condition participants read the following:

In this study, you will work on two tasks concurrently. Therefore, you will need to multitask.

1. Learning Task
This task is meant to test individuals' learning abilities regarding Zoology. The task in this survey is to watch an educational video from Animal Planet's Shark Week.

2. Transcribing Task
This task is meant to test individuals' writing abilities. This task will require you to write down or transcribe exactly what is said in the video from Animal Planet's Shark Week.

In the single-tasking condition participants read the following description, which described the same activity but it was framed as a single task:

In this study, you will work on the Learning Task.

Learning Task
This task is meant to test individuals' learning and writing abilities regarding Zoology. The task in this survey is to watch an educational video from Animal Planet's Shark Week and write down or transcribe exactly what is said in the video.

After, participants responded whether they would feel as if they were engaging in a single-task or multitask activity. Then, participants indicated (i) to what extent they would feel they were multitasking (1 Not at all, 4 Somewhat, 7 Totally), (ii) the extent to which they would perceive their activity in the study as multitasking compared to talking on the phone and answering work emails (1 Not at all multitasking compared to the example, 4 Somewhat multitasking compared to the example, 7 Totally multitasking compared to the example), and (iii) whether they would feel like they were completing two different tasks, a single task with two components, or a single task.

Results

67% of participants who were assigned to the multitasking condition indicated that they perceived they were multitasking relative to 40% of those assigned to the single-tasking ($\chi^2_{(1, N=178)} = 13.02$, $p < .001$). The two 7-point scales were highly correlated ($r(176) = .73$, $p < .001$) and thus were combined. An ANOVA verified that the participants in the multitasking condition indeed felt like they were multitasking to a greater extent than those in the single-tasking condition ($M_{\text{multitasking}} = 4.58$, 95% CI = [4.25, 4.92]; $M_{\text{single-tasking}} = 3.66$, 95% CI = [3.32, 4.00]; $F(1, 176) = 14.51$, $p < .001$). Additionally, of the participants who were assigned to the multitasking [single-tasking] condition, 37% [19%] indicated perceiving the described activity as working on two separate tasks ($\chi^2_{(1, N=178)} = 7.12$, $p = .008$), and 17% [38%] indicated perceiving the activity as working on a single task ($\chi^2_{(1, N=178)} = 10.17$, $p = .001$).

Study 4b: Methods

Sixty-seven participants recruited from Amazon's Mechanical Turk were instructed to imagine that they were participating in a study with the following instructions. Participants were randomly assigned to one of two framing conditions. In the multitasking condition, participants read:

In this study, you will work on two tasks simultaneously:

Task 1: ***You will watch an online lecture about Pangaea and Earth's geographical history.*** *You will receive additional compensation based on how much you remember about what is said and shown during the lecture.*

Task 2: ***You will take notes on the lecture about Pangaea and Earth's geographical history.*** *You will receive additional compensation based on how detailed your notes are. Your notes should be detailed enough to answer questions like: Which direction are the plates in North America rotating? (answer: counterclockwise)*

You must work on both tasks at the same time. Therefore, you will both be watching the lecture and taking notes concurrently.

In the single-tasking conditions, participants read the following:

In this study, you will work on a single task.

You will watch an online lecture and take notes about Pangaea and Earth's geographical history. *You will receive additional compensation based on how much you remember about what is said and shown during the lecture and how detailed your notes are. Your notes should be detailed enough to answer questions like: Which direction are the plates in North America rotating? (answer: counterclockwise)*

Then, to prevent participants from stating post hoc that they perceived the activity as multitasking, and to increase the validity of their responses, I incentivized participants to answer truthfully by employing a particular response format. Specifically, I told them that they would be matched with a partner, and that they and their partner would need to indicate whether they perceived working on the activity as a multitasking or single-task activity. If their partner and they both responded to the question in the same way, they would each receive an additional $0.05 bonus payment. Finally, participants indicated to what extent they would feel they were multitasking (1 Not at all, 4 Somewhat, 7 Totally).

Results

Of the participants who were assigned to the multitasking condition, 72% indicated that they would perceive they were multitasking relative to 40% of those assigned to the single-tasking condition ($\chi^2_{(1, N=67)} = 6.87$, $p = .009$). An ANOVA verified that participants who were assigned to the multitasking condition indicated that they would perceive they were multitasking more relative to those assigned to the single-tasking condition ($M_{multitasking} = 5.16$, 95% CI = [4.43, 5.88]; $M_{single\text{-}tasking} = 3.46$, 95% CI = [2.76, 4.15]; $F(1, 65) = 11.41$, $p < .001$).

Study 4c: Methods

Eighty participants were recruited from Amazon's Mechanical Turk. Participants read the instructions for an activity that they were ostensibly about to work on. I manipulated the framing of the activity's instructions across conditions. In the multitasking condition participants were instructed that they would work on two studies simultaneously, the perceptual study and the identification study. The perceptual study involved finding words in a matrix of letters, while the identification study involved working on a scrabble task. The scrabble task was described as constructing words out of a string of letters. Participants were instructed to work on the studies simultaneously, but no explicit mention of the term "multitasking" was used (see appendix for full instructions). In the single-tasking condition participants were told that they were going to be working on the same puzzles but they were framed as part of a single study, the perceptual-identification study. I held constant the description of the two tasks, but described them as a single activity. In both conditions, participants were instructed they would earn $0.01 for each word they found in the study (or studies).

Next, participants responded whether they would feel as if they were engaging in a single-task or multitask activity. Participants then indicated (i) to what extent they would feel they were multitasking (1 Not at all, 4 Somewhat, 7 Totally), and (ii) the extent to which they would perceive their activity in the study as multitasking compared to talking on the phone and answering work emails (1 Not at all multitasking compared to the example, 4 Somewhat multitasking compared to the example, 7 Totally multitasking compared to the example). Finally, participants were informed they would no longer need to work on the actual activity.

Results

The two 7-point items were highly correlated ($r(80) = .715$, $p < .001$) and were combined. An ANOVA revealed that those assigned to the multitasking condition felt like they were multitasking to a greater extent than those assigned to the single-tasking condition ($M_{\text{multitasking}} = 5.18$, 95% CI = [4.63, 5.72]; $M_{\text{single-tasking}} = 3.58$, 95% CI = [3.08, 4.09]; $F(1, 78) = 18.33$, $p < .001$).

Discussion

Studies 4a-4c demonstrate that the perception of multitasking can be induced using the principles of separation and simultaneity. In Studies 4a and 4b, I show that what most people would construe as a single-activity can be framed as multitasking by highlighting the distinct components of the activity. In Study 4c, I show that what most people would consider two tasks can be made to feel like a single activity by highlighting the similarity and relatedness of the tasks.

DISCUSSION

Across seven studies, Chapter 1 identifies two necessary conditions for the perception of multitasking, which I term the principles of separation and simultaneity. First, people need to feel as if they are engaging in multiple tasks and, second, they need to also feel as if they are engaging in these tasks simultaneously. Across a variety of contexts, I show that an activity can be made to feel like multitasking by applying these principles. Many “single” activities can be broken down into multiple components and construed as multitasking. Inversely, multiple distinct activities can often be collapsed and framed as a single task. Thus, studying the malleability of multitasking perception is important. The next chapter will explore how the perception of multitasking actually influences performance on tasks.

CHAPTER 2: THE POSITIVE EFFECTS OF THE PERCEPTION OF MULTITASKING ON PERFORMANCE

The results thus far show that multitasking is often a matter of subjective perception. That is, holding the actual activity constant, some situations may cause people to perceive their overall activity as multitasking, whereas other situations may cause people to construe the very same activity as single-tasking. Further, in this chapter I propose that the way people mentally construe an activity, either as multitasking or single-tasking, can affect their performance on that activity. For example, imagine being asked to watch a video and type everything that is said. If you construe this activity as transcribing, you will probably consider this a single task. However, if you construe this activity as watching the video and typing at the same time, two distinct tasks done simultaneously, you will be more likely to consider this activity as multitasking.

This chapter's central question and the focus of this dissertation is how the mere difference in perception of the same activity impacts performance. That is, holding constant the actual activity, how would simply perceiving it as either multitasking or single-tasking affect performance? I hypothesize that when individuals construe the impending activity as multitasking, they become more motivated and more attentive and engaged with the task. This increased engagement I hypothesize will lead to improved performance. Consistent with this hypothesis, across 29 studies with 7,880 participants who engaged in different tasks and were incentivized based on their performance, I find that the mere perception of multitasking of the same activity increases motivation and improves performance. Next, I report fully report four studies that demonstrate that the perception of multitasking increases performance. In Chapter 3, I will provide evidence that this is a result of heightened engagement and an expectation of difficulty.

STUDIES 5A AND 5B: MULTITASKING PERCEPTIONS AND THEIR IMPACT ON PERFORMANCE

The goal of Studies 5a and 5b was to test whether framing a certain activity as multitasking, as opposed to single-tasking, improves performance. In Study 5a, I asked participants to watch and transcribe an educational video. In Study 5b, I asked participants to summarize a virtual lecture.

Study 5a: Method

One hundred and sixty-two participants (62% female; mean age = 21.04) were recruited from a northeastern university to participate in an hour-long lab session in exchange for a base payment of $10. In the following chapters, sample size for this study and all subsequent studies was determined based on an expected medium effect size (Cohen's $d \approx .5$) that was observed in an initial study (see Study 10). Sample size for studies conducted in the university lab varied based on the number of participants recruited for a standard lab session taken place over a week (normally 150 to 200 participants). In this study and all subsequent studies, all participants were included in the analysis unless otherwise specified.

Participants were asked to watch an educational video and transcribe what was said. Participants were then randomly assigned to either the multitasking or single-tasking conditions. Using the same instructions as described in Study 4a, participants assigned to the multitasking condition were told that they would be working on two tasks concurrently and, therefore, would need to multitask between watching and transcribing an educational video. Participants assigned to the single-tasking condition were asked to perform the exact same activity, merely framed as a single task that involved watching and transcribing an educational video.

In both conditions participants were told that both their learning and writing abilities would be tested. All participants learned they would receive an additional $0.02 for each word they correctly transcribed, and that they could work for as long as they liked up until the video ended after 6 minutes. The first measure of performance was how many words participants transcribed. The second measure of performance tested participants' comprehension of the information provided in the video. Specifically, at the end of the study I administered a 10-question multiple-choice pop quiz about the video's content.

Results

The first measure of performance I analyzed was the number of words transcribed in each condition. Participants assigned to the multitasking condition transcribed significantly more words (M = 274.13, 95% CI = [247.02, 301.24]) than participants assigned to the single-tasking condition (M = 229.60, 95% CI = [199.53, 259.67]; $F(1, 160) = 4.63$, $p = .033$). Analyzing, using a text match application, how accurate participants' transcriptions were, I found that participants assigned to the multitasking condition wrote more words accurately (M = 223.77, 95% CI = [200.20, 247.34]) than participants assigned to the single-tasking condition (*M* = 177.20, 95% CI = [152.88, 201.52]; $F(1, 160) = 7.27$, $p = .008$).

As an additional measure of performance, I checked how well participants performed on the pop quiz. As predicted, participants assigned to the multitasking condition performed significantly better on the test (*M* = 6.60, 95% CI = [6.21, 6.99]) than participants assigned to the single-tasking condition (*M* = 5.81, 95% CI = [5.30, 6.32]; $F(1, 160) = 5.82$, $p = .017$).

We next analyzed how long participants spent transcribing the video using the log-transformed time spent on the task. Since the video ended for all participants after six minutes, the data were right-censored. Thus, I used a cox regression survival analysis, and find that there was not a significant difference in persistence ($M_{\text{multitasking}} = 2.43$, 95% CI = [2.38, 2.48]; $M_{\text{single-tasking}} = 2.32$, 95% CI = [2.24, 2.40]; B = .32, 95% CI = [-.15, .79]; Wald-$\chi^2_{(1,N=162)} = 1.82$, $p = .178$). This analysis method is employed for all subsequent persistence analyses.

Moreover, controlling for time differences, participants assigned to the multitasking condition wrote more words per second (*M* = 0.91, 95% CI = [0.86, 0.96]) than participants assigned to the single-tasking condition (*M* = 0.84, 95% CI = [0.78, 0.90]; $F(1, 160) = 3.49$, $p = .064$).

In this study I triggered the perception of multitasking by explicitly telling participants that the activity involved multitasking. Accordingly, one concern may be that the effect is driven by explicitly mentioning the notion of multitasking and will not persist when individuals spontaneously construe their activity. Although this is not concerning from a policy perspective (i.e., using an explicit manipulation to trigger multitasking perceptions is easy to implement), it is important to examine whether the effect persists without explicitly mentioning multitasking. I address this in Study 5b.

Study 5b: Method

Two hundred and ninety participants (50% female; mean age = 36.53) were recruited from Amazon's Mechanical Turk. Participants were paid a base payment of $0.90 and were told that they could earn additional compensation based on their performance. All participants worked on the exact same task. The task required participants to watch an online lecture from an educational platform about Pangaea and Earth's geographical history and take notes about its content. Participants were told that they would receive additional compensation based on how much they remembered about the lecture and how detailed their notes were. To ensure the computer audio was working, prior to engaging in the study, participants had to watch a video clip that instructed them to write a test word. Three participants did not write the correct test word and were excluded from the analysis.

Participants were randomly assigned to one of two framing manipulations, which were based on those described in Study 4b. In the multitasking condition, watching a lecture and taking notes were described as two distinct tasks that would be performed simultaneously. Of importance, in this study no explicit mention of the word multitasking was used. Rather, the instructions emphasized to participants, "…you will be both watching the lecture and taking notes concurrently." The single-tasking condition described watching a lecture and taking notes as a single task. Participants were allowed to quit at any time up until the lecture finished (6 minutes). Following the task, participants indicated how boring they thought the activity was (measured on a 1 to 7 scale). No significant differences were observed on this measure (p = .52) and will not be discussed further.

Two coders, who were blind to hypothesis and condition, coded the quality of the notes. The coders evaluated participants' notes on (1) how detailed, thorough, and comprehensive the notes were, (2) what the overall clarity of the notes were, and (3) how much effort they thought the participant put into writing the notes. All items were measured on a 1 to 7 scale, and were highly correlated (α = .97). Therefore, I collapsed these measures to form a single measure of quality. Further, the two coders' ratings were highly correlated (r = .91, p < .001) and were therefore averaged, resulting in a single quality score for each participant.

Results

Seventeen participants (5.9%) who spent less than two standard deviations of time (log-transformed) on reading the manipulation (i.e., less than 1.92 seconds) were excluded from the below analyses. The same pattern of results holds if these participants are included in the analysis.

Participants' performance was analyzed based on the coders' quality measure. As predicted, the average notes quality was higher in the multitasking condition (M = 3.76, 95% CI = [3.48, 4.04]) compared to the single-tasking condition (M = 3.32, 95% CI = [3.03, 3.61]; $F(1, 271)$ = 4.55, p = .034). In addition, participants assigned to the multitasking condition wrote, on average, more words (M = 64.16, 95% CI = [56.45, 71.87]) compared to participants assigned to the single-tasking condition (M = 51.20, 95% CI = [41.76, 60.64]; $F(1, 271) = 5.30$, $p = .022$). No difference was observed on how long overall participants spent on the task ($p = .477$) as the majority of participants (86%) viewed the entire video, which played for 6 minutes. Taken together, the results of Studies 5a and 5b support that performance on a given activity improves when it is perceived as a multitasking (as opposed to single-tasking) activity.

