# EXPLORING THE EFFECTS OF MEDITATION AND SELF-AWARENESS ON TEMPORAL JUDGEMENTS

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# Abstract

This thesis examined the role of meditation and self-awareness on judgments of time duration. Drawing from research in the areas of meditation and self-awareness, it was hypothesized that self-focused (body focused) meditation would increase perceived time duration. Employing a 2 (meditation/audiobook) x 2 (bodily focus/narrative focus) design, college subjects either meditated while focusing on themselves (bodily focus) or externally (narrative focus) or did not meditate (audiobook) and were either made self-focused or not. The time devoted to these tasks was held constant across conditions. Subjects completed a set of time estimation tasks and estimated the amount of time they spent listening to the recording. They also completed measures that assessed general levels of mindfulness and self-awareness. Results showed that meditation, regardless of whether bodily or narratively focused, caused subjects to make shorter judgements of time.

## Acknowledgements

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# Introduction

## Time Perception

The experience and perception of time has long been a topic of study to not just theologians and philosophers, but neuroscientists, psychologists and biologists alike. Advancements in neuroscientific technologies like fMRI have allowed us to gain a much better understanding of the brain components associated with different time mechanisms. For example, Rao, Mayer & Harrington used event-related fMRI to analyze the activation of various brain regions over the course various time-related activities and found that different regions were activated depending on the type of timing (Rao, Mayer, & Harrington, 2001). These findings were later supported by Warren H. Meck's work on interval timing. In his 2004 paper, he detailed the many examples of people with psychiatric conditions having impaired or modified temporal perception. Meck listed the disruption of normal functioning of the frontal cortex, hippocampus, basal ganglia, and cerebellum as factors that can affect interval timing (Meck, 2004). Building on the idea of the "internal clock," he concluded that the aforementioned clock is dependent on the multiple, integrative neurological systems (Hinton & Meck, 1997). This supported the findings of Rao et al. and provide a basis for the claims of Vago & Silbersweig (2012) that will be discussed later.

Self-transcendent experiences (STEs), which include states of mindfulness, flow, self-transcendent positive emotions, awe, peak experiences and lastly mystical experiences, are states of consciousness that are marked by decreased self-salience and increased perceived connectedness with the world and others. They profoundly modify standard consciousness and influence the senses of time, space and mind perception

(Yaden, Haidt, Hood, Vago, & Newberg, 2017). In an experiment that induced awe among participants, those in the experimental condition perceived time as being "more plentiful" than in the control (Rudd et al., 2012). Religious, spiritual or mystical experiences (RSMEs) are often reported as positive and even transformative experiences that can be occasioned through a variety of different mechanisms. RSMEs can occur spontaneously, through practices like meditation or prayer, religious rituals and through the use of psychoactive substances known as psychedelics, or hallucinogens. These include substances such as lysergic acid diethylamide, mescaline, *N*,*N*-Dimethyltryptamine, and psilocybin. Regardless of the source, powerful mystical experiences have been shown to emphasize feelings of "transcendence" of time (Yaden et al., 2016).

**Mindfulness Meditation**

Of the various forms of self-transcendent and RSMEs, meditation has received the most attention in research and the popular press. Though it has a long tradition in Buddhist practice, there has been a massive spike in interest in "mindfulness" practice in the general public, media and research community since the early 2000s (Figure 1, page 25; Van Dam et al., 2017). Originating from the Pali word *sati*, it is defined as having awareness, attention, and remembering (Bodhi, 2000). Mindfulness meditation encourages practitioners to focus on "moment-by-moment awareness" (Germer et al., 2005). While there is a litany of literature discussing the traditional and philosophical dimensions of mindfulness practice, it is a relatively recent topic of interest among

researchers. The most well-known of empirically backed mindfulness programs is Mindfulness-Based Stress Reduction (MBSR; Kabat-Zinn, 1990).

Designed by Jon Kabat-Zinn in 1979, MBSR has been used in a variety of clinical and health settings, with studies showing efficacy in treatment of chronic pain intensity (Bakhshani et al., 2015), decreased negative emotion reactivity and increased emotion regulation (Goldin and Gross, 2010) as well as generally enhanced quality of life and decreased stress symptoms (Carlson et al., 2007). Kabat-Zinn became a student of Zen Buddhism while working on his Ph.D. in molecular biology at MIT. He adapted traditional Buddhist teachings on mindfulness to fit into a secular, structured program that he originally called the "Stress Reduction and Relaxation Program" before renaming it "Mindfulness-Based Stress Reduction." The program removed all theological and metaphysical connotations from the teachings, instead framing it in a scientific context (Wilson, 2014). Kabat-Zinn defined mindfulness as "the awareness that arises from paying attention, on purpose, in the present moment, and non-judgmentally" (Purser, 2015). By training in mindfulness skills and cultivating present moment awareness, practitioners are able to learn how to quiet the mind, reduce rumination and enhance coping. MBSR groups are usually made up of up to 20 participants complete an eight, two-hour long weekly sessions and a one-day retreat that consists of six hours of mindfulness exercises between sessions six and seven. Participants are given home assignments to complete 45 minutes of mindfulness practice daily throughout the duration of the program and are encouraged to continue the practices and integrate them into their lives (Will et al., 2015).

Despite the success of programs like MBSR, the proliferation of writing on mindfulness and its roots in the more abstract concepts of Buddhist philosophy have made the concept difficult to strictly define and measure. Popular press' dissemination of the virtues of mindfulness practice has led to some backlash from those in the general and scientific community. While neuroimaging studies have begun to illustrate the physiological mechanisms and areas that mediate the reported effects of meditation and mindfulness practice, it is still not completely clear. The methodological rigor of the research has been called into question, due to the minimal amounts of corresponding longitudinal control studies. Most researchers in the field are enthusiastic meditators themselves, which allows for experimenter bias to be mediating factor (Tang, Hölzel, & Posner, 2015). The experimenter-expectancy effect should also be considered (Colman, 2009). Psychologist Robert Rosenthal showed the power of this effect in a series of studies carried out in the 1960s by differentiating what effects he told psychology students to expect from experiments on rats (Rosenthal, 1966). If mindfulness practice has practical or clinical applicability, it is important to know if the effects can be reliably occasioned without the favorable conditions set up.

Mindfulness and meditation researchers themselves are not ignorant to the challenges levied against their field. In a paper titled *Mind the Hype: A Critical Evaluation and Prescriptive Agenda for Research on Mindfulness and Meditation*, mindfulness researchers from all across the globe attempted to address some of the aforementioned challenges and weed out poor research practices that might hold back future progress (Van Dam et al., 2017). They highlight the semantic ambiguity in the term "mindfulness," insufficient construct validity, difficulties in operationalizing and

measuring mindfulness and misperception of its efficacy as some of the key challenges Still, researchers find themselves having to consistently address the misconceptions others make about their findings. In an interview with Dan Harris of the *10% Happier* podcast, Dr. David Vago, research director of the Osher Center for Integrative Medicine at Vanderbilt University and one of the authors of the paper, addressed some of the misconceptions that the popular press took from their findings. “I didn’t say the science is shoddy, the science is still very good. But it is young, and we should be cautious in how we interpret it… there’s a lot of confusion about how we understand, how we operationalize the word. It’s used in many different ways and we often don’t contextualize it appropriately” (Harris, 2017). Contextualizing mindfulness and the methods of measuring it are key to advancing research in the field.

*Mind the Hype* concludes that key goals among those studying these mental processes should be to improve the rigor of these studies, the accuracy of media publicity and clarify public misunderstanding. The four methods they propose to go about this is through: first, clarifying the semantic ambiguities from the various possible meanings of the term “mindfulness.” Second, learn lessons from the ongoing “replication crisis” in psychology through practices like pregistering experiments and open-science replications. Third, seek more uniformity and better control in mindfulness-based interventions. Fourth, neuroimaging findings must be reported modestly, and their practical significance must be rigorously vetted before grand claims of their value can be made (Van Dam et al., 2017).

Guided by Van Dam and colleagues, we will define the mindfulness state as one of “*psychological freedom* that occurs when attention remains quiet and limber, *without*

*attachment* to any particular point of view," (Martin, 1997) so that it can afford the practitioner "a receptive attention to and awareness of present events and experience" (Brown & Ryan, 2003).

**Mindfulness and Time**

Mindfulness meditators have a longer duration of *subjective nowness* than nonexperts/nonmeditators (Sauer et al., 2012). In the Sauer et al. study, participants were tasked with pressing a button on a computer when they saw a change in an image of a Necker Cube. Individual mindfulness levels were significantly correlated with duration of perceiving of one of the two cubes. In other words, to those who scored higher on the measures of mindfulness, the present, i.e. the moment that the cube was on the screen, was perceived as longer. Results supported the hypothesis of a longer duration of *subjective nowness* among those who are more mindful (Sauer et al., 2012). Similarly, Berkovich-Ohana, Glicksohn, & Goldstein reported that those practicing mindfulness meditation made longer judgments of temporal duration than control subjects (2012).

Kramer, Weger, and Sharma directly compared duration estimates between subjects who meditated and a control group (2013). They used a temporal bisection task for time judgments. The task had two phases: a training phase and a testing phase. In the training phase, participants were shown a short standard stimulus (S) of 400 ms duration and a long one (L) that lasted 1600 ms. The stimuli were colored squares or circles. Participants were then randomly shown S and L stimuli and made "S" or "L" judgments. Training was completed when they made eight consecutive accurate judgments. The number of stimuli increased in the testing phase to seven, with durations of 400, 600,

800, 1000, 1200, 1400, and 1600 ms. The participants then had to classify each stimulus as either “short” (S) or “long” (L). This yielded a baseline accuracy score. Then subjects were assigned to either a meditation or audiobook (control) condition. The meditation group listened to a “mindfulness of body and breath” exercise that was eight minutes long (Williams, Penman, & Kabat-Zinn, 2011). The audiobook book group listened to a recording of an excerpt from *The Hobbit* by J.R.R. Tolkien of the same length (Shaw, 2005). They then completed the bisection task again (Kramer et al., 2013). Results indicated that subjects in the meditation condition were more likely to classify stimulus durations as long (L) than were subjects in the audiobook (control) condition after listening to their respective recordings. Thus, time appeared to slow down for the meditators. Because mindfulness induced by meditation is a conscious state, its effects may well be related to another conscious state that turns attention inward – that of self-awareness.

**Self-Awareness**

Psychology has long been enamored with defining and understanding the self (James, 1890; Cooley, 1902; Mead, 1934), but empirical analyses of self-awareness were kickstarted by Shelly Duval and Robert Wicklund with their book *A Theory of Objective Self-Awareness*. They posited that attention can be focused outwards or inwards: "When attention is directed inward and the individual's consciousness is focused on himself, he is the object of his own consciousness--hence 'objective' self awareness" (Duval & Wicklund, 1972, p. 2) Merely manipulating focus of attention (inward or outward) has

been shown to affect a variety of judgments including attributions of causality (Duval & Wicklund, 1973), perspective taking, and empathy (Geracy, Day, Casey & Mohr, 2017).