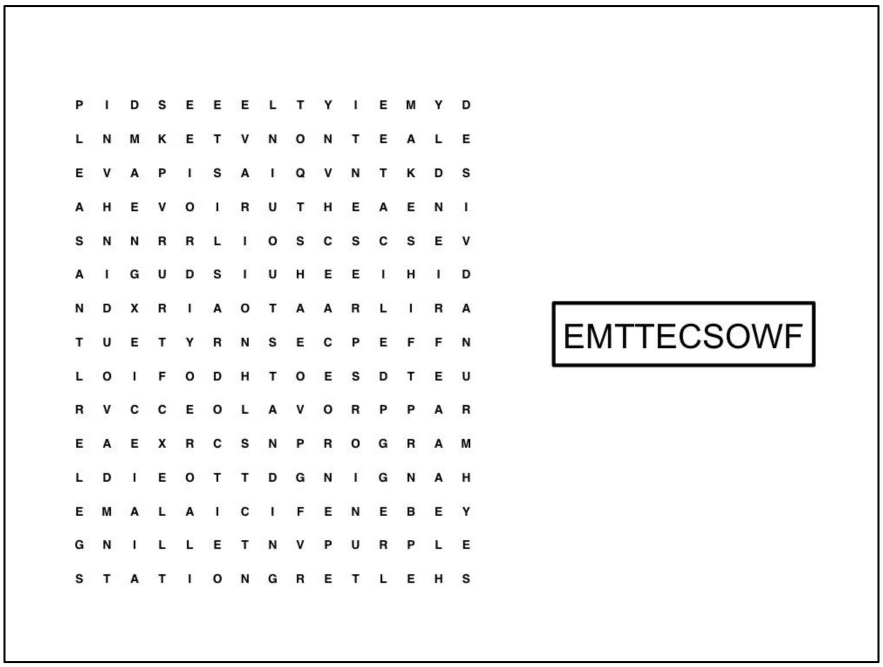
STUDIES 6A AND 6B: MEASURING AND MANIPULATING MULTITASKING PERCEPTIONS

Unlike Studies 5a and 5b, in Study 6a, instead of manipulating participants' perceptions of multitasking I measured them. This allowed us to test whether the instructions trigger a behavior that would not occur naturally. Using this natural variation in how people construed the activity, I examined how such perceptions correlate with performance. To support causal claims, in Study 5b I used the same task used in Study 5a but manipulated multitasking perceptions.

Study 6a: Method

Eighty participants (43% female; mean age = 36.66) were recruited from Amazon's Mechanical Turk to take part in this study. Participants were asked to work on an assignment involving two distinct puzzles. The first puzzle was a word puzzle in which participants observed a 15 by 15 matrix of letters and were asked to find as many words as possible in a horizontal, vertical, or diagonal pattern in the matrix. The second puzzle was an anagram task in which participants observed a 10-letter string and were asked to construct as many words as possible using the letters in the string. Participants were paid a base payment of $0.40 and were told that each correct answer (i.e., a 4 or more letter word) would earn them an additional $0.01. The two puzzles appeared on the same screen side by side, and participants worked on the tasks concurrently for four minutes and could submit as many words they could find (See Figure 1).

Fig. 4: Puzzles used in Study 6.



After participants finished working on the task, I measured the extent to which they perceived their activity as either multitasking or single-tasking using two types of measurements. First, participants were told that they would be matched with a partner, and they and their partner would indicate whether they perceived the activity as a single task activity or a multitask activity. If both they and their partner answered the question in the same way, they would earn an additional $0.05, which incentivized participants from stating post hoc that they perceived their activity as multitasking. Four additional binary items were used to measure perceptions of multitasking (see appendix for details). Responses to all five binary measures were combined into a single measure of multitasking perception ($\alpha = .61$).

Results

One participant was more than two standard deviations from the mean performance and was therefore excluded from the analyses. Results hold if this participant is included.

We regressed the number of words found in the puzzles on the measure of multitasking perception. I examined both overall number of words submitted as well as the number of correct words found (these two measures were highly correlated; $r(77) = .98$, $p < .001$). As predicted, I found a significant positive relationship between the perception of multitasking and number of words attempted (B = 4.33, 95% CI = [.83, 7.82]; $t(77) = 2.47$, $p = .016$), as well as number of correct words (B = 3.83, 95% CI = [.64, 7.02]; $t(77) = 2.39$, $p = .019$). That is, the more participants felt they were multitasking the better they performed. Obviously, one cannot make any causal claims based on this study because reverse causality could drive the observed correlation. To test causality, in Study 6b I use the same activity but instead of measuring the perception of multitasking I manipulate it.

Study 6b: Method

Two hundred and thirty-seven paid online participants were recruited from Amazon's Mechanical Turk (55% female; mean age = 36.33) to take part in this study which employed the same puzzles and same incentives described in Study 6a. Participants were randomly assigned to one of two conditions. In the multitasking condition, the two puzzles were described as relating to two different studies ("Perceptual Study" and "Identification Study"), were separated on the screen by a vertical line and had a different background color. In the single-tasking condition, both puzzles were described as being part of the same study ("Perceptual-Identification Study"), and were not visually distinguished by different background colors or separated by a line. Unlike Study 6a, participants were allowed to quit the tasks at any time up until four minutes, thus enabling us to examine persistence as another indication of performance.

Since the framing manipulation was relatively subtle, I also included an additional factor intended to further strengthen the manipulation. Specifically, I also manipulated (between-subjects) whether or not I disclosed to participants that in this study some participants would work on a single study while others would work on two studies at the same time. The disclosure manipulation did not produce any main effects or interactions on any of the dependent variables or with the framing manipulation. I therefore collapsed the analyses and do not discuss this factor further. This does not meaningfully change the pattern of results.

As a manipulation check, participants indicated to what extent they felt they were multitasking (1 Not at all, 4 Somewhat, 7 Totally) and whether they felt like they were completing two different tasks, a single task with two components, or a single task (selected one of the three descriptions that matched their experience).

For exploratory purposes, upon finishing their assignment, participants in all conditions were asked to answer several questions about their multitasking habits and feelings of productivity (reported in the appendix). None of these measures moderated the effect; therefore, I do not discuss these further.

Results

Manipulation checks. Participants assigned to the multitasking condition indicated that they perceived their activity as multitasking (M = 4.40, 95% CI = [4.08, 4.72]) to a greater extent than those assigned to the single-tasking condition (M = 2.52, 95% CI = [2.24, 2.80]; $F(1, 235) = 76.06$, $p < .001$). Furthermore, of the participants who were assigned to the multitasking [single-tasking] condition, 46% [5%] indicated perceiving their activity as working on two separate tasks ($\chi^2_{(1, N=237)} = 51.35$, $p < .001$), and 11% [71%] indicated perceiving their activity as working on a single task ($\chi^2_{(1, N=237)} = 88.81$, $p < .001$). Thus, the manipulation worked as intended.

Performance. An ANOVA revealed that participants assigned to the multitasking condition submitted, on average, more words (M = 14.42, 95% CI = [13.07, 15.77]) than those assigned to the single-tasking condition (M = 8.08, 95% CI = [7.17, 8.99]; $F(1, 235) = 57.86$, $p < .001$)[3]. Again, the number of words submitted and number of correct words were highly correlated ($r(235) = .98$, $p < .001$). Analyzing the number of correct words reveals the same pattern ($M_{multitasking}$ = 13.65, 95% CI = [12.31, 14.99]; $M_{single-tasking}$ = 7.50, 95% CI = [6.64, 8.36]; $F(1, 235) = 56.34$, $p < .001$).

[3] Results hold after adjusting for unequal variance across conditions.

Persistence. Participants worked on the puzzles for at most four minutes, but could quit at any point prior to that. Using survival analysis of log(time), I found that participants who were assigned to the multitasking condition persisted longer (M = 2.35, 95% CI = [2.08, 2.62]) than those assigned to the single-tasking condition (M = 2.26, 95% CI = [1.73, 2.79]; B = 1.17, 95% CI= [1.75, 5.96]; Wald-$\chi^2_{(1, N=237)}$ = 14.02, p < .001).

Moreover, even after controlling for the time participants spent on the tasks, participants in the multitasking condition still submitted more words (F(1, 234) = 46.49, p < .001), and performed better (F(1, 234) = 44.60, p < .001) suggesting that the quality of work, and not only the overall time spent on the task (i.e., persistence), drove the improvement in performance.

Discussion

By both manipulating and measuring multitasking perceptions, the results of Studies 6a and 6b further support the notion that performance improves when individuals construe their activity as multitasking. Across different incentivized activities, participants performed better and earned more when the same activity was merely perceived as multitasking.

Admittedly, in Studies 6a and 6b, while I kept the actual activity fixed, I did not control or restrict participants' work sequence on the word puzzles. That is, some participants may have switched more often than others and such variation in work sequence may have, at least partially, driven the results. Although such account is less plausible for the tasks employed in Studies 5a and 5b, which involved transcribing and summarizing an educational video, I directly address this account in the next chapter.

DISCUSSION

Voluminous research demonstrates that working on more than one task at the same time is detrimental to performance (e.g., Pashler, 1994). However, when examining multitasking's effect on performance, this work manipulated both the workload and the perception of multitasking. Unlike previous literature, I study how the perception of multitasking impacts performance holding the workload constant. In this chapter, by both manipulating and measuring multitasking perceptions, I find that holding the activity constant, the mere perception of multitasking improves performance rather than harms it.

Stated differently, one implication of this research is that separating a task into its components and merely creating the perception of multitasking could improve peoples' performance on this task. For example, if I was to mention that reading this article entails two distinct tasks (e.g., switching back and forth between the text and figures), to the extent that this framing would trigger a perception of multitasking, one should observe an improvement in performance (i.e., better comprehension). Furthermore, the findings suggest that if people are already engaged in multiple tasks, making them aware that they are multitasking should help them perform better. So, if you are doing other activities while reading this article, such as answering urgent emails, realizing you are multitasking should improve your performance in each of these activities.

CHAPTER 3: THE ROLE OF ENGAGEMENT AS AN UNDERLYING MECHANISM

Why does the perception of multitasking improve performance on a task? I propose that the perception of multitasking leads people to be more engaged the activity, which in turn improves their relative performance[4]. People who are engaged with a given activity are "involved, occupied, interested and attentive to it; they are absorbed or engrossed in it" (Higgins, 2006, p. 442). Consistent with my findings, engagement has been shown to enhance information processing and learning (Greene & Miller, 1996; Nolen, 1988) and improve performance (Bianco, Higgins, Klem 2003; Kahneman, 1973).

There are a number of factors that could contribute to this increase in engagement. Existing research demonstrates that individuals' motive for investing effort and cognitive control increases with the difficulty of the task (e.g., Kukla, 1972; Sanders, 1983), as well as with the expectation of task difficulty (e.g., Schrift, Netzer, & Kivetz, 2011). Indeed, several findings support the notion that more challenging tasks increases individuals' attention and ultimately leads to improvement in performance (e.g., Kofman et al., 2006; Hommel et al., 2012; Plessow et al., 2011). Similarly, neuroscientific observations (Botvinick et al., 2001; Egner & Hirsch, 2005) suggest that greater difficulty during task performance leads to increased attention. Hommel et al. (2012) summarize, "…there is both behavioral and neuroscientific evidence for Hillgruber's (1912) claim that increasing the challenge of the task spontaneously increases one's effort to compensate for and to

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[4]Although attention and engagement are linked constructs, I choose the term engagement because attention in the dual task literature refers to process of selecting particular stimuli for awareness (Pashler, 1994). I argue that the construct underlying the effect is not just being aware of the activity but also being motivated.

overcome that challenge." Building on these findings, I hypothesize that when individuals construe the impending activity as multitasking, which is perceived to be more challenging, they become more motivated and more attentive and engaged with the task. This increased engagement I hypothesize will lead to improved performance.

In the next three studies, I establish that there is an increase in engagement using a physiological measurement, and that the perception of multitasking's difficulty is a key contributor to this increase in engagement. Five additional studies are presented to test additional accounts.

STUDY 7: PHYSIOLOGICAL MEASURES OF ENGAGEMENT

Study 7 employs the same paradigm used in Study 6b, but uses eye-tracking technology to measure participants' pupil dilation while working on the tasks. Using this validated physiological measure of engagement (e.g., Beatty & Lucero-Wagoner, 2000; Hoeks & Levelt, 1993), I examine whether the increase in performance is driven by greater engagement.

Method

One hundred and fifteen participants were recruited from a behavioral lab at a northeastern university (60% female; mean age = 20.46) in exchange for $5 in base payment. The procedure was identical to that employed in Study 6b, but while participants worked on the tasks, I used SMI RED-m eye-tracking equipment to track their eye movements and pupil dilation. Furthermore, participants were paid $0.03 for each word found in the puzzles to make the bonus payment more comparable to the base payment in the lab.

To ensure that the use of different background colors did not impact the pupil dilation measures, I counterbalanced all background colors across conditions. Further, I verified that the level of luminance across conditions (which may affect pupil dilation) was nearly identical by calculating the mean luminance over the pixels[5] and scaling them from 0-255, (since the colors were counterbalanced there were two task stimuli per condition: Single task = 194.36, 194.44 vs. Multitask = 194.57, 194.63) and thus unlikely to have caused a change in pupil dilation.

Results

Consistent with eye-tracking research practices, I made several exclusions based on data quality and criteria determined a priori. Participants were excluded if (i) their time on the task exceeded two standard deviations from the average time (five participants; results hold if not excluded), (ii) if the eye-tracking device did not read their pupil dilation (2 participants), or (iii) if they had other technical difficulties (1 participant), leaving us with a total of 107 participants.

Performance. As predicted, participants submitted more words in the multitasking condition (M = 18.21, 95% CI = [15.22, 21.20]) than in the single-tasking condition (M =10.65, 95% CI = [8.36, 12.95]; $F(1, 105) = 13.84$, $p < .001$). Examining the number of correct words revealed a similar pattern ($M_{multitasking}$ = 17.16, 95% CI = [14.30, 20.02];

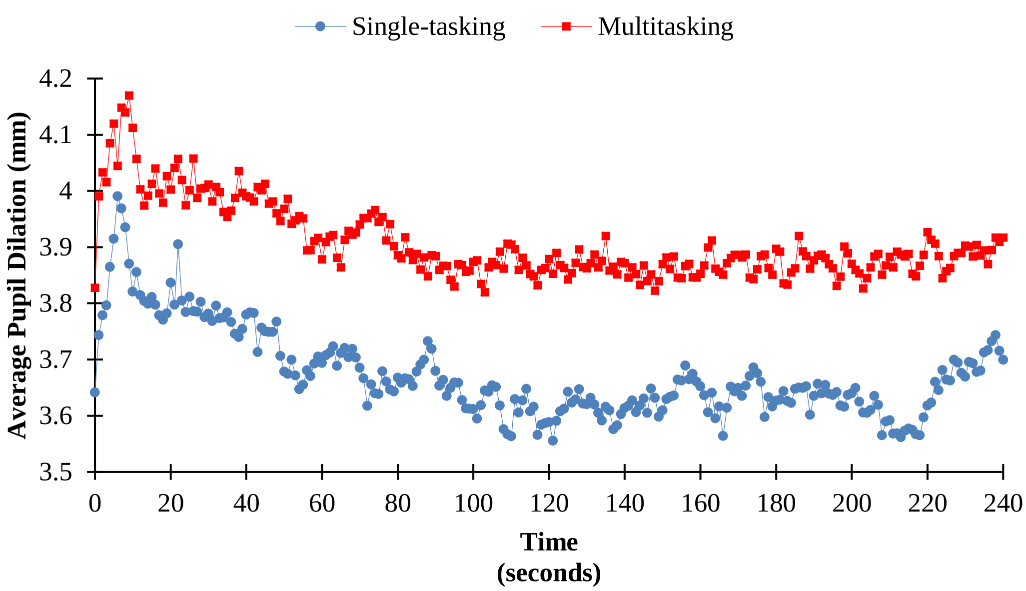
[5] I use a Gamma correction to account for nonlinearity in processing luminance (Poynton, 2002).

$M_{\text{single-tasking}}$ = 9.78, 95% CI = [7.56, 12.00]; $F(1, 105) = 14.36$, $p < .001$). Additionally, I found that most participants (97.20%) worked for the full 4 minutes. Thus, in this study, the framing manipulation had no significant effect on how long participants worked on the task ($p > .25$).

Pupil dilation. Participants' average pupil dilation was larger in the multitasking condition (M = 3.90, 95% CI = [3.77, 4.03]) than in the single-tasking condition (M = 3.64, 95% CI = [3.50, 3.78]; $F(1, 105) = 7.12$, $p = .009$). These results hold when analyzing either median or maximum pupil dilation (see appendix). The effect of the multitasking framing on pupil dilation remained significant even after controlling for the number of switches participants made ($F(1, 99) = 5.90$, $p = .017$)[6]. A mediation analysis using a bootstrap estimation approach with 5,000 samples (model 4 from the PROCESS macro; Hayes, 2013) supported the assertion that the increase in pupil dilation mediated the impact of task framing on words correctly identified (B = 0.59, SE = .33, 95% CI = [0.08, 1.41])[7]. Figure 5 depicts participants' average pupil dilation over time across conditions.

[6] The sample size changed for this analysis because the eye-tracking equipment failed to record the exact fixation location of five participants, thus I could not calculate their number of switches.
[7] The mediation results looks similar when examining words submitted: B = 0.59, SE = .34, 95% CI = [0.12, 1.65].

Fig. 5: Average pupil dilation in the multitasking and single-tasking conditions in Study 7



Given the correlational nature of any mediation analysis, one should be cautious with causality interpretations between pupil dilation and performance. In particular, participants' pupils might have been dilated due to happiness and excitement from finding more words (i.e., reverse causality). Although I cannot fully rule out this account, an additional analysis that controls for the number of words found in each condition casts doubt on this interpretation. Specifically, when analyzing average pupil dilation up until participants found their first word in the puzzles, participants in the multitasking condition still had a greater average pupil dilation (M = 3.93, 95% CI = [3.80, 4.06]) than those in the single-tasking condition (M = 3.71, 95% CI = [3.55, 3.87]; $F(1, 105) = 4.28$, $p = .041$). Similar patterns were found when examining pupil dilation up until the second, third, fourth, and fifth word found. Thus, regardless of the number of words found in the puzzles, participants in the multitasking condition exhibited greater physiological signs of engagement than participants in the single-tasking condition.

Switching Patterns. As would be expected, participants in the multitasking condition switched more (M = 11.83, 95% CI = [10.04, 13.50]) than those in the single-tasking condition (M = 6.62, 95% CI = [4.83, 8.82]; $F(1, 100) = 14.44$, $p < .001$)[8]. However, although I do find a positive correlation between number of words found and the number of switches made ($r(100) = .55$, $p < .001$), the directionality of the causal relationship between these two measures is unclear. Specifically, while one could argue that such correlation implies that switches impact the number of words found, one could also reasonably argue the reverse. That is, that in the current paradigm, the likelihood of switching increases after a word is found. According to the latter account, because participants in the multitasking condition found more words, one should expect to see more switches in this condition and that the two would be highly correlated. Therefore, whether switches are the cause, versus the outcome, of improvement in performance in this paradigm is not clear. Importantly, for this reason, I used other paradigms (Studies 10 and 11) that show the effect itself persists even after experimentally controlling for switching patterns, which is the strongest test of this account. Further, in the following meta-analysis in Chapter 4, I provide an estimate for how much of the variance might be explained by shifts in switching patterns.

[8] Five participants were excluded from the switch analyses because the eye-tracking equipment failed to record their fixation location. Please see appendix for more details on how switches were defined and analyzed.

Discussion. I find that the perception of multitasking increases engagement with an activity. The results show that there is an immediate increase in pupil dilation, suggesting that the increase in engagement is at least partially a result of participants preparing to engage in the activity. When people anticipate working on a difficult task, they recruit greater cognitive resources for the task(s) at hand (Hommel et al., 2012). I conjecture that because multitasking activities are perceived to be more difficult, merely framing the same task as multitasking may increase individuals' motivation. In the next study, I directly explore this hypothesis.

STUDY 8: MANIPULATING THE PERCEPTION OF DIFFICULTY

If the perception of difficulty is driving the improvement in performance on an activity construed as multitasking, prior to engaging in a multitasking activity people will anticipate that it will be more difficult than a single-tasking activity. Accordingly, directly informing participants that the activity is easy to perform should attenuate the effect. In the current study I directly test this hypothesis.

Method

Four hundred paid online participants were recruited from Amazon's Mechanical Turk (46% female; mean age = 36.48) to participate in a study for a base payment of $0.60. This study was a 2 (multitasking condition vs. single-tasking condition) × 2 (easy vs. control) between-subjects design. All participants were first told that they would be assigned to one of two versions of the MTurk Hit. They were told that the first version involved working on one task and the second version involved working on two tasks simultaneously. In order to manipulate how easy participants expected the activity to be, participants assigned to the easy conditions were also informed, “Participants who took both versions said that they were both very easy and not challenging. Therefore, expect them to be fairly simple and straightforward activities.” In the control condition, participants were given the exact same instructions without any mention of the activity being easy or not challenging.

Participants were then randomly assigned to either the multitasking or single-tasking condition using the same methods and tasks as Study 6b. Of note, I did not explicitly use the term multitasking (like the framing in Study 6b), but highlighted that participants would be engaging in the studies “simultaneously” and “concurrently.” Participants were told that each correct answer would earn them an additional $0.01. Participants were allowed to quit the tasks at any time up until four minutes.

Although I verified the manipulation in a separate study (see appendix), I also included three items meant to measure perceptions of multitasking and actual task difficulty. First, participants were told that they would be matched with a partner. If they and their partner responded in the same way they would receive a bonus of $0.05. The question was whether they perceived the activity they engaged in as multitasking or single-tasking. Participants also indicated the extent to which they were multitasking (1 Not at all, 4 Somewhat, 7 Totally). Finally, participants responded how easy or difficult they thought the task was (1 Extremely easy, 7 Extremely difficult)[9].

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[9] Of note, this did not capture the expectation of difficulty, which I presumed was primarily driving the results. As a result there were no differences observed on this measure (*p*'s > .320).

Results

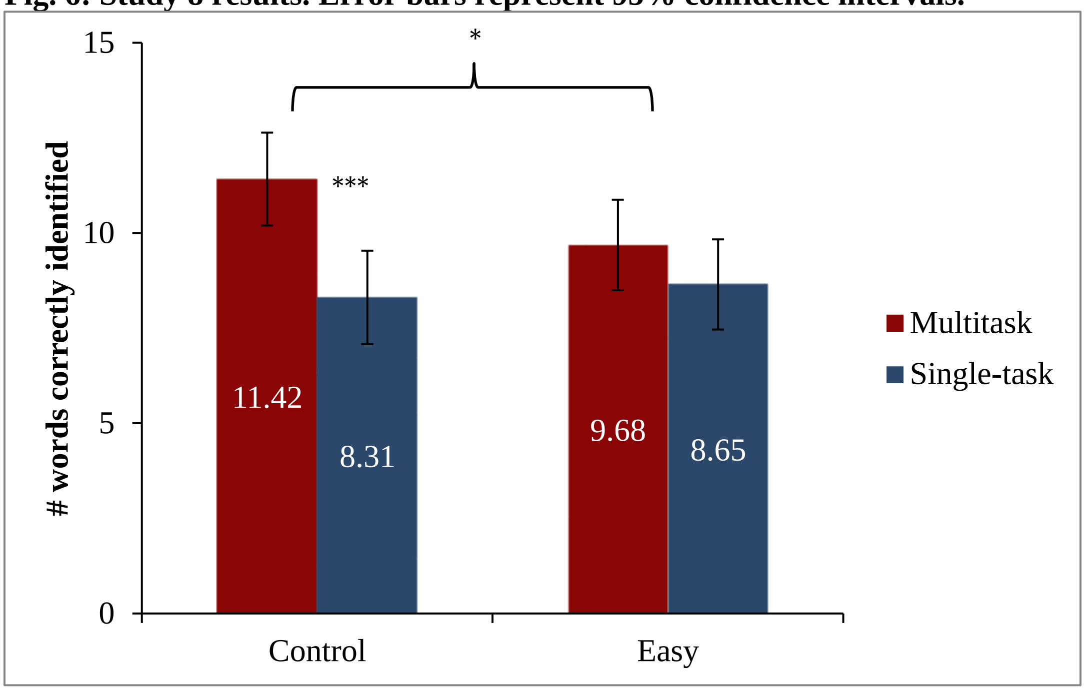
We excluded six participants whose mean attempted performance was greater than three standard deviations above the mean. Thus, the final sample is three hundred ninety-four.

Manipulation Checks. The results of a logistic regression revealed that of the participants who were assigned to the multitasking [single-tasking] condition, 77% [24%] indicated perceiving their activity as multitasking (B = 2.17, SE = .324; $\chi^2_{(1, N=394)}$ = 44.89, $p < .001$). There was neither an effect of the easy manipulation nor an interaction (p's > .500)

An ANOVA further verified that the manipulation had the intended effect. Participants assigned to the multitasking condition indicated that they perceived their activity as multitasking to a greater extent than those assigned to the single-tasking condition ($M_{multitasking}$ = 5.20, 95% CI = [4.91, 5.50]; $M_{single\text{-}tasking}$ = 2.70, 95% CI = [2.41, 2.99]; $F(1, 390) = 139.49$, $p < .001$). There was neither an effect of the easy manipulation nor an interaction (p's > .647).

Performance. An ANOVA revealed that participants assigned to the multitasking condition submitted more correct words, on average, ($M_{multitasking}$ = 10.55, 95% CI = [9.69, 11.42]), than those assigned to the single-tasking condition ($M_{single\text{-}tasking}$ = 8.48, 95% CI = [7.64, 9.32]; $F(1, 390) = 11.43$, $p = .001$). There was no effect of the easy manipulation on performance ($F(1, 390)= 1.29$, $p = .257$). The interaction was marginally significant ($F(1, 390) = 2.86$, $p = .092$), suggesting that expected difficulty plays a moderating role. Specifically, I observe that in the control conditions people in multitasking condition perform better (M = 11.42, 95% CI = [10.20, 12.64]) than those in the single-tasking conditions (M = 8.31, 95% CI = [7.12, 9.50]; $t(195) = 3.59$, $p < .001$). However, this effect attenuates in the easy conditions such that the difference between the multitasking condition (M = 9.68, 95% CI = [8.46, 10.91]) and the single-tasking condition is no longer significant (M = 8.65, 95% CI = [7.46, 9.83]; $t(195)= 1.20$, p = .232). Furthermore, in the two single-tasking conditions, the contrast between the control condition and the easy condition was not significant ($t(203)= 0.40$, p = .691), but this same contrast was significant in the multitasking conditions ($t(191)= 1.97$, p = .050).

Fig. 6: Study 8 results. Error bars represent 95% confidence intervals.



* p = .05, *** p < .001

The same pattern holds when looking at attempts. An ANOVA revealed that participants assigned to the multitasking condition submitted, on average, more words (M

= 12.45, 95% CI = [11.44, 13.45]), than those assigned to the single-tasking condition (*M* = 9.85, 95% CI = [8.88, 10.82]; $F(1, 390) = 13.33$, $p < .001$). There was no effect of the easy manipulation on performance ($F(1, 390) = 0.51$, $p = .478$), and the interaction did not reach statistical significance ($F(1, 390) = 2.06$, $p = .152$). Although the interaction did not reach significance, planned contrasts revealed that in the control conditions people in the multitasking condition performed better (*M* = 13.21, 95% CI = [11.79, 14.62]) than those in the single-tasking condition (*M* = 9.59, 95% CI = [8.22, 10.97]; $t(195) = 3.60$, $p < .001$). However, this effect attenuated in the easy conditions such that the difference between the multitasking condition (*M* = 11.68, 95% CI = [10.26, 13.11]) and the single-tasking condition was no longer significant (*M* = 10.11, 95% CI = [8.74, 11.48]; $t(195) = 1.57$, $p = .118$). Furthermore, in the single-tasking conditions, the contrast between the control condition and the easy condition was not significant ($t(203)= 0.52$, $p = .604$), and, in the multitasking conditions, this contrast was directional ($t(191)= 1.49$, $p = .136$).

Persistence. The results of a cox regression survival analysis revealed that there were no differences across condition as a result of the multitasking manipulation, easy manipulation or their interaction (*p*'s > .203)

Discussion

Again, I find that the mere perception of multitasking improves performance compared to the perception of single-tasking. However, this effect attenuates when participants expect the multitasking activity to be easy. Although the interaction did not reach significance, this study provides suggestive evidence that the perception of difficulty is one driver of the increased engagement and improved performance. The next study provides further evidence for this finding.

STUDY 9: MEDIATION BY DIFFICULTY

In Study 9, I continue to explore the role of expected difficulty but instead of manipulating it (Study 8) in the current study I measure it. Specifically, I measure participants' expectations of difficulty prior to engaging in the task. Furthermore, I also measure other factors that may drive greater engagement since robust effects often have multiple drivers. Accordingly, I also measure and test productivity expectations and the desirability to appear adept at multitasking as drivers for the improvement in performance.

Method

Two hundred and one participants were recruited from Amazon's Mechanical Turk (60% female; mean age = 20.46) in exchange for $0.60 in base payment. Participants were assigned to either a multitasking condition or a single-tasking condition. The multitasking and single-tasking framing manipulations and tasks were identical to that employed in Study 6b.

Prior to engaging in the study, participants indicated (in random order) how difficult they thought working on the activity would be, how productive they expected to be, how important it was to succeed while working on the activity, how desirable the ability to perform well was, how challenging they thought the activity would be, and how stressed they would be while working on the activity (all items were measured 1 Not at all, 7 Extremely). I also included a reading check intended to assess the degree to which people were paying attention[10].