In *Self-awareness, Self-regulation, and Self-transcendence (S-ART): A Framework for Understanding the Neurobiological Mechanisms of Mindfulness*, aforementioned mindfulness researcher David R. Vago and his colleague David A. Silbersweig (2012) describe a theory of brain function that posits that that the regions of the lateral cerebellum, dorsal anterior cingulate cortex, anterior medial prefrontal cortex, frontopolar cortex, anterior inferior parietal lobe, temporoparietal junction and the ventrolateral prefrontal cortex collectively make up an integrative control network called the fronto-parietal control network (FPCN). They argue that that these brain regions are linked to S-ART, noting that "advanced meditators show resistance to age-related decline in FPCN and self-specifying brain areas" (Vago & Silbersweig, 2012). "Self-specifying" refers to areas of the brain that are associated with what they refer to as the "experiential enactive self (EES)" and the "experiential phenomenological self (EPS)." The EES refers to non-conscious sensory-affective motor processing whereas the EPS refers to the "agentic, self-as-subject acting as awareness in the present moment" (Vago & Silbersweig, 2012). This suggests an integrative approach for the concept of self-awareness (frequently called meta-awareness by Vago & Silbersweig).

**Self-Awareness and Time**

Closely associated with self-awareness (Vago & Silbersweig, 2012) is "self-regulation" (Vohs and Schmeichel, 2003). Processes typically encompassed in self-regulation include the modification of an undesired response; the replacement of an

undesired response with a desired response; and most forms of inhibition, in which the occurrence of a response is repressed" (Vohs and Schmeichel, 2003). Following a self-regulatory resource model (which views the ability to control impulses and desires as a generalized yet limited resource; Bauemeister & Heatherton, 1996), Vohs and Schmeichel argued that when self-regulating their behavior, people are likely to be attuned to the time spent using said resource. In other words, the act of self-regulation is closely associated with the passage of time.

They conducted four studies to empirically test their claims. Subjects were tasked with giving time estimates based on their time spent in participating in a given task, and depending on the condition, were asked to engage in some form of self-regulatory behavior. For example, when required to exert effort by exaggerating or suppressing emotions, subjects estimated that a film clip they were watching was longer than when they were not required to engage in self-regulation while viewing the clip. Ultimately, Vohs and Schmeichel were able to conclude that self-regulation caused a sensation of an "extended now," altering a person's perception of time (Vohs and Schmeichel, 2003).

**Thesis Experiment**

Past research has shown that mindfulness manipulations (focused on "body and breath") have been shown to increase estimations of time duration (Kramer et al., 2013). They have also been shown to increase a subject's self-awareness (Vago & Silbersweig, 2012). We conducted this experiment to compare the effects of manipulating both the type of meditation and the focus of awareness on time judgments.

Employing a 2 (recording type: meditation/audiobook) x 2 (focus of attention: bodily focus/narrative focus) design, college subjects either meditated while focusing on themselves (bodily focus) or externally (narrative focus) or did not meditate (listened to an audiobook) while either self-focused or focused on the narrative. The time devoted to these tasks was held constant across conditions. Subjects completed a set of time estimation tasks and estimated the amount of time they spent listening to the recordings. They also completed measures that assessed general levels of mindfulness and self-awareness.

**Hypotheses**

Based on previous work, it was hypothesized that bodily focused mindfulness meditation will result in longer temporal judgements in comparison to a non-meditation control (audiobook; Kramer et al., 2013). A second hypothesis was that increased self-awareness in general *(Meditation/Bodily Focus* and *Audiobook/Bodily Focus)* would increase duration relative to an *Audiobook/Narrative* control condition. The purpose of the *Meditation/Narrative* condition was to see if the effects of meditation shown in Kramer et al.'s study were unique to a bodily focused meditation or were an effect of meditation in general.

# Materials and Methods

## Participants

Subjects were 305 Rutgers university undergraduate students enrolled in General Psychology who participated in the research in exchange for course credit. Of those, 91 subjects were excluded for the following reasons: 14 for procedural errors, 8 for failure to follow directions, and 69 because English was their second language. Because it was critical that subjects understand the meditation instructions, only native English speakers were retained for the experiment. That resulted in a total of 214 participants distributed as follows: 54 in the *Meditation/Narrative* condition, 59 in the *Meditation/Body* condition, 41 in *Audiobook/Narrative* condition and 60 in the *Audiobook/Body* condition. The experiment was conducted in accordance with the protocols approved by the Rutgers University Institutional Review Board.