Results

We excluded one participant whose performance was more than three standard deviations away from the average performance leaving us with a final sample of two hundred.

Performance. The results of an ANOVA revealed that participants assigned to the multitasking condition submitted, on average, more words ($M_{multitasking}$ = 13.47, 95% CI = [12.13, 14.80]), than those assigned to the single-tasking condition ($M_{single\text{-}tasking}$ = 10.04, 95% CI = [8.69, 11.39]; $F(1, 198) = 12.66$, $p < .001$). A similar analysis on correct words revealed a similar pattern ($M_{multitasking}$ = 11.26, 95% CI = [10.02, 12.49]; $M_{single\text{-}tasking}$ = 8.74, 95% CI = [7.49, 9.99]; $F(1, 198) = 8.02$, $p = .005$).

Drivers of engagement. As predicted, participants assigned to the multitasking condition expected the activity to be more difficult ($M_{multitasking}$ = 4.76, 95% CI = [4.49, 5.03]), than those assigned to the single-tasking condition ($M_{single\text{-}tasking}$ = 4.36, 95% CI = [4.06, 4.64]; $F(1, 198) = 4.22$ $p = .041$). However, there was no effect of the framing condition on how productive they expected to be ($M_{multitasking}$ = 5.19, 95% CI = [4.93, 5.44]; $M_{single\text{-}tasking}$ = 5.16, 95% CI = [4.91, 5.42]; $F(1, 198) = .02$, $p = .885$), how important it was to succeed while working on the activity ($M_{multitasking}$ = 5.79, 95% CI = [5.53, 6.06]; $M_{single\text{-}tasking}$ = 5.57, 95% CI = [5.30, 5.83]; $F(1, 198) = 1.42$, $p = .235$), how

[10]We present the results including all participants who did not answer this correctly (17 participants), but the findings are the same if you exclude them.

desirable the ability to perform well was ($M_{multitasking}$ = 6.02, 95% CI = [5.78, 6.26]; $M_{single\text{-}tasking}$ = 5.76, 95% CI = [5.52, 6.00]; $F(1, 198) = 2.31$, $p = .130$), how challenging they thought the activity would be ($M_{multitasking}$ = 5.25, 95% CI = [5.01, 5.49]; $M_{single\text{-}tasking}$ = 5.05, 95% CI = [4.81, 5.29]; $F(1, 198) = 1.30$, $p = .256$), and how stressed participants expected to be ($M_{multitasking}$ = 4.11, 95% CI = [3.79, 4.43]; $M_{single\text{-}tasking}$ = 3.75, 95% CI = [3.34, 4.07]; $F(1, 198) = 2.43$, $p = .121$).

Mediation. A mediation analysis using a bootstrap estimation approach with 10,000 samples (model 4 from the PROCESS macro; Hayes, 2013) estimated whether perceptions of difficulty mediated the effect of task framing on correctly identified words controlling for the other five measures (B = 0.1391, SE = .1405, 95% CI = [-.0171, .5306]). However, although the estimated effect was positive, the tail of the 95% CI included zero, thus indicating the mediation only approached significance. The 90% CI did not include zero (B = 0.1391, SE = .1262, 90% CI = [.0028 to .4539])[11].

Discussion

In this study I observe that expectations of difficulty of the task partially mediates the effect of multitasking framing on performance. Of importance, this mediation is only observed after controlling for several alternative mechanisms that most likely explain some of the variance in this effect. Although I argue that the perception of difficulty is an important driver of engagement, it is not the only one. In the next section, I will first rule

[11] The results are the same when looking at words submitted: B= 0.17, SE = 0.14, 90% CI = [0.01, 0.51]).

out several rival accounts before concluding with a discussion of the findings in this chapter.

RIVAL ACCOUNTS

STUDY 10: CONTROLLING WORK SEQUENCE (SWITCHING PATTERNS)

In the studies reported thus far, I find that holding constant the actual task, the mere perception of multitasking improved performance. However, while I controlled for the actual task, I did not experimentally control the sequence in which participants performed the task. In particular, in Studies 6-9, participants were free to switch whenever they wanted between the word puzzles. Therefore, it is possible that the framing manipulation changed the work sequence (i.e., participants switched sooner versus later, or switch more versus less frequently, etc.), which then drove the effect. Although, this may be part of what is driving the proposed effect, it does raise a certain concern about the scope of the effect. Specifically, one could argue that the findings are limited to specific tasks that favor one sequence over the other.

In addition to addressing this concern in Studies 5a and 5b where the switching occurs very rapidly, and both components of the task actually occurred simultaneously, in this study, I also address this concern by directly controlling the work sequence that participants used. In particular, instead of allowing participants to switch between tasks whenever they like, I externally impose a switching pattern. Because restricting the pattern in which participants switch back and forth might reduce their sense of agency, I also manipulated participants' sense of agency over the switching pattern to address this concern.

Method

One hundred and sixty-one paid online participants (52% female; mean age = 36.99) were recruited from Amazon's Mechanical Turk and were asked to complete an assignment in which they would be paid based on their performance. The assignment was comprised of two tasks. The first task was a word location task in which participants were given a pair of numbers to identify a word in different passages taken from Shakespeare's *Hamlet*. In particular, the first number indicated the row in the text that the word was located in, and the second number indicated its location in that specific row. For example, the number pair 14-8 indicated that the word participants needed to identify was the 8^{th} word on the 14^{th} line.

The second task was a letter-count task. In this task, participants were given different passages taken from Mary Shelley's *Frankenstein* and asked to count the number of times a specific letter appeared in that passage. For both tasks, participants were asked to choose the right answer (either word or number depending on the specific task) from five multiple-choice options. Overall, there were 24 available questions and, for each correct answer participants earned an additional $0.02.

Although the tasks were held constant across conditions, I randomly assigned participants to either the multitasking or single-tasking condition. Participants assigned to the multitasking condition learned that they would work on two distinct studies (labeled the "Cognitive Study" and the "Visual Study") comprised of the aforementioned word location and letter-count tasks, respectively. In order to make it salient that these were two different studies, I employed different fonts and background colors for each task. In the single-tasking condition, the two tasks were framed as part of a single study (labeled the "Cognitive-Visual Study") comprised of two types of questions. The instructions for the tasks were identical in both conditions and, although participants were told that they should finish the task in 9 minutes, they were actually allowed to work on the task for as long as they liked.

Unlike the word puzzles paradigm (e.g., Study 6b), in which both tasks were simultaneously visible on the screen, in this study participants observed only a single type of task at any point of time (either the word location or the letter-count task). Further, the task type alternated after every two questions. Thus, I externally controlled the work sequence and switching pattern (i.e., the task type switched every two questions).

Because imposing a strict switching pattern may reduce participants' sense of agency, I also manipulated (between-subjects) participants' sense of agency. In particular, in the agency condition, participants were asked to choose, in advance, the frequency with which they would switch from one type of question to the other (every 2, 4, or 6 questions). Participants assigned to the no agency condition were not given this choice and they had to switch every two questions. In order to keep the experimental conditions as similar as possible, I motivated participants in the agency condition to choose to switch every two questions by telling them that based on the performance of other participants taking this study in the past, the recommended frequency of switching was every two questions. Thus, the agency manipulation aimed to give participants the illusion of agency while keeping the switching patterns as similar as possible to those in the no agency manipulation. Indeed, the vast majority of participants in the agency condition (95%) chose to switch every two questions (analyzing the data with or without the 8 participants, 4 in the multitasking and 4 in the single-tasking condition, that chose a different switching pattern does not substantially change the pattern of results).

As measures of engagement, once participants finished working on the tasks, they reported how tired they felt and how bored they were (both measured on a 1 to 7 scale). As a manipulation check for the task framing, participants indicated to what extent they were multitasking (1 Not at all, 4 Somewhat, 7 Totally) and whether they felt like they were completing two different tasks, a single task with two components, or a single task (selected one of the three descriptions that matched their experience). As a manipulation check for sense of agency, participants indicated to what extent they felt they had control over the switching pattern between the two studies.

For exploratory purposes, upon finishing their assignment, participants in all conditions were asked several items adapted from Keinan (2007)'s productivity mindset measures.

Further, I asked participants to indicate their satisfaction with their performance on the task, how productive they felt, and their level of distraction during the task, (all measured on a 1 to 7 scale). Finally, participants responded to Sherer et al.'s (1982) self-efficacy scale to test whether this was affected by the task framing manipulation.

Results

Framing Manipulation Checks. Using an ANOVA I examined whether the manipulation worked as intended. Participants who were assigned to the multitasking condition indicated that they perceived that they were multitasking more relative to those assigned to the single-tasking condition ($M_{\text{multitasking}}$ = 3.92, 95% CI = [3.49, 4.35]; $M_{\text{single-tasking}}$ = 3.09, 95% CI = [2.73, 3.45]; $F(1, 151) = 8.65$, $p = .004$). Of the participants who were assigned to the multitasking [single-tasking] condition, 30% [26%] indicated perceiving their activity as working on two separate tasks ($\chi^2_{(1, N=153)} = 0.30$, $p > .58$), and 6% [16%] indicated perceiving their activity as working on a single task ($\chi^2_{(1, N=153)} = 4.02$, $p = .045$). Admittedly, the difference in perception, though statistically significant on the continuous measure (which offers more statistical power), is relatively small. This is not surprising given the specific characteristics of how I designed the stimuli in this study (i.e., observing the tasks sequentially as opposed to simultaneously). Nevertheless, I still find a statistically significant shift in the continuous measure and a weaker directional shift in the choice measures.

Agency Manipulation Check. An ANOVA verified that participants assigned to the agency condition reported having more control over the switching pattern of the questions than those assigned to the no agency condition (M_{agency} = 3.82, 95% CI = [3.39, 4.25]; $M_{\text{no\_agency}}$ = 2.95, 95% CI = [2.56, 3.34]; $F(1, 151) = 10.16$, $p = .002$). However, because this manipulation did not impact the dependent variables or interact with task framing (with the exception of participants' perceptions of their performance), I collapsed the results and do not discuss this factor further. Note that doing so does not substantially change the pattern of results.

Performance. I next examined the average number of attempted questions across conditions. Because there were overall 24 questions and some respondents completed all questions, the data was right censored. Therefore, I analyzed the data using a cox regression survival analysis in which I regressed the number of questions attempted on the task framing manipulation ($M_{multitasking}$ = 16.45, 95% CI = [14.79, 18.11]; $M_{single\text{-}tasking}$ = 13.73, 95% CI = [12.03, 15.43]; B = .35, 95% CI = [-.03, .73]; Wald-$\chi^2_{(1, N=153)}$ = 3.31, p = .069). Participants assigned to the multitasking condition also answered more questions correctly compared to those assigned to the single-tasking condition ($M_{multitasking}$ = 12.32, 95% CI = [10.87, 13.78]; $M_{single\text{-}tasking}$ = 9.79, 95% CI = [8.55, 11.04]; $F(1, 151)$ = 6.81, p = .010).

Persistence. An ANOVA comparing log-transformed time across conditions indicated that participants assigned to the multitasking condition worked, on average, longer on the assignment compared to those assigned to the single-tasking condition ($M_{multitasking}$ = 2.64, 95% CI = [2.56, 2.72]; $M_{single\text{-}tasking}$ = 2.50, 95% CI = [2.41, 2.59]; $F(1, 151)$ = 4.92, p = .029).

Boredom. The two items measuring boredom and fatigue were correlated ($r(151)$ = .54, $p < .001$) and collapsed. Despite working on average 90 seconds longer, participants assigned to the multitasking condition reported being less bored and less tired after working on the tasks compared to those assigned to the single-tasking condition ($M_{multitasking}$ = 2.99, 95% CI = [2.64, 3.34]; $M_{single\text{-}tasking}$ = 3.52, 95% CI = [3.20, 3.85]; $F(1, 151)$ = 4.89, p = .028).

Additional Analyses. I find no evidence to suggest that the framing manipulation affected any of the measures of subjective performance, feelings of productivity, or distraction (all p's > .34). Further, I find no evidence to suggest that participants' feelings of self-efficacy were impacted by the framing manipulation ($F(1, 151)$ = 2.19, p = .141).

Discussion

Study 10 replicates the focal effect using new tasks and a different paradigm (word location task and letter-count task) and shows that the perception of multitasking increases persistence and improves performance regardless of participants' switching pattern or sense of agency over the switching pattern. Interestingly, participants in the multitasking condition also reported being less bored and tired, despite spending longer on the task. This, again, suggests that participants in the multitasking condition were more engaged and aroused during the activity when such activity was construed as multitasking as opposed to single-tasking.

STUDY 11: CONTROLLING WORK SEQUENCE (SWITCHING PATTERNS)

The goal of this study was to replicate the main findings of Study 10 using a different paradigm that also explicitly controls for participants' work sequence.

Method

Ninety-nine paid online participants (41% female; mean age = 37.06) were recruited from Amazon's Mechanical Turk and were asked to complete an activity in which they would be paid based on their performance. The activity involved answering different questions that popped up in a messenger window for 15 seconds. During this time, participants were asked to choose the correct answer from five multiple-choice options. For example, a question may require participants to count the number of times an object appeared in an image or require participants to determine which image would come next in a certain visual pattern they viewed. After 15 seconds elapsed, the pop-up window would disappear, and a new pop-up window with a new question would appear two seconds later. Thus, at any given time, only one window with one question was visible on the screen. For each correct answer, participants earned an additional bonus of $0.03.

Although the tasks were held constant across conditions, I randomly assigned participants to either the multitasking or single-tasking condition. Participants assigned to the multitasking condition learned that they would "play two games simultaneously against two different people, named, Joe & Cam." Accordingly, in this condition, each pop-up question that appeared either related to a game against Joe or a game against Cam. I made this salient by adding an image and writing the name of the person this game is played against, on the top of the pop-up window. Thus, from the participants' perspective, every new question switched between the two games they were playing.

In the single-tasking condition, the task was framed as part of a single game against Joe. This was made salient by keeping the image and name of the person they were playing against constant on top of each pop-up window. Other than these, the instructions for the task were identical in both conditions. Participants could play the game(s) for as long as they liked. The game automatically stopped after 24 questions.

Results

Performance. I next examined the average number of attempted questions across conditions. Because some respondents (61%) completed all questions, the data was right censored. Therefore, I analyzed the data using a cox regression survival analysis in which

I regressed the number of questions attempted on the task framing manipulation. As predicted, participants assigned to the multitasking condition attempted more questions compared to those assigned to the single-tasking condition ($M_{multitasking}$ = 20.75, 95% CI = [18.76, 22.74]; $M_{single-tasking}$= 16.60, 95% CI = [14.03, 19.17]; B = 1.09, 95% CI = [.41, 1.78]; Wald-$\chi^2_{(1, N=99)}$ = 9.86, p < .002). An analysis of number of correct answers, revealed a similar directional pattern, albeit, not significant ($M_{multitasking}$ = 11.14, 95% CI = [9.48, 12.80]; $M_{single-tasking}$ = 9.50, 95% CI = [7.61, 11.39]; F(1, 97) = 1.64, p = .200). Thus, although participants in the multitasking condition tried to solve more questions, this increased motivation did not translate to significant improvement in performance at the aggregate level.

Discussion

This study provides further support for the main hypothesis. Participants that perceived their activity as multitasking (i.e., playing two games simultaneously) answered more questions than participants who felt they were playing a single game. As in real life, an increase in motivation does not always translate into an improvement in performance. Indeed, in this study I found that although participants in the multitasking condition, on average, answered more questions correctly, the difference did not reach statistical significance.

A replication of this study was conducted (N = 98), with a similar design but different number of overall questions (i.e., 28 instead of 24) and a different compensation scheme (i.e., $0.02 per correct answer instead of $0.03). The results of this replication study showed a similar pattern (attempts: Wald-$\chi^2_{(1, N=98)}$ = 3.95, p = .047; correct: F(1, 96) = 2.08, p = .152).

STUDY 12: SENSE OF AGENCY

Individuals often have the freedom to choose whether or not to multitask. Thus, to explore the robustness and ecological validity of the findings, this study aimed to test whether or not the observed effect is limited to situations in which individuals' activity of multitasking or single-tasking is externally imposed. Therefore, in this study I also manipulated participants' sense of agency in deciding whether or not to multitask.

Method

One hundred and fifty-nine paid online participants were recruited from Amazon's Mechanical Turk (48% female; mean age = 31.61). The procedure and methods were identical to those described in Study 6b. In addition to manipulating the task framing (multitasking vs. single-tasking), I also manipulated whether participants had a sense of agency over the decision of whether or not to multitask. Thus, the study was a 2 (multitasking condition vs. single-tasking condition) × 2 (agency vs. no agency) between-subjects design. In the no agency condition, participants were randomly assigned to either the multitasking or single-tasking condition. In contrast, in the agency condition, I gave participants a choice of whether to work on an assignment that would require them to multitask or single-task. In order to prevent self-selection, I randomly assigned participants in the agency condition to one of two incentive schemes. In one scheme, participants were informed that the average earnings of the multitasking assignment were high ($0.13) compared to the single task assignment ($0.02). This encouraged participants in this scheme to choose the multitasking assignment, yet maintained a sense of agency in the form of free choice. In the second incentive scheme, I told participants that the average earnings of the single task assignment were higher ($0.13) compared to the multitasking assignment ($0.02). In order to keep the incentive scheme as similar as possible across all conditions, participants in the no agency condition were also told that the average pay for the assignment they engaged in (either multitasking or single-tasking) was $0.13.

The majority of participants (97%) chose the assignment with higher expected earnings; thus, almost completely eliminating the possibility that a self-selection bias would significantly impact the results. However, in order to be as conservative as possible, in an auxiliary analysis, the 5 participants that chose to work on the lower-earning tasks were coded in a way that counters the hypothesis. Even after conducting this extremely conservative test, all results reported below hold.

As a manipulation check, participants indicated the extent to which they were multitasking (1 Not at all, 4 Somewhat, 7 Totally) and whether they felt like they were completing two different tasks, a single task with two components, or a single task (selected one of the three descriptions that matched their experience).

For exploratory purposes, upon finishing their assignment, participants in all conditions were asked to respond to the same post-task questions detailed in Study 6b (i.e., items relating to subjective feelings of performance, willingness to multitask on a subsequent task, perception of time, and attitudes). In addition, participants also indicated (i) how difficult they found the assignment to be (using two items), (ii) how efficiently they used their time while working on the assignment, and (iii) the extent they found the activity to be enjoyable, and (iv) the extent they found the activity to be challenging (all items measured on a 1 to 7 scale).

Results

Manipulation Checks. An ANOVA verified that the manipulation had the intended effect. Participants assigned to the multitasking condition indicated that they perceived their activity as multitasking to a greater extent than those assigned to the single-tasking condition ($M_{multitasking}$ = 4.76, 95% CI = [4.40, 5.12]; $M_{single\text{-}tasking}$ = 2.46, 95% CI = [2.09, 2.83]; $F(1, 150) = 75.59$, $p < .001$). There was no impact of agency ($F(1, 150) = 0.10$, $p > .70$) or an interaction between the agency and task framing manipulations on the extent to which participants indicated they were multitasking ($F(1, 150) = 0.73$, $p > .39$). Furthermore, of the participants who were assigned to the multitasking [single-tasking] condition, 34% [8%] indicated perceiving their activity as working on two separate tasks ($\chi^2_{(1, N=154)} = 15.01$, $p < .001$), and 4% [69%] indicated perceiving their activity as working on a single task ($\chi^2_{(1, N=154)} = 71.70$, $p < .001$). Thus, the framing manipulation worked as intended.

Performance. An ANOVA revealed that participants assigned to the multitasking condition submitted, on average, more words ($M_{multitasking}$ = 14.31, 95% CI = [12.80, 15.82]), than those assigned to the single-tasking condition ($M_{single\text{-}tasking}$ = 8.22, 95% CI = [7.19, 9.25]; $F(1, 150) = 42.97$, $p < .001$). The analysis also revealed a main effect of agency on performance (M_{agency} =12.63, 95% CI = [11.06, 14.20]; M_{no_agency} = 10.26, 95% CI = [8.90, 11.62]; $F(1, 150) = 5.25$, $p = .023$). However, more pertinent to the goal of this study, the interaction between agency and framing manipulation was not statistically significant ($F(1, 150) = 2.60$, $p = .109$) indicating that participants perceiving their activity as multitasking, performed better regardless of whether or not they had a sense of agency over the decision to multitask.

The same pattern holds when looking at correct responses. Specifically, an ANOVA revealed that participants assigned to the multitasking condition submitted more correct words, on average, ($M_{\text{multitasking}} = 12.78$, 95% CI = [11.42, 14.14]), than those assigned to the single-tasking condition ($M_{\text{single-tasking}} = 7.31$, 95% CI = [6.37, 8.25]; $F(1, 150) = 42.17$, $p < .001$). The analysis also revealed a main effect of agency on performance ($M_{\text{agency}} = 11.23$, 95% CI = [9.77, 12.69]; $M_{\text{no\_agency}} = 9.17$, 95% CI = [7.99, 10.35]; $F(1, 150) = 4.84$, $p = .029$). However, more pertinent to the goal of this study, the interaction between agency and framing manipulation did not reach statistical significance ($F(1, 150) = 2.14$, $p = .145$).

Persistence. Participants assigned to the multitasking condition spent, on average, longer on the task ($M_{\text{multitasking}} = 2.35$, 95% CI = [2.33, 2.37]) compared to those assigned to the single-tasking condition ($M_{\text{single-tasking}} = 2.25$, 95% CI = [2.18, 2.32]). However, the results failed to reach statistical significance (B = .18, 95% CI = [0.10, 0.26]; Wald-$\chi^2_{(1, N=154)} = 0.13$, $p > .70$). No main effects of the agency manipulation or its interaction with the framing manipulation were observed (Wald-$\chi^2_{(1, N=154)} = 0.41$, $p = .522$; Wald-$\chi^2_{(1, N=154)} = 2.59$, $p = .108$, respectively). In all subsequent analyses, no other main effects of the agency manipulation or its interaction with the framing manipulation reached statistical significance. Thus, I collapsed the results across this factor and do not discuss it further.

Additional Analyses. The three questions of subjective performance were combined into a single scale ($\alpha = .91$). An ANOVA revealed that participants assigned to the multitasking condition believed they performed better compared to those assigned to the single-tasking condition ($M_{\text{multitasking}} = 4.10$, 95% CI = [3.79, 4.41]; $M_{\text{single-tasking}} = 3.58$, 95% CI = [3.26, 3.90]; $F(1, 152) = 5.52$, $p = .020$). These results suggest that, in general, participants' perceptions were calibrated with their actual performance. Participants assigned to the multitasking condition were also more likely to choose to multitask on a subsequent task (58%, 95% CI = [46%, 69%]) compared with those assigned to the single-tasking condition (16%, 95% CI = [8%, 24%]; $\chi^2_{(1, N=154)} = 27.91$, $p < .001$).

Participants assigned to the multitasking condition indicated feeling that time passed more quickly than those assigned to the single-tasking condition ($M_{\text{multitasking}} = 5.19$, 95% CI = [4.88, 5.50]; $M_{\text{single-tasking}} = 4.69$, 95% CI = [4.32, 5.96]; $F(1, 152) = 3.63$, $p = .059$), and also felt more rushed ($M_{\text{multitasking}} = 4.81$, 95% CI = [4.49, 5.13]; $M_{\text{single-tasking}} = 4.24$, 95% CI = [3.85, 4.64]; $F(1, 152) = 4.25$, $p = .041$). All other measures (estimation of minutes spent on activity, enjoyment, and perceived efficiency) were all not affected by the framing manipulation (all p's > .25). Additionally, I did not observe any differences on perceptions of task difficulty ($p > .25$). Of note, the hypothesis about task difficulty improving productivity is specific to the *expectation* of task difficulty. Since I hold the activity constant across conditions, it is unsurprising this measure did not differ.

Discussion

This study demonstrates that the mere perception of multitasking improves performance regardless of whether or not individuals have a sense of agency over the decision to multitask.

STUDY 13: EXTRAVERSION AND NEUROTICISM

Previous research has demonstrated that individuals' tendency to habituate and adapt impacts their task performance (Deutsch & Deutsch, 1963). In particular, when people habituate to an activity they pay less attention to it, which could hurt performance on that activity. Accordingly, one potential reason for the observed difference in performance across the framing conditions is that individuals who perceive their activity as multitasking habituate slower and therefore perform better. If such a mechanism is the main driver of the effect, one should expect to find that the impact of the framing manipulation on performance should be stronger for individuals who tend to adapt quicker to activities. Building on previous literature, in this study I test this habituation account. In particular, previous literature found that individuals who are typically quicker to adapt to different stimuli and environments, score high on extraversion and neuroticism scales (Mangan & O'Gorman, 1969). Thus, to the extent that rate of habituation is a driver of the effect, one should expect to see that the effect would be stronger for people who score higher on these scales. To test this, in the current study I measured participants' individual differences on the extraversion and neuroticism scales and examined whether these would moderate the observed effect.

Method

Six hundred six paid online participants were recruited from Amazon's Mechanical Turk (48% female; mean age = 36.09). The procedure and methods were identical to those described in Study 6b. As a proxy for participants' tendency to adapt to different stimuli, participants also completed the extraversion and neuroticism subscales of Eysenck's Personality inventory (Eysenck & Eysenck, 1975) either before or after the main tasks in this study (manipulated between-subjects).

Results

Whether participants answered the neuroticism and extraversion questions before or after working on the task did not significantly impact the pattern of results, and thus I present the results collapsed across this factor.

Performance. An ANOVA showed that participants in the multitasking condition submitted more words (M = 12.50, 95% CI = [11.61, 13.39]) than participants in the single-tasking condition (M = 8.35, 95% CI = [7.63, 9.07]; $F(1, 604) = 50.43$, $p < .001$). An ANOVA also showed that participants in the multitasking condition submitted more correct words (M = 11.72, 95% CI = [10.84, 12.60]) than participants in the single-tasking condition (M = 7.61; 95% CI = [6.94, 8.28]; $F(1, 604) = 53.47$, $p < .001$).

Persistence. A cox regression survival analysis revealed that participants assigned to the multitasking condition worked longer on the task (M = 2.34, 95% CI = [2.33, 2.35]) compared to participants in the single-tasking condition (M = 2.25, 95% CI = [2.21, 2.29]; B = .33, 95% CI = [.15, .51]; Wald-$\chi^2_{(1, N=606)} = 13.27$, $p < .001$).

Extraversion and Neuroticism. Participants' responses to the extraversion scale were averaged and mean-centered. A regression analysis revealed that although the main effect of the framing manipulation on words correctly submitted was significant (B = 2.07, 95% CI = [1.52, 2.63]; $t(604) = 7.38$, $p < .001$), neither participants' extraversion nor its interaction with the framing manipulation was statistically significant (B = -0.08, 95% CI = [-.17 .01], $t(604) = -1.78$, $p = .076$; B = 0.01, 95% CI = [-.08, .11]; $t(604) = 0.33$, $p = .741$). A similar procedure was employed for examining participants' responses to the neuroticism scale. Again, neither neuroticism nor its interaction with the framing manipulation significantly impacted performance (B = -0.03, 95% CI = [-.11, .05]; $t(604) = -0.67$, $p = .506$; B = -0.02, 95% CI = [-.10, .06]; $t(604) = -0.51$, $p = .613$, respectively).

Discussion

By measuring participants' neuroticism and extraversion, I find no evidence to support that the effect of the framing manipulation on performance is driven by individuals' tendency to adapt more slowly to different stimuli.

STUDY 14: WORK RELATED CONSTRUCTS

The goal of this study was to test whether the multitasking framing will impact work related constructs. Specifically, previous research demonstrated that individuals' self-efficacy and locus of control are positively correlated with performance (Judge & Bono, 2001; Stajkovic & Luthans, 1998). Therefore, in the current study, after administering the manipulation, I measured Rotter's locus of control scale (Rotter, 2011) or Sherer et al.'s self-efficacy scale (Sherer et al., 1982) to test whether these were affected by the task framing.

Methods

One hundred and eighty-three participants from Amazon's Mechanical Turk (44% female; mean age = 37.96) were recruited to take part of a study. Participants were assigned to either a multitasking or single-tasking condition (between-subjects) and the descriptions of the tasks in this study were identical to those in Study 6b. Participants were led to believe that they were going to work on the tasks but prior to beginning were asked to respond to several items. In particular, I randomly assigned participants to respond to either a 9-item version of Rotter's locus of control scale (Rotter, 2011) or Sherer et al.'s self-efficacy scale (Sherer et al., 1982). This randomization procedure ensured that participants' responses to one scale would not affect their responses to the other. Consequently, participants responded to either all of the items from the self-efficacy scale or the locus of control scale (items for both scales are listed in the appendix).

Results

Locus of control. (N = 89) Participants' responses to the locus of control scale were averaged ($\alpha = .59$). An ANOVA showed that the framing manipulation did not affect participants' locus of control ($M_{multitasking} = 4.51$, 95% CI = [4.19, 4.84]; $M_{single\text{-}tasking} = 4.86$, 95% CI = [4.55, 5.17]; $F(1, 87) = 2.36$, $p = .128$).

Self-efficacy. (N = 94) Participants' responses to the self-efficacy scale were averaged ($\alpha = .67$). The results of an ANOVA showed that the task framing manipulation did not affect participants' self-efficacy ($M_{multitasking}$ = 5.32, 95% CI = [5.03, 5.62]; $M_{single\text{-}tasking}$ = 5.20, 95% CI = [4.91, 5.49]; $F(1, 92) = 0.34$, $p > .56$).

Discussion

In this study, I find no evidence to support that the task framing impacted the work related constructs, locus of control and self-efficacy. Thus, I find no evidence to support that the effect of the framing manipulation on performance is driven by a shift in individuals' locus of control or self-efficacy.