## Procedure

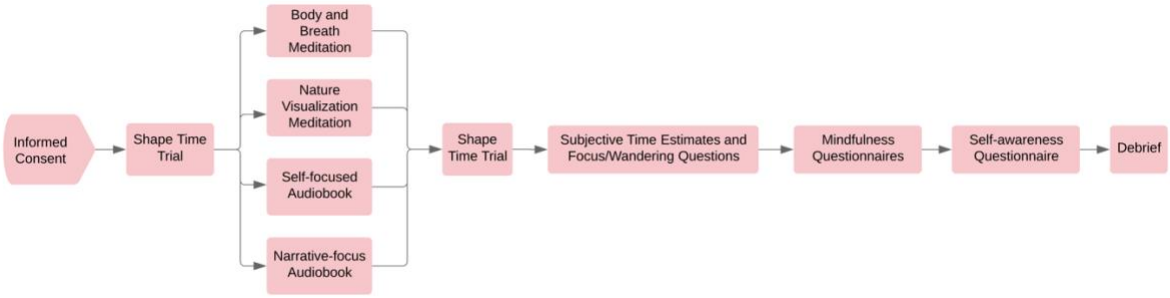
Subjects completed all tasks and measures on a Dell desktop and listened to the recordings via a Bluetooth speaker. All measures and trials were administered via Qualtrics. After signing the consent form, each subject was seated in front of a computer screen and completed the "Shape Time Trial." For this task they viewed images of shapes that appeared briefly (between a few seconds and a minute) on the computer screen and were asked after each trial to estimate how long the shape had been on the screen. There were four trials; one trial was a triangle that appeared for 7 seconds; the second was a pentagon that appeared for 17 seconds; the third a circle that appeared for 37 seconds; the

fourth a square that appeared for 57 seconds. The order of the four trials was randomized across subjects.

After completing the "Shape Time Trial," subjects were randomly assigned to one of four conditions in a 2x2 between subjects design, the factors being type of recording subjects heard (meditation induction vs. listening to an audiobook) and focus of awareness (self/ body vs. narrative). Note that the time spent doing the meditation or listening to the audiobook excerpt was held constant at 8 minutes for subjects in all four conditions.

1. *Meditation/Bodily*: Subjects were given the "mindfulness of body and breath" exercise (Williams & Penman, 2011) that focuses attention on the body.
2. *Meditation/Narrative*: Subjects were given a "visualization meditation" (Foster, 2018) that took them on a nature walk to a waterfall.
3. *Audiobook/Bodily*: Subjects listened to an audio recording of *The Hobbit* (Shaw, 2005) while sitting in front of a mirror and were instructed focus on themselves. In order to increase self-awareness in the audiobook condition, we placed mirrors that were 6-1/4" in diameter in each of the computer booths and told the subjects to focus on themselves rather than the narrative being presented. Mirrors have been used extensively in research to increase self-awareness (e.g., Duval & Wicklund, 1972).
4. *Audiobook/Narrative*: Subjects just listened to the same excerpts from *The Hobbit* (Shaw, 2005) that was used in the Audiobook/bodily-focus condition. They were asked to pay attention to the story.

*Flowchart of experimental procedure; See Figure 2 on page 26 to see a larger diagram*




After subjects had completed either the meditation induction or the audiobook, they made a second set of time judgments on the "Shape Time Trial" measure. This was followed by the following measures: "Subjective Time Estimates," questions on focus/mind wandering, a measure of mindfulness -- FFMQ (Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006), and a self-awareness scale -- SSAS (Govern & Marsch, 2001).

**Shape Time Trial**: In order to obtain time judgements that are more directly applicable to real world scenarios, we created our own time estimation task. Participants were provided images of a triangle, pentagon, circle and square for seven seconds, seventeen seconds, thirty-seven seconds and fifty-seven seconds respectively. The order the four shapes were presented in was randomized, but the durations for each corresponding shape was consistent.

**Subjective Time Estimates:** Subjects were asked two questions about how long the meditation induction or audiobook passage seemed to be. The first question (interval) was "How long was the audiobook that you listened to?" They could either answer 1-2

minutes, 3-4 minutes, 5-6 minutes, 7-8 minutes, 9-10 minutes, 11-12 minutes or 13-14 minutes. They were then asked a second question (sliding scale): "In your opinion, how long did the audiobook seem to last? For this question, subjects judged how long the recording lasted by selecting one point on a 0 (Very Short) to 100 (Very Long) sliding scale, with the response option starting in the middle (at 50). See Figure 3 on page 27 for an image of the scale.

**Focus/Mind Wandering Questions**: Subjects were asked a questioned on how focused they were on the recording: "How focused were you on the audiobook/meditation?" Subjects judged how focused they were by selecting one point on a 0 (Not Much) to 100 (Completely) sliding scale, with the response option starting in the middle (at 50). Subjects were also asked a question on mind wandering: "How often did you find your mind wandering away from the task during the audiobook?" Subjects judged how their level of mind wandering by selecting one point on a 0 (Never) to 100 (Most of the Time) sliding scale, with the response option again starting in the middle (at 50). See Figures 4 and 5 on pages 28 and 29 respectively for images of the scales.

**Five-Factor Mindfulness Questionnaire (FFMQ; Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006):** The FFMQ is a 39 item measure consisting of five subscales (observing, describing, acting with awareness, non-judging of inner experience, and non-reactivity to inner experience) derived from a variety of questionnaires, including the Mindful Attention Awareness Scale (MAAS; Brown & Ryan, 2003), Freiburg Mindfulness Inventory (FMI; Buchheld, Grossman, & Walach, 2001), the

Kentucky Inventory of Mindfulness Skills (KIMS; Baer, Smith, & Allen, 2004, the Cognitive and Affective Mindfulness Scale (CAMS; Feldman, Hayes, Kumar, Greeson, & Laurenceau, 2006) and the Mindfulness Questionnaire (MQ; Chadwick, Hember, Mead, Lilley, & Dagnan, 2005). Participants answer questions using a 5-point Likert scale. Higher scores on the FFMQ means a subject is more "mindful," whereas lower values mean the subject is less "mindful."

**Situational Self-Awareness Scale (SSAS; Govern & Marsch, 2001)**: The Situational Self-Awareness Scale was developed to detect differences in public and private self-awareness over time. It is a nine-item questionnaire with answer options ranging from 1 (strongly disagree) to 7 (strongly agree) on a 7-point Likert scale. Larger values mean the subject is more "self-aware," and smaller values mean the subject is less "self-aware."