DISCUSSION

This chapter showed that the perception of multitasking improves performance because of heightened engagement, and an important driver of this engagement in perceived task difficulty. In four studies, I show that switching, agency, adaptation, and work-related constructs cannot explain the perception of multitasking's effect on performance. Although I rule out these rival accounts, there is still likely to be other drivers of engagement that contribute to this robust effect. In light of the findings that multitasking is a desirable trait, an additional reason for the improvement in performance may relate to one's motivation to appear as an adept multitasker by being successful at the multitasking activity. Another potential mechanism is that participants about to engage in a multitasking activity as opposed to a single-tasking activity, may have an expectation that they will be more productive and thus need to exert effort. Additional research is needed to disentangle the different psychological mechanisms that drive this effect.

CHAPTER 4: REPLICATIONS AND META-ANALYSIS

Using five different paradigms, I tested across 29 studies the central hypothesis that the perception of multitasking improves performance. To assess the size and robustness of the focal effect, I conducted and report next an internal meta-analysis.

Method

Overall, I conducted a total of 29 studies[12] (k = 29) that employed the paradigms reported in this dissertation and appendix. Of these studies, 23 employed the word puzzles task (reported in Study 6b), 2 used a count-locate task (see Study 10), 2 used an online game task (see Study 11), 1 used a transcription task (Study 5a), and 1 used a note-taking task (Study 5b).

In addition to the exclusions described in this dissertation, one of the studies had an additional condition in which participants were told to expect that they might need to multitask during the task without directly manipulating their perception of the focal task. I excluded this condition from the analysis (n = 37). Thus, bringing the total sample size of participants for the meta-analysis to 7,880.

Of the 29 studies, 5 studies were conducted in a behavioral lab at a northeastern university (n = 784; 38% males, and average age 22.48, 95% CI = [22.06, 22.89]), and 24 studies (n = 7096; 43% males and average age 36.33, 95% CI = [36.05, 36.61]) were conducted online using Amazon's Mechanical Turk. These samples had significantly

[12] Three earlier studies in which the framing manipulation check failed are excluded from this analysis. Including these does not substantively change the reported results.

different average ages ($t(7878) = 33.06$, $p < .001$) and gender distributions ($\chi^2 = 166.69$, $p < .001$).

Dependent Variable

Across all of the studies, performance was calculated based on the specific paradigm that was employed. Specifically, in the transcription task, I used correct words transcribed (as described in Study 5a). In the note-taking task, I used coders' scores (as described in Study 5b). In the word puzzles task, I measured the number of correct words identified (as described in Study 6). In the count-locate task and in the online game task, I measured the number of correct multiple-choice responses (as described in Studies 10 and 11, respectively). Table 2 summarizes all the studies conducted.

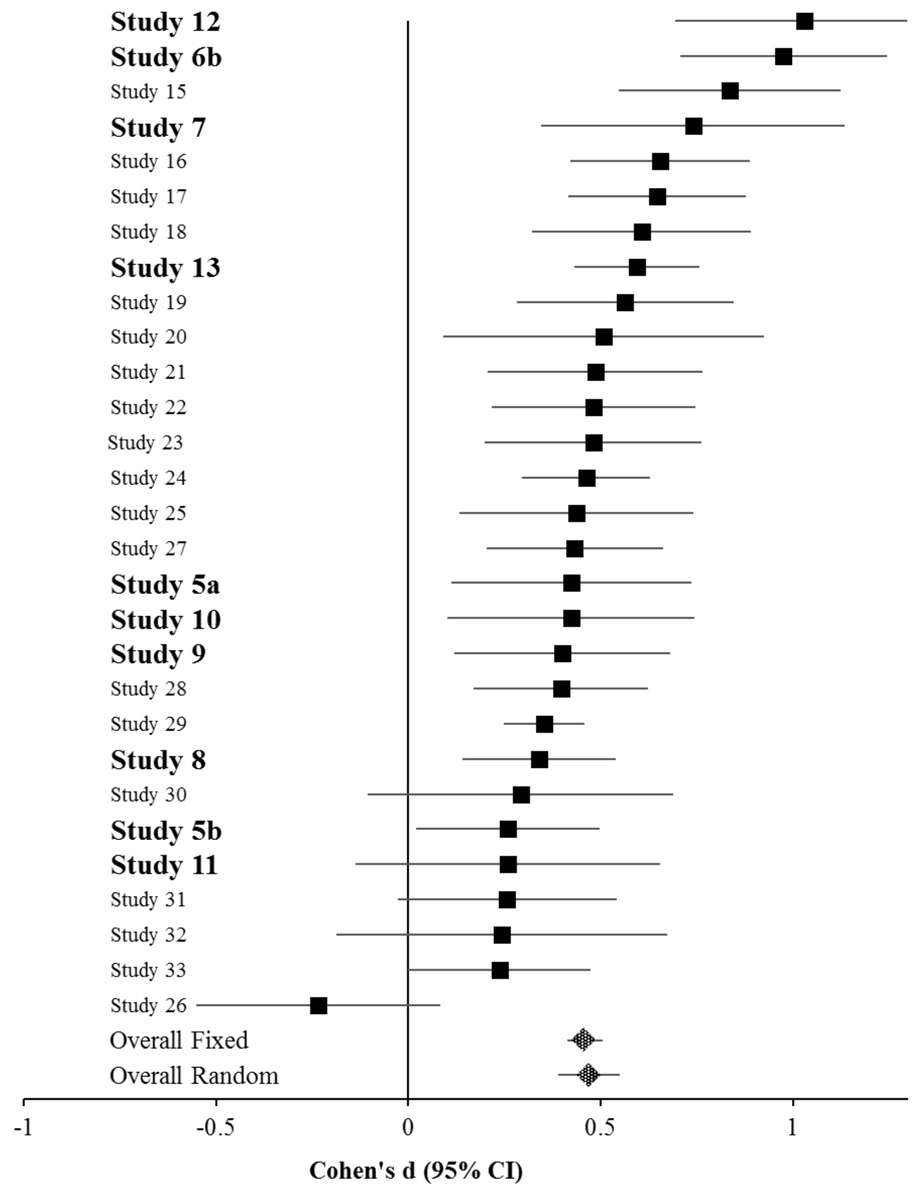
Table 2: Summary of studies conducted that manipulate the perception of multitasking to examine its effect on performance.

Study	Task	Multitask			Single Task			F-stat	p-value
		N	Mean	SD	N	Mean	SD		
Study 5a	Transcription	82	223.77	108.89	80	177.20	110.97	7.27	0.01
Study 5b	Note-taking	128	3.76	1.63	145	3.32	1.77	4.55	0.03
Study 6b	Word Puzzles	120	13.65	7.50	117	7.50	4.76	44.60	0.00
Study 7	Word Puzzles	61	17.16	11.39	46	9.78	7.69	14.36	0.00
Study 8	Word Puzzles	191	11.14	6.04	203	9.50	6.67	1.64	0.20
Study 9	Word Puzzles	101	10.55	6.60	99	8.48	5.58	11.42	0.00
Study 10	Count-locate	71	12.32	6.24	82	9.79	5.75	6.81	0.01
Study 11	Game	51	11.14	6.04	48	9.50	6.67	1.64	0.20
Study 12	Word Puzzles	80	12.78	6.21	74	7.31	4.12	42.17	0.00
Study 13	Word Puzzles	301	11.72	7.75	305	7.61	5.99	53.47	0.00
Study 15	Word Puzzles	101	12.53	9.48	99	5.28	7.76	34.95	0.00
Study 16	Word Puzzles	153	11.22	6.55	146	7.09	6.04	32.01	0.00
Study 17	Word Puzzles	144	13.04	8.37	157	8.39	5.90	31.40	0.00
Study 18	Word Puzzles	98	12.23	8.95	102	7.95	4.55	18.40	0.00
Study 19	Word Puzzles	101	13.13	6.26	99	9.46	6.76	15.84	0.00
Study 20	Word Puzzles	45	14.49	10.71	46	9.63	8.28	5.88	0.02
Study 21	Word Puzzles	101	11.33	8.94	100	7.82	4.93	11.83	0.00
Study 22	Word Puzzles	153	12.01	7.86	88	8.56	5.73	12.97	0.00
Study 23	Word Puzzles	94	12.83	9.13	105	8.38	9.36	11.46	0.00
Study 24	Word Puzzles	284	11.58	6.59	285	8.75	5.61	30.29	0.00
Study 25	Word Puzzles	86	14.00	8.35	84	10.44	7.95	8.10	0.01
Study 26	Count-locate	78	10.84	6.55	76	12.27	5.62	2.11	0.15
Study 27	Word Puzzles	151	11.97	7.55	149	8.77	7.23	14.07	0.00
Study 28	Word Puzzles	142	11.32	5.80	161	8.95	6.13	11.90	0.00
Study 29	Word Puzzles	722	11.62	7.42	697	9.28	5.68	44.08	0.00
Study 30	Game	50	12.67	8.30	48	10.26	8.20	2.08	0.15
Study 31	Word Puzzles	96	17.49	9.39	95	15.08	9.37	3.14	0.08
Study 32	Word Puzzles	38	12.42	7.58	46	10.35	6.64	1.79	0.19
Study 33	Word Puzzles	139	10.34	6.74	136	8.98	4.53	3.84	0.05

In order to determine the effect size on performance, I conducted an internal meta-analysis using the conventional approach (e.g., Borenstein, Hedges, & Rothstein, 2007; Cumming, 2014; Wilson, 2006). For each study, I calculated the Cohen's *d* for the main effect of task framing (multi- vs. single-tasking) regardless if an additional factor was manipulated or if I required all participants to work the same amount of time. Thus, I calculated a conservative estimate for the effect size. In order to calculate each study's Cohen's *d*, I subtracted the average performance in the multitasking condition by the average performance found in the single-tasking condition and divided the difference by the pooled standard deviation. I then weighted the Cohen's *d* based on the inverse variance of the study's sample.

In order to determine if a fixed or random effects model was appropriate, I conducted a test of homogeneity that revealed that the variability observed across the effect sizes exceeded what would be expected from sampling error ($Q(28) = 78.21$, $p < .001$). Thus, I estimated an average Cohen's $d = .470$, 95% CI = [.39, .55], using a random effects model. The fixed effect results yield a similar effect and confidence interval (Cohen's $d = .457$, 95% CI = [.41, .50]). Both the random effects and fixed effects models demonstrate that the effect of the perception of multitasking on performance is moderate in size and is significantly greater than zero, Z = 11.69 (Z = 19.92 for fixed effects), $p < .001$. See Figure 7 for forest plot.

Fig. 7: Forest Plot of Observed Effect Sizes Broken Down by Study



*All 29 studies conducted ordered by effect sizes with 95% confidence interval. Studies that appear in main text are in larger font.

Moderators

The 29 studies I conducted, varied systematically on several dimensions. I explore some of these variations using a meta-analytic approach (Wilson, 2006). Because these analyses were exploratory, and because I did not make a priori predictions about these potential moderators, I adjusted the critical p-value using a Bonferroni correction. Since I are testing 6 potential moderators, the threshold for statistical significant was set at a p-value of .009.

Lab versus online sample. I first tested whether there was a significant difference in effect size as a result of running studies in the lab (5 studies; coded as “1”) or online (24 studies; coded as “0”). The analysis did not reveal a significant difference using the Bonferroni corrected critical value (.009) as a result of where the study was conducted. Fixed effects model: B = -.18, 95% CI = [-.33, -.03]; Z= -2.36, p = .018; Method of moments random effects: B = -.19, 95% CI = [-.41, .03]; Z = -1.72, p = .086;

Including the term “multitasking” in the manipulation. In several of the studies (21; coded as “1”) I used stronger manipulations in which I explicitly mentioned the word “multitasking” as part of the instruction in the multitasking condition. The rest of the studies (8; coded as “0”) did not explicitly use this term. The analysis did not reveal a significant difference, using the Bonferroni corrected critical value (.009), of using the term “multitasking” in the manipulation. Fixed effects model: B = .03, 95% CI = [-.08, .14]; Z = .48, p = .630; Method of moments random effects: B = .04, 95% CI = [-.15, .22]; Z= .19, p = .847.

Time on task. I next tested whether there was a significant difference as a result of exogenously controlling the time participants spent on the task. Specifically, I compared studies (2; coded as “1”) in which all participants were forced to work on the task for a specific amount of time, with studies in which they were free to quit at any time (27; coded as “0”). I do not observe a significant difference as a result of holding time constant. Fixed effects: B = .19, 95% CI = [.01, .37]; Z= 2.12, *p* = .034; Method of moments random effects: B = .22, 95% CI = [-.08, .51]; Z = 1.41, *p* = .244.

Switching and work sequence. As alluded to earlier, in the word puzzles paradigm, participants were free to switch between the tasks whenever they liked. Thus, it is possible that part of the effect may be driven by a shift in work sequence due to different switch-patterns across conditions. To approximate how much of the effect the switching account could explain, I coded each study (using a dummy variable) whether it employed the word puzzles paradigm (23 studies; coded as "1") or used a different paradigm (6 studies; coded as "0"). The analysis revealed a significant difference on this dimension, suggesting a stronger observed effect for studies that employed the word puzzles paradigm. Fixed effects: B = .25, 95% CI = [.11, .39]; Z= 3.59, $p < .001$; Method of moments random effects: B = .28, 95% CI = [.09, .48]; Z = 2.83, *p* = .005.

This significant difference in effect size may be driven by factors inherent to the specific word puzzles paradigm, but may also suggest that participants' difference in switching patterns across conditions are partly driving the effect. Because in the data these two are fully confounded I cannot disentangle these possibilities. Further, as alluded to earlier, one should be cautious in interpreting this analysis as the word puzzles paradigm does not allow one to distinguish whether a task switch is an outcome of finding a word, or vice versa. Additional research is needed to more thoroughly and directly address this issue of causality. Having said that, I find that the effect persists even when not including all studies that employed the word puzzles paradigm. Random effects: Cohen's *d* = .24, 95% CI = [.06, .41]; Fixed effects: Cohen's *d* = .24, 95% CI =

[.11, .36]. Both the random effects and fixed effects models are significantly greater than zero; Z = 2.57, $p = .010$ (Z = 3.58 for fixed effects, $p < .001$).

Incentive Strength. I next tested whether there was a significant difference in the effect size as a function of incentives strength. Because the current studies differed in the level of monetary incentives, for each study, I calculated the expected amount of bonus per minute based on the average correct performance, and used a regression to examine its effect. No significant difference was observed as a function of the expected bonus incentives employed. Fixed effects model: B = -.17, 95% CI = [-.53, .20]; Z= -.90, p = .369; Method of moments random effects: B = -.19, 95% CI = [-.75, .37]; Z = -.67, p = .511. I did a similar analysis examining actual bonuses received, which differed from expected bonuses when real time coding of correct responses could not be done (e.g. the number of correct words transcribed). Again, I did not observe a significant impact on effect as a function of the strength of incentives employed. Fixed effects model: B = -.15, 95% CI = [-.52, .21]; Z= -.83, p = .409; Method of moments random effects: B = -.17, 95% CI = [-.71, .37]; Z = -.62, p = .534.