**Debrief:** After completing these measures, subjects were debriefed and subsequently released from the experiment. Credit was given to them electronically within one week of participation.

# Results

The primary measures of interest were the three sets of time judgments made by subjects: the "Shape Time Trial" and two "Subjective Time Estimates" of how long the recording or audio book lasted. Across the three time measures, a pattern for shorter estimates for subjects in the *Meditation* conditions relative to the *Audiobook* conditions emerged.

## Shape Time Trial

Data from the Shape Time Trial were analyzed in a 2 x 2 x 2 ANOVA. Between subjects factors were Recording *(Meditation/Audiobook*) and Focus *(Bodily/Narrative)*; Time Trial (*Time 1, Time 2)* was a within subjects factor. There was a main effect of Recording, $F(1,840) = 4.856$, $p < .028$. Subjects in the *Meditation* conditions made shorter estimates (25.963 seconds) than those in the *Audiobook* conditions (27.503 seconds) across the four shape stimuli. In addition, there was a marginally significant interaction between Recording and Time Trial, $F(1, 840) = 3.653$, $p < .056$. As shown in Table 1 (see page 32) and Figure 6 (see page 30), subjects showed significant decreases in time estimates in the *Meditation* conditions from *Time 1* to *Time 2.*

## Subjective Time Estimate (Interval)

For this measure, subjects selected from one of the following alternatives to estimate the duration of the recording they had heard (either meditation induction or audiobook): "1-2 minutes, 3-4 minutes, 5-6 minutes, 7-8 minutes, 9-10 minutes, 11-12 minutes or 13-14 minutes." Data from this measure were coded on a 7-point scale (1 = 1-

2 minutes, 2 = 3-4 minutes… 7 = 13-14 minutes) and entered into a 2x2 ANOVA. The factors were Recording *(Meditation/Audiobook*) and Focus *(Body/Narrative).* There was a significant effect of Recording, $F(1, 210) = 23.126$, $p < .001$. Subjects in the *Meditation* conditions (3.456) estimated the recordings they listened to were shorter than those in the *Audiobook* conditions (4.105). There was also a marginal Recording by Focus interaction, $F(1, 210) = 3.218$, $p < .074$. Judgments of longer time in the *Audiobook* conditions were largely driven by those in the *Audiobook/Narrative* condition

**Subjective Time Estimate (Sliding Scale)**

In this measure, subjects judged how long the recording lasted by selecting one point on a 0 (very short) to 100 (very long) sliding scale. Data from this measure were entered into a 2x2 ANOVA. The factors were Recording *(Meditation/Audiobook)* and Focus *(Body/Narrative).* There was a main effect of Recording that was marginally significant, $F(1, 210) = 3.193$, $p < .075$. Those in the *Meditation* conditions estimated that the duration was shorter (60.724 on the sliding scale) than subjects in the *Audiobook* conditions (65.291).

**Focus on Recording**

For the question "How focused were you on the recording," subjects judged how focused on recording they felt by selecting one point on a 0 (very short) to 100 (very long) sliding scale. The 2x2 ANOVA and revealed a significant main effect for Recording, $F(1, 210) = 9.270$, $p < .003$. Subjects in the *Meditation* conditions were significantly more focused (62.901) on the recording than the *Audiobook* conditions

(52.679) on the sliding scale of subjective focus (0-100). There was also a significant interaction between Recording and Focus, $F(1, 210) = 4.383$, $p < .038$. As illustrated in Table 2 (see page 33) and Figure 7 (see page 31), the higher level of focus on the recording in *Meditation* in comparison to *Audiobook* appeared largely in the *Meditation/Body* condition. The measure of "mind wandering" (How often did you find your mind wandering away from the task during the audiobook?) found no significant differences among the conditions.

**Situational Self-Awareness Scale (SSAS)**

A 2x2 ANOVA showed a significant interaction between Recording and Focus, $F(1,210) = 6.416$, $p < .012$. Subjects in the *Meditation/Body* condition indicated a higher level of self-awareness than those in the *Meditation/Narrative* condition. That would be expected given subjects in the former condition were instructed to focus on their body during meditation. There was no significant difference between the audiobook conditions, as shown Table 3 (page 34).

**Five-Factor Mindfulness Questionnaire (FFMQ)**

Analysis of the data from the FFMQ measure found a significant interaction between recording and focus, $F(1, 210) = 6.898$, $p < .009$. As shown in Table 4 (page 35), subjects in the *Meditation/Body* condition scored higher on the FFMQ than those in the *Meditation/Narrative* condition. The opposite pattern occurred in the audiobook conditions; those in the *Audiobook/Narrative* condition scored higher on the FFMQ than those in the *Audiobook/Body* condition. Neither the SSAS nor FFMQ scales were

correlated with measures of time and were, therefore, unhelpful in interpreting the findings for time estimates.

# Discussion

Overall, across the three measures of time estimation, subjects in the *Meditation* conditions made shorter time judgments than those in the *Audiobook* conditions. Focus of attention did not consistently predict time judgments. Contrary to the main hypothesis, based on prior research, bodily focused meditation did not increase perceived duration relative to an audiobook control. On the contrary, time judgments for meditation were the opposite of those reported by Kramer et al (2013).