We next examined the effect of the bonus incentives as a proportion of the base payment amount (i.e., what participants typically receive per minute work in the lab or on Amazon's Mechanical Turk without bonus payments). Since there are different base payment amounts typically used in the lab and in the online panel, the proportion yields a standardized measure. For each study, I calculated the expected bonus amount based on the average correct submissions and divided it by the base bonus amount ($0.10 per minute for online studies and $0.17 per minute for lab studies). Again, I do not observe a significant difference as a result of the different bonus incentives employed. Fixed effects: B = -.03, 95% CI = [-.09, .04]; Z= -.79, p = .432; Method of moments random effects: B = -.03, 95% CI = [-.12, .07]; Z = -.61, p = .544. Similarly, using the calculation for actual bonus as a proportion of the different base amounts did not yield a difference in the size of the effect. Fixed effects: B = -.04, 95% CI = [-.13, .05]; Z= -.92, p = .360; Method of moments random effects: B = -.05, 95% CI = [-.18, .08]; Z = -.70, p = .486.

Analyzing Performance as a Function of Perceptions

In sixteen of the studies, I measured participants' perceptions of multitasking versus single-tasking, at the end of the study. Given the time that elapsed between when the manipulation was administered (prior to the task) and when the manipulation check (To what extent did you feel like you are multitasking on these studies [1 Not at all, 4 Somewhat, 7 Totally]) was measured (only at the end of the experiment), this measure was suspected to be relatively noisy. Indeed, when pooling the results from only these studies I find a significant positive relationship between perceptions of multitasking and answers submitted (using z-scores calculated for each study: B = 0.11, 95% CI = [.08, .14]; $t(4799) = 7.61$, $p < .001$). A mediation analysis using a bootstrap estimation approach with 5,000 samples (model 4 from the PROCESS macro; Hayes, 2013) identified a significant mediating role of the manipulation check (B = 0.013, SE = .0061, 95% CI = [.0005, .0252]).

CONCLUSIONS, IMPLICATIONS, AND NEXT STEPS

Although the prevalence of technology is bringing multitasking to almost every aspect of life, social scientists have focused on the detrimental effects of doing multiple tasks rather than doing a single task. By contrast, I make a different comparison: given that many activities consist of different components, and that for non-automatic tasks people cannot actually multitask, I test which factors induce perceptions of multitasking and whether such perceptions impact performance. I show that in this context, the perception of multitasking is malleable and that, on its own, benefits rather than harms performance. The results suggest that this effect is due to heightened engagement and perceived difficulty of the task, which could have important managerial and marketing implications.

In Chapter 1, I explore how different factors influence the perception of multitasking. I establish two principles that are necessary for the perception of multitasking. In the Studies 1 and 2, I provide evidence for the principle of separation, which posits that for an individual to perceive their activity is multitasking they must feel as if the components of the activity they are engaging in are distinct and separate. Study 3 supports the principle of simultaneity by showing that perceived switching could induce the perception of multitasking. Finally in Study 4, I demonstrate how these two principles can be used in conjunction to make people construe the exact same activity as multitasking or single-tasking.

In Chapter 2, I demonstrate that the perception of multitasking can impact performance. Although previous literature has identified detrimental effects of multitasking, I show that when participants are doing the exact same activity and perceive it as multitasking as opposed to single-tasking they actually perform better. In four studies, I replicate this finding across several paradigms by both manipulating and measuring the perception of multitasking. Of importance, I show that this effect on performance extends to both activities that people naturally construe as single-tasking (Studies 5a and 5b) and activities they naturally construe as multitasking (Studies 6a and 6b).

In Chapter 3, I first show that the perception of multitasking heightens engagement using a physiological measure. Then, in two studies, I demonstrate that a driver of this engagement is the expectation that multitasking is difficult. Although I identify an important driver of engagement, it is plausible that like many robust effects there are additional drivers of engagement such as expectations of productivity and the desirability of multitasking. Future work will need to full examine these. Finally, in four studies, I rule out several rival accounts: switching, agency, adaptation, and work-related constructs.

I conclude with an internal meta-analysis reported in Chapter 4 that demonstrates the robustness of the effect across different paradigms and stimuli. The meta-analysis tests key moderators such as sample (lab vs. online), using the term “multitasking” in the manipulation, time on the task, controlling switching patterns, and incentive strength. I find that the focal effect that the perception of multitasking improves performance is robust to all these moderators.

This work has a number of important implications. Although I would never suggest that people actively choose to multitask, if an individual must multitask, recognizing that they are doing so could help mitigate some of the detrimental effects of doing more at once. Furthermore, even if an individual perceives what they are doing to be a single-task, breaking that task into its components so the individual feels like they are multitasking can also improve performance. This simple change in framing could have a large impact for education, driving, gaming, management, and marketing. I will next discuss managerial and marketing implications and next steps in greater depth.

Managerial implications and next steps

The current work has clear implications for how managers can improve the performance of their employees. People frequently try to multitask in the workplace and this behavior has been shown to be detrimental to performance (e.g., Kreckler et al., 2008). For example, customer service agents who multitask while chatting online with customers tend to have longer service delays and lower problem resolution rates, which in turn leads to lower customer satisfaction (Goes et al., 2017). The results reported in this dissertation suggests that given that people are indeed engaged in multiple activities, recognizing that they are multitasking may mitigate the detrimental effects of multitasking. Therefore, an important implication of the current work is that managers should make employees who have to switch frequently between tasks aware that they are multitasking. So, a manager of customer service agents should encourage their employees to recognize that they are multitasking as they navigate between customer queries. Future work could examine how such an intervention in a field setting affects performance, and the duration and magnitude of the intervention on performance.

The ubiquity of reported multitasking in the workplace suggests that people are frequently choosing to engage in multitasking. Another important question related to this research are under what conditions people choose to multitask. While there could be a number of reasons why an individual would engage in multitasking, I anticipate that people who want to feel productive and busy will prefer activities that they perceive are multitasking. Understanding why people actively choose to multitask, an activity they expect to be difficult, could further help managers mitigate multitasking's detrimental effects.

Marketing implications and next steps

The current work has implications for how people prepare to engage in multitasking and how the perception of multitasking can influence consumer experiences. In the studies, when participants are about the engage in an activity they perceive as multitasking they recruit cognitive resources to prepare for a task they perceive as more challenging and difficult. In many situations, people also prepare to multitask and, as a result, they are likely to behave differently. For example, if you are purchasing a tablet that you know you are going use to multitask. What type of attributes would be important to you? How might the way you search and purchase this tablet be different if it wasn't highlighted that you would frequently use the tablet to multitask? In this dissertation I find that when people are about to engage in an activity that they perceive as multitasking, they cognitively prepare to enhance their performance and productivity. Accordingly, consumers who are about to purchase a tablet to use for multitasking might seek out attributes that will help them prepare and enhance their performance, such as processing capabilities and other technical attributes. They also might search for the tablet longer to look at more options. Anticipating multitasking might not only change shopping behaviors but also how one prepares to cook, travel, or work. Therefore, additional research on how preparing to engage in multitasking seems warranted and potentially fruitful.

I argue that many activities can be made to feel like they are multitasking by employing the factors discussed in Chapter 1. This finding suggests that the perception of multitasking could have an impact on how people process content in stores, on television, and while playing videos games. Recently, there has been an increase in the use of scannable shelf displays, which allows consumers to have an in-store and mobile shopping experience simultaneously (Lacy, 2018). The current work would suggest that recognizing that you are multitasking, as you switch back and forth between tabs on your browser, and the actual store display, would increase your engagement with the content. Furthermore, it is possible that when people watch television using split screens (or even shows that employ split screens like Red Zone), priming viewers to recognize their experience as multitasking might also increase their engagement with the displayed content. Finally, I find initial evidence that online gaming can employ the perception of multitasking to improve performance and engagement. In Study 11, I find that when participants felt they were playing two games versus one they performed relatively better. Future work will be needed in order to further explore the importance of the perception of multitasking to marketers.

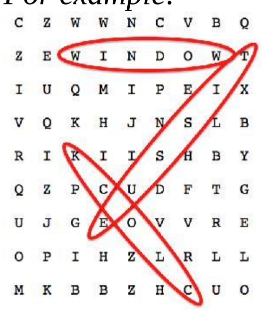
APPENDIX

STUDY 4C:

ADDITIONAL INFORMATION REGARDING METHOD

Multitasking framing manipulation

In this survey you will work on two studies simultaneously: Perceptual Study and Identification Study.
In the Perceptual Study you will work on a word find puzzle. A word find puzzle is a game in which you observe a matrix containing letters and need to find as many meaningful words inside the matrix. The words could appear vertically, horizontally, or diagonally, and in either straight or reversed order.
For example:



In the Identification Study you will work on a scrabble game. A scrabble game is a game in which you observe a string of letters, and are asked to use the letters in the string (all or part) in any order you would like, in order to construct meaningful words.
For example:

You are to (i) in the Perceptual Study, find (in the matrix) as many meaningful words as possible and write these words in the appropriate box below, and (ii) in *the Identification Study, construct (from the string of letters) as many meaningful words as possible and write these words in the appropriate box below.*

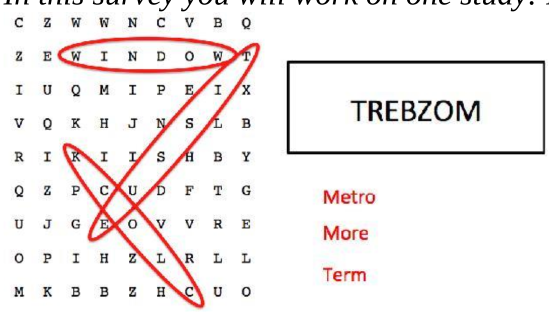
You are to work on the two studies ***simultaneously****.*

Each correct word that you find in the ***perceptual study*** *will earn you additional $0.01.*

Each correct word that you find in the ***identification study*** *will also earn you additional $0.01.*

Single-tasking framing manipulation

In this survey you will work on one study: Perceptual-Identification Study.



In the perceptual-identification study you will work on a word find-scrabble game. A word find-scrabble game is a game in which you observe a matrix containing letters and need to find as many meaningful words inside the matrix. The words could appear vertically, horizontally, or diagonally, and in either straight or reversed order. Furthermore, in a word find-scrabble game, you observe a string of letters, and are asked to use the letters in the string (all or part) in any order you would like, in order to construct meaningful words.

In the Perceptual-Identification Study, you are to find (in the matrix and string of letters) as many meaningful words as possible and write these words in the appropriate box below.

Each correct word that you find in the perceptual-identification study will earn you additional $0.01.

STUDY 5A:

ADDITIONAL INFORMATION REGARDING METHOD, PROCEDURES AND ANALYSES

Need for structure. After completing the task, participants navigated to an ostensibly unrelated survey in which they responded to items about their need for structure (Thompson et al., 2001). This scale measures individuals' preference for structure and clarity in the information they process (Thompson et al., 2001). Because it is possible that the multitasking framing also adds structure to the activity at hand by making the components of a given activity more salient, one might expect the effect to increase for individuals with greater need for structure.

After completing the task, participants navigated to an ostensibly unrelated survey in which they responded to items about their need for structure (Thompson et al., 2001). One participant did not respond to the need for structure items and was therefore eliminated from the analysis. Thus, the responses of the remaining one hundred and sixty-one participants were averaged and mean-centered their responses on the need for structure scale. I tested whether the effect of the task framing on the number of words transcribed was moderated by participants' need for structure. A regression analysis revealed that, the main effect of the framing manipulation on the number of correct words was positive and significant (B = 25.93, 95% CI = [8.89, 42.96]; $t(159) = 3.01$, $p = .003$), replicating the proposed effect. Interestingly, the main effect of need for structure on number of correct words was positive and reached marginal significance (B = 21.70, 95% CI = [-2.78, 45.67]; $t(159) = 1.78$, $p = .076$), suggesting that, generally, people with a higher need for structure performed better on this specific task. However, I did not find that the need for structure moderated the effect of framing on performance since the interaction was not significant (B = 12.37, 95% CI = [-11.61, 36.34]; $t(159) = 0.99$, $p = .310$).

STUDY 6A:
ADDITIONAL INFORMATION REGARDING METHOD, PROCEDURES AND ANALYSES

After all participants finished working on the main task, I measured the extent to which they perceived their activity as either multitasking or single-tasking. Specifically, participants were given four sets of two scenarios and were asked to indicate, in each set, which of the two scenarios they perceived to be more similar to the activity they had just completed. I framed each scenario to be perceived as either multitasking or single-tasking, but kept the actual activity fixed. The four sets described buying a knife set and responding to emails, preparing a proposal and presentation for a marketing campaign, filling out a survey and listening to music, and, lastly, balancing corporate books and writing a memo.

As an additional way to measure how participants construed their activity, I told participants that they would be matched with a partner, and that if their partner and they both responded to a question in the same way, they would each receive an additional $0.05 bonus. The question was whether they perceived working on the tasks as a multitasking or single-task activity.

STUDY 6B:

ADDITIONAL INFORMATION REGARDING METHOD, PROCEDURES AND ANALYSES

As indicated in the main text of the manuscript, since the framing manipulation was relatively subtle, I also included in this study an additional factor intended to further strengthen the manipulation. In particular, I also manipulated (between-subjects) whether or not it was disclosed to participants that some participants in this study would be asked to work on a single study while others would be asked to work on two studies in the same amount of time. Thus, potentially making the multitasking manipulation more salient for participants assigned to the disclosure condition. Participants in the no-disclosure condition were not aware of this randomization procedure. The disclosure manipulation did not produce any main effects or interactions on any of the dependent variables or with the framing manipulation. Therefore, I collapsed the results and do not discuss this factor further. Note that including this factor in the analysis does not substantially change the pattern of results.

For exploratory purposes, upon finishing their assignment, participants in all conditions were asked to indicate whether they would prefer to multitask or single-task on a subsequent task. Further, I asked participants to indicate (i) their satisfaction with their performance, (ii) how well they believed they performed relative to others, (iii) how productive they felt, (iv) how long they considered the duration of the assignment to be, (v) how quickly they felt time passed, and (vi) how rushed they felt while working (all measured on a 1 to 7 scale).

Participants also responded to several exploratory individual difference questions to understand their attitudes towards multitasking. Specifically, participants indicated the extent to which, (i) they multitasked often, (ii) multitasking helped them be more efficient, (iii) they made more mistakes when multitasking, (iv) multitasking helped them get things done more quickly when they were busy, (v) multitasking helped them do the work at hand, (vi) multitasking was enjoyable, and (vii) multitasking was stressful (all measured on a 1 to 7 scale). None of these individual difference measures moderated the effect or were influenced by the manipulations; therefore, I do not discuss these further.

Results

Performance Controlling for Time. The observed increase in performance may be driven by two main factors. Specifically, it is possible that the multitasking manipulation increased performance because participants in this condition worked longer; hence, they found more words. However, it is also possible that aside from working longer, participants in the multitasking condition were more efficient with their time. In order to examine how each of these two sources improved performance, I examined the number of words identified across the conditions controlling for time (i.e., using an ANCOVA with log-transformed time as a covariate). As expected, I find a main effect of time on performance ($F(1, 234) = 20.34$, $p < .001$), indicating that the longer participants worked on the tasks the better they performed. Importantly, even after controlling for time, I still found a significant effect of condition on performance ($F(1, 234) = 46.49$, $p < .001$), suggesting that participants in the multitasking condition not only worked longer, but also were more efficient in their work. Furthermore, I did a similar analysis looking at correct responses and see a similar effect of time on correct responses ($F(1, 234) = 21.28$, $p < .001$) and multitasking when controlling for time ($F(1, 234) = 44.60$, $p < .001$).

Additional Analyses. The three questions of subjective performance were combined into a single scale ($\alpha = .92$). An ANOVA revealed that participants assigned to the multitasking condition believed they performed better compared to those assigned to the single-tasking condition ($M_{\text{multitasking}} = 3.91$, 95% CI = [3.65, 4.17]; $M_{\text{single-tasking}} = 3.50$, 95% CI = [3.25, 3.75], $F(1, 235) = 5.02$, $p = .026$). This suggests that, in general, participants' perceptions were calibrated with their actual performance. Therefore, it is unsurprising that participants in the multitasking condition were also more likely to choose to multitask on a subsequent task (37.50%, 95% CI = [29%, 46%]) compared with those assigned to the single-tasking condition (23.93%, 95% CI = [16%, 32%]; $\chi^2_{(1, N = 237)} = 5.12$, $p = .017$).

Participants assigned to the multitasking condition were marginally more likely to perceive that time passed more quickly than those who experienced the single-tasking condition ($M_{\text{multitasking}} = 4.86$, 95% CI = [4.64, 5.08]; $M_{\text{single-tasking}} = 4.62$, 95% CI = [4.43, 4.81]; $F(1,235) = 2.80$, $p = .096$), and they also felt more rushed ($M_{\text{multitasking}} = 5.11$, 95% CI = [4.83, 5.39]; $M_{\text{single-tasking}} = 4.44$, 95% CI = [4.14, 4.74]; $F(1, 235) = 9.89$, $p = .002$).

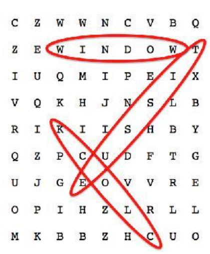
Discussion

This study demonstrates that, holding the actual tasks constant, the mere perception of multitasking improves performance. Participants that construed their activity as multitasking (as opposed to single-tasking) persisted longer and worked more efficiently. Interestingly, participants that perceived their activity as multitasking also reported feeling time had passed more quickly. Such distortions in time perception have been shown in previous research to arise, among other things, from greater engagement and feelings of excitement (Gable & Poole, 2012). Thus, the results may indicate that at least part of the underlying mechanism for the improved performance is due to increased engagement with the task.

Multitasking framing manipulation

In this study, you will be given a ***<u>MULTITASKING ASSIGNMENT</u>*** *in which you will be working on two different studies:*

The Perceptual Study and the Identification Study



In the Perceptual Study, you will work on a word find puzzle. A word find puzzle is a game in which you observe a matrix containing letters and need to find as many meaningful words inside the matrix. The words could appear vertically, horizontally, or diagonally, and in either straight or reversed order.

In the Identification Study, you will work on a scrabble game. A scrabble game is a game in which you observe a string of letters, and are asked to use the letters in the string (all or part) in any order you would like, in order to construct meaningful words.

*Your **<u>multitasking assignment</u>** is to (i) in the Perceptual Study, find (in the matrix) as many meaningful words as possible and write these words in the appropriate box below, and (ii) in the Identification Study, construct (from the string of letters) as many meaningful words as possible and write these words in the appropriate box below.*

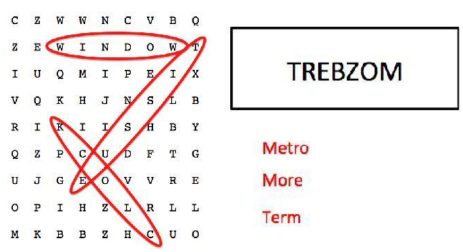
*In order to complete this assignment, you are to **<u>MULTITASK</u>** between the two studies.*

*Each correct word that you find in the **perceptual study** will earn you additional **$0.01**. Each correct word that you find in the **identification study** will also earn you additional **$0.01.***

Single-tasking framing manipulation

*In this study, you will be given an **<u>ASSIGNMENT</u>** in which you will work on one study:*

The Perceptual-Identification Study



In the perceptual-identification study, you will work on a word find-scrabble game. A word find-scrabble game is a game in which you observe a matrix containing letters and need to find as many meaningful words inside the matrix. The words could appear vertically, horizontally, or diagonally, and in either straight or reversed order. Furthermore, in a word find-scrabble game, you observe a string of letters, and are asked to use the letters in the string (all or part) in any order you would like, in order to construct meaningful words.

*Your **assignment** in the Perceptual-Identification Study is to find (in the matrix and string of letters) as many meaningful words as possible and write these words in the appropriate box below.*

*Each correct word that you find in the perceptual-identification study will earn you additional **$0.01.***

STUDY 7:

ADDITIONAL INFORMATION REGARDING METHOD, PROCEDURES AND ANALYSES

One hundred and fifteen participants were recruited from a behavioral lab at a northeastern university (60% female, mean age = 20.46). At the beginning of the study, I determined participants' dominant eye[13]. Participants were then asked to complete an assignment identical to that employed and described in Study 6b and following the same procedure except they were paid $0.03 for each word found. Specifically, participants worked on the puzzles for as long as they liked and their pupil dilation and eye movement were tracked using SMI RED-m eye-tracking equipment.

Results

Persistence. Since the data was censored at four minutes, I used a cox regression survival analysis to compare persistence on the puzzles task across conditions and found that most participants worked for the full 4 minutes. Thus, the framing manipulation had

[13] If the test was inconclusive (i.e. participants were dominant in both eyes), I coded their dominant eye as their right eye. This coding affected five participants.

no significant effect on how long participants worked on the task (B = 1.00, 95% CI = [1.40, 3.40]; Wald-$\chi^2_{(1, N=107)}$ = 0.66, *p* = .415).

Pupil Dilation. Common practices when employing pupil dilation measures are to analyze average pupil dilation (Beatty & Lucero-Wagoner, 2000)[14]. To examine whether the perception of multitasking increased participants' pupil dilation and to make sure the results were robust, I analyzed average, median and maximum pupil dilation measures of participants' dominant eye and used ANOVA analyses on each measure. Participants' average pupil dilation (averaged across the entire duration of the task) was found to be significantly larger in the multitasking condition (*M* = 3.90, 95% CI = [3.77, 4.03]) than the single-tasking condition (*M* = 3.64, 95% CI = [3.50, 3.78]; *F*(1, 105) = 7.12, *p* = .009). The same significant difference was found when analyzing median pupil dilation ($M_{\text{multitasking}}$ = 3.81, 95% CI = [3.63, 3.99]; $M_{\text{single-tasking}}$ = 3.53, 95% CI = [3.30, 3.76]; *F*(1, 105) = 3.50, *p* = .064) and maximum pupil dilation ($M_{\text{multitasking}}$ = 4.73, 95% CI = [4.58, 4.89]; $M_{\text{single-tasking}}$ = 4.47, 95% CI = [4.29, 4.65]; *F*(1, 105) = 4.89, *p* = .029).

Switches. Using eye-tracking, I was able to track participants' switching patterns when working on the tasks. One important concern is whether or not the observed improvement in performance is triggered by a specific work sequence. Although Studies 4 and 5 directly address this possibility, in this study I conducted additional analyses to address it further.

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[14] Some papers also report maximum and median pupil dilation. Although these measures are typically noisier, I report these as well.

The eye-tracking equipment measures participants' pupil dilation and where they are looking on the screen every 60 Hz (around 16.6 milliseconds)[15]. By defining, a priori, two specific areas of interest on the screen (i.e., the areas in which the word puzzles appear) I was able to determine which task participants attended to at any given point in time. Furthermore, this allowed us to observe when participants switched between tasks. However, a certain assumption needs to be made with regards to what constitutes a "switch". In particular, one needs to define the minimum amount of time a participant fixates on a specific task prior to fixating on the other task to be considered a real switch in attention (as opposed to noise or momentary fixation which does not indicate a shift in attention and a task switch). Given the nature of the task, I defined the minimum amount of fixation time to be one second. That is, any fixation of less than one second will not be considered as an actual deliberate switch. Further, since what constitutes a switch is not standardized in previous literature and highly depends on the specific nature of the task, I conducted auxiliary analyses and robustness checks. I find that the results hold for other specifications of a "switch" in which I defined the minimum fixation time to be two or three seconds.

Pupil dilation controlling for number of switches. One account for why participants' pupils were more dilated in the multitasking condition is that these participants switched more often. Indeed, and unsurprisingly, participants in the multitasking condition switched more (M = 11.83, 95% CI = [10.04, 13.50]) than those in the single-tasking condition (M = 6.62, 95% CI = [4.83, 8.82]; $F(1, 100) = 14.44$, p <

[15] Five participants were excluded from the switch analyses because the eye-tracking equipment failed to record their fixation location.

.001). Accordingly, it is possible that merely switching between tasks might have heightened participants' arousal level, and therefore, their dilation. In order to assess whether the number of switches drove the increase in pupil dilation, I conducted an ANCOVA in which I controlled for the number of switches (defined as at least one-second fixation on one task followed by at least one-second fixation on the other task). I found that even after controlling for the number of switches, participants' average pupil dilation was higher in the multitasking condition ($F(1, 99) = 5.90$, $p = .017$). This result held also when analyzing participants' median pupil dilation ($F(1, 99) = 3.26$, $p = .074$), and maximum pupil dilation ($F(1, 99) = 3.85$, $p = .052$). Further, the same pattern was observed when I defined switches as two and three second fixations[16].

Mediation analysis. Next, I conducted a mediation analysis (using model 4 of the macro PROCESS; Hayes, 2013) in order to test whether the effect of task framing on performance was mediated by average pupil dilation. The dependent variable was the number of words correctly found, the independent variable was task framing (multi- vs. single-tasking), and the mediator was participants' average pupil dilation. The indirect effect was tested using a bootstrap estimation approach with 5,000 samples and was found to be significant (B = 0.59, SE = .33, 95% CI = [0.08, 1.41]). Thus, as hypothesized, the effect of task framing on performance was mediated by participants' pupil dilation. The mediation results hold when analyzing median or maximum pupil dilation.

[16] Excluding maximum pupil dilation, which was a much noisier measure.

Pupil dilation for a fixed number of words found. Given the correlational nature of any mediation analysis, one should be cautious with causality interpretations. For example, although manipulating the perception of multitasking improved performance (i.e., participants found more words), it is possible that the increase in pupil dilation was not the cause for the improvement in performance but rather its outcome. In particular, it is possible that because participants found more words in the multitasking condition their pupils dilated due to happiness and excitement. While I cannot fully rule out this account, an additional analysis that controls for the number of words found in each condition casts doubt on this interpretation. Specifically, I first examined participants' average pupil dilation up until they found their first word in the puzzles. Again, participants' pupil dilation was greater in the multitasking than the single-tasking condition ($M_{\text{multitasking}}$ = 3.93, 95% CI = [3.80, 4.06]; $M_{\text{single-tasking}}$ = 3.71, 95% CI = [3.55, 3.87]; $F(1, 105) = 4.28$, $p = .041$). The results hold when I look at participants' pupil dilation up until they identified their second, third, fourth, and fifth word (all *p's* < .08). Thus, the results cast doubt on the argument the participants' pupils dilated more in the multitasking condition just because they found more words.

STUDY 10:
ADDITIONAL INFORMATION REGARDING METHOD

Manipulation check. I validated the manipulation in a separate pre-test, using the same population. One hundred and twenty participants were randomly assigned to either read the instructions from one of four framing conditions as part of a 2 (multitasking vs. single-tasking) × 2 (easy vs. neutral) as described in the main text. After, participants responded whether they would feel as if they were engaging in a single-task or multitask activity. They were incentivized ($0.05) to respond in the same was as a randomly assigned partner. Then, participants answered two more manipulation checks in which they indicated (i) to what extent they would feel they were single-tasking or multitasking (1 Definitely single-tasking, 7 Definitely multitasking) and (ii) how easy they thought the activity was going to be (1 Not at all, 7 Extremely).

71% (95% CI = [59%, 84%]) of participants who were assigned to the multitasking condition indicated that they perceived they were multitasking relative to 12% (95% CI = [4%, 19%]) of those assigned to the single-tasking ($\chi^2_{(1, N=120)} = 44.34$, $p < .001$). An ANOVA verified that the multitasking framing manipulation worked as intended ($M_{multitasking} = 4.92$, 95% CI = [4.39, 5.46]; $M_{single\text{-}tasking} = 2.33$, 95% CI = [1.87, 2.80]; $F(1, 116) = 52.01$, $p < .001$). There was no effect of the easy manipulation or interaction (*p's* > .798).

An ANOVA also verified that the easy manipulation worked as intended ($M_{neutral} = 4.20$, 95% CI = [3.87, 4.522]; $M_{easy} = 4.92$, 95% CI = [4.58, 5.26]; $F(1, 116) = 9.27$, $p = .003$). There was an effect of the multitasking framing condition such that participants in the multitasking condition ($M = 4.20$, 95% CI = [3.84, 4.55]) perceived the task to be less easy than those in the single-tasking condition ($M = 4.92$, 95% CI = [4.61, 5.23]; $F(1, 116) = 9.20$, $p = .003$). There was no interaction between the two factors ($p = .963$).

STUDY 14:

MEASURES OF LOCUS OF CONTROL AND SELF-EFFICACY

Items used to measure locus of control:

1. My life is determined by my own actions.
2. I am usually able to protect my personal interests.
3. I can pretty much determine what will happen in my life.
4. To a great extent, my life is controlled by accidental happenings. (R)
5. Often there is no chance of protecting my personal interest from bad luck happenings. (R)
6. When I get what I want, it's usually because I'm lucky. (R)
7. People like myself have very little chance of protecting our personal interests where they conflict with those of strong pressure groups. (R)
8. My life is chiefly controlled by powerful others. (R)
9. I feel like what happens in my life is mostly determined by powerful people. (R)

Items used to measure self-efficacy:

1. When I make plans, I am certain I can make them work.
2. One of my problems is that I cannot get down to work when I should. (R)
3. If I can't do a job the first time. I keep trying until I can.
4. When I set important goals for myself, I rarely achieve them. (R)
5. I give up on things before completing them. (R)
6. I avoid facing difficulties. (R)
7. If something looks too complicated, I will not even bother to try it. (R)
8. When I have something unpleasant to do, I stick to it until I finish it.
9. When I decide to do something, I go right to work on it.

10. When trying to learn something new, I soon give up if I am not initially successful. (R)

11. When unexpected problems occur, I don't handle them well. (R)

12. I avoid trying to learn new things when they look too difficult for me. (R)

13. Failure just makes me try harder.

14. I feel insecure about my ability to do things. (R)

15. I am a self-reliant person.

16. I give up easily. (R)

17. I do not seem capable of dealing with most problems that come up in life. (R)

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