Although this experiment was modeled on the Kramer et al. research, there was one major difference with respect to measures of time. In their study, subjects made time judgments at a very micro level; stimuli were appeared for no more than two seconds on their Temporal Bisection Task. In designing the present experiment, longer time intervals were chosen to make the tasks more comparable to temporal experiences in daily life outside the lab. People have little experience making time estimates that are under a second or two. They more often make estimates of time in the range of several seconds to a minute (Shape Time Trial measure) or subjective estimates involving several minutes, such as listening to the meditation instructions or the audiobook excerpt (Subjective Time Estimate measures).

Another finding from this experiment may help explain the briefer time estimates made by those who meditated. When asked how focused they were on the task (meditation or audiobook), subjects in the *Meditation* conditions reported being significantly more focused on the recording they listened to than those in the *Audiobook* conditions (62.901 and 52.679 respectively on the sliding scale (0-100) of subjective focus). This finding indicates that the meditators were much more immersed in the task

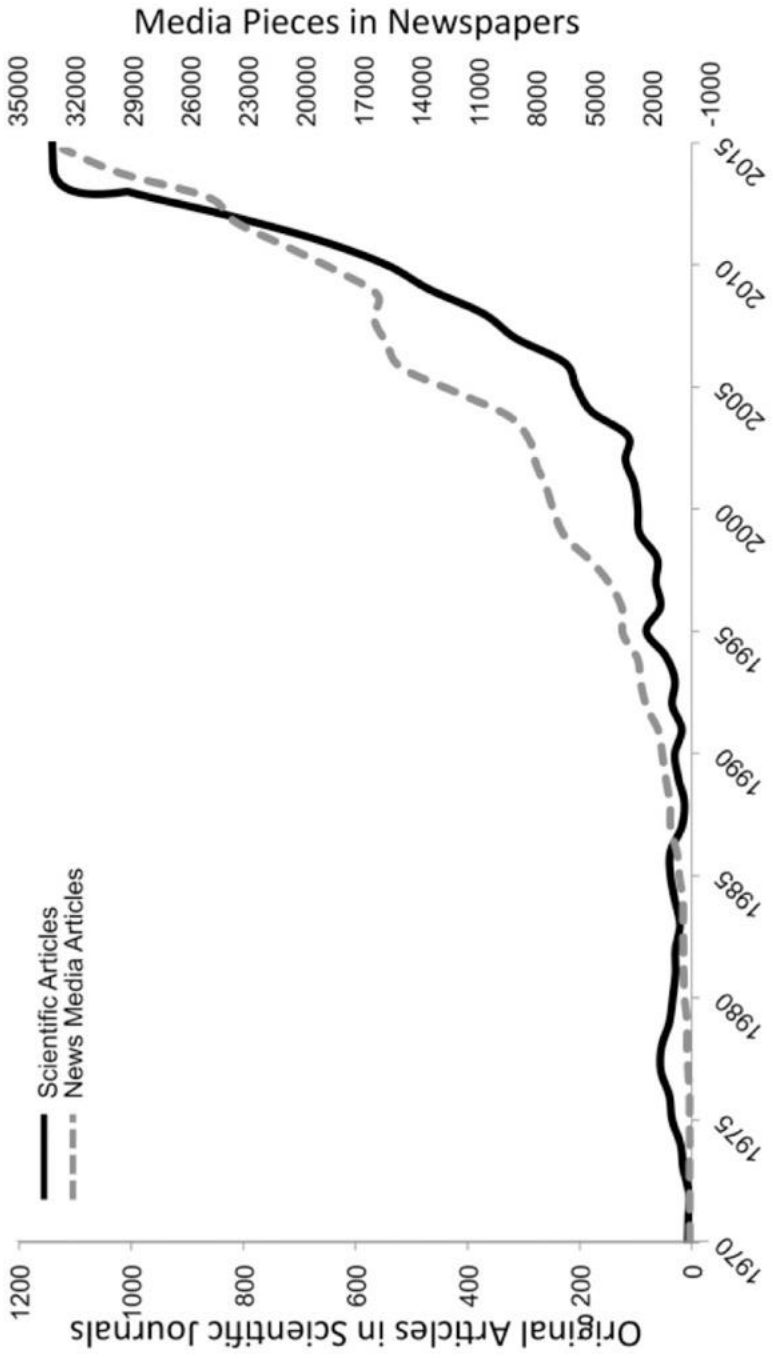
than those who passively listened to the excerpt from the story in *Audiobook* conditions. Time flies when we are having fun and we become immersed in the activity; this is viewed as characteristic of the state of "flow" (Csikszentmihalyi, 1995). As described by Csikszentmihalyi, "in waiting situations without the possibility of distraction, when time is in the focus of awareness and duration expands, self-consciousness is most pronounced. In contrast, when we are absorbed in a pleasant activity, we are less aware of ourselves. Time is hardly noticed and therefore contracts" (Csikszentmihalyi, 1995). This stands in contrast to the state of boredom, in which individuals do relatively overestimate duration (Danckert & Allman, 2005; Watt, 1991).

Consistent with a "flow" interpretation of the findings, the meditation recordings did provide specific instructions to keep the listeners engaged/following along, so it would make sense that that the subjects in the "Meditation" conditions had an easier time of getting into a state of flow while listening to their recordings. If so, then further explorations of time perception might well focus on assessing a sense of flow as well as straightforward time judgments. Standard measures to measure flow states include the "Flow Questionnaire" and the "Experience Sampling Method" (Moneta, 2012). Other means used to measure flow have included electromyographic signals (EMG) and the electroencephalogram (EEG) to identify flow states (Cheron, 2016). Both physiological and psychological measures should be considered in future investigations of flow. They may complement one another and eventually help unlock the puzzle of time perception.

# Tables and Figures

## Figure 1

## Mindfulness Article Popularity



## Figure 2

## Flowchart of Procedure

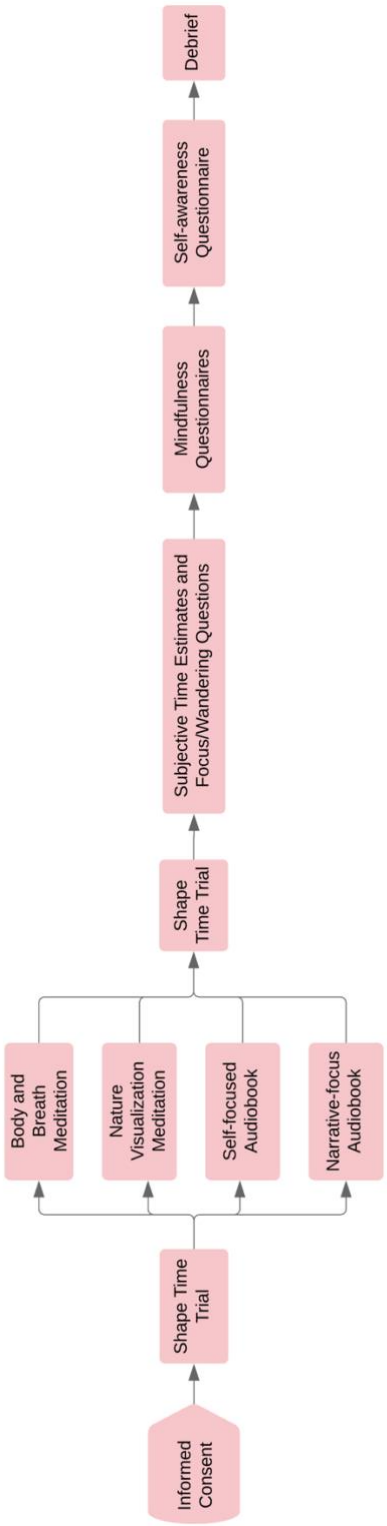


**Figure 3**

**Subjective Time Estimate (Sliding Scale)**

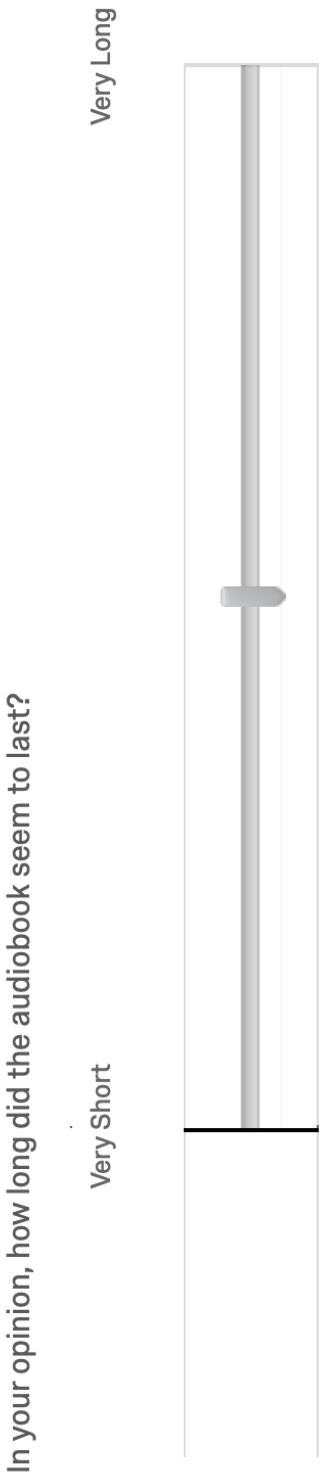


**Figure 4**

**Focus Scale**

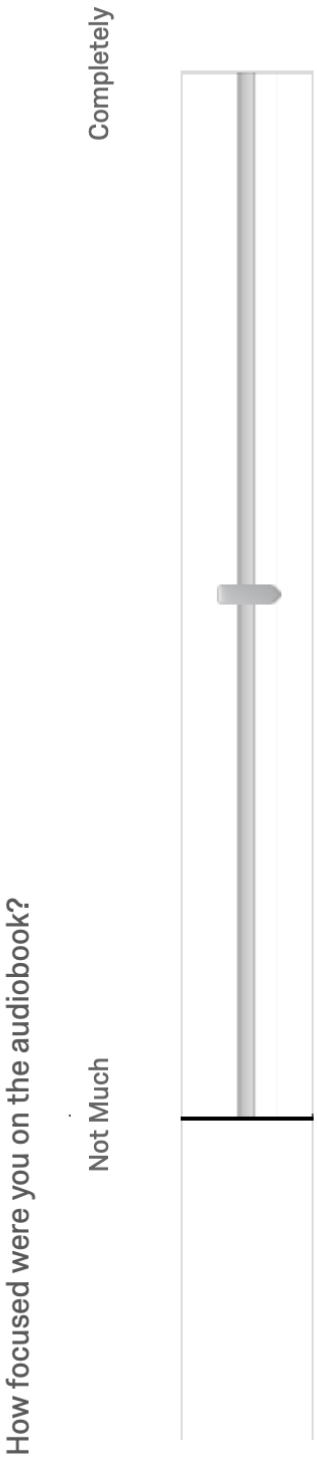


**Figure 5**

**Wandering Scale**

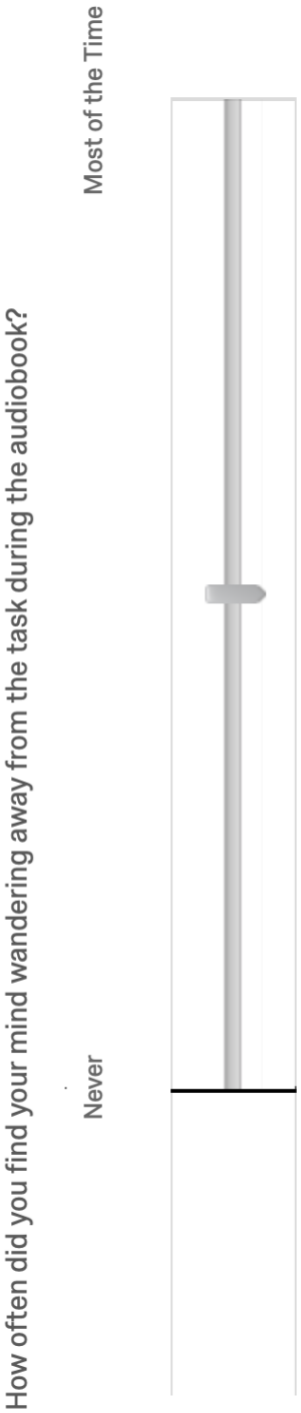


**Figure 6**

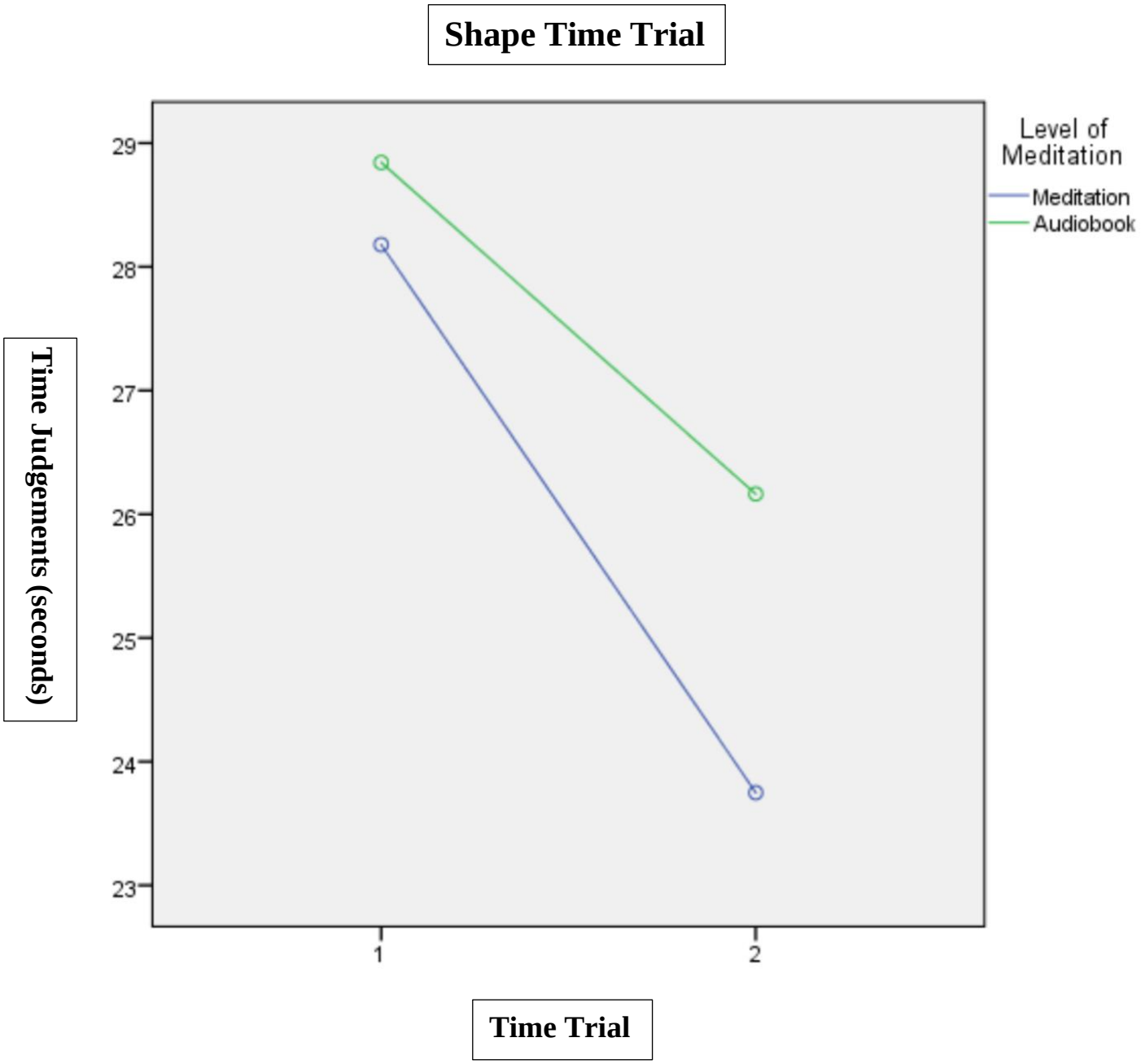

Shape Time Trial
Level of Meditation
Meditation
Audiobook
Time Judgements (seconds)
29
28
27
26
25
24
23
1
2
Time Trial

**Figure 7**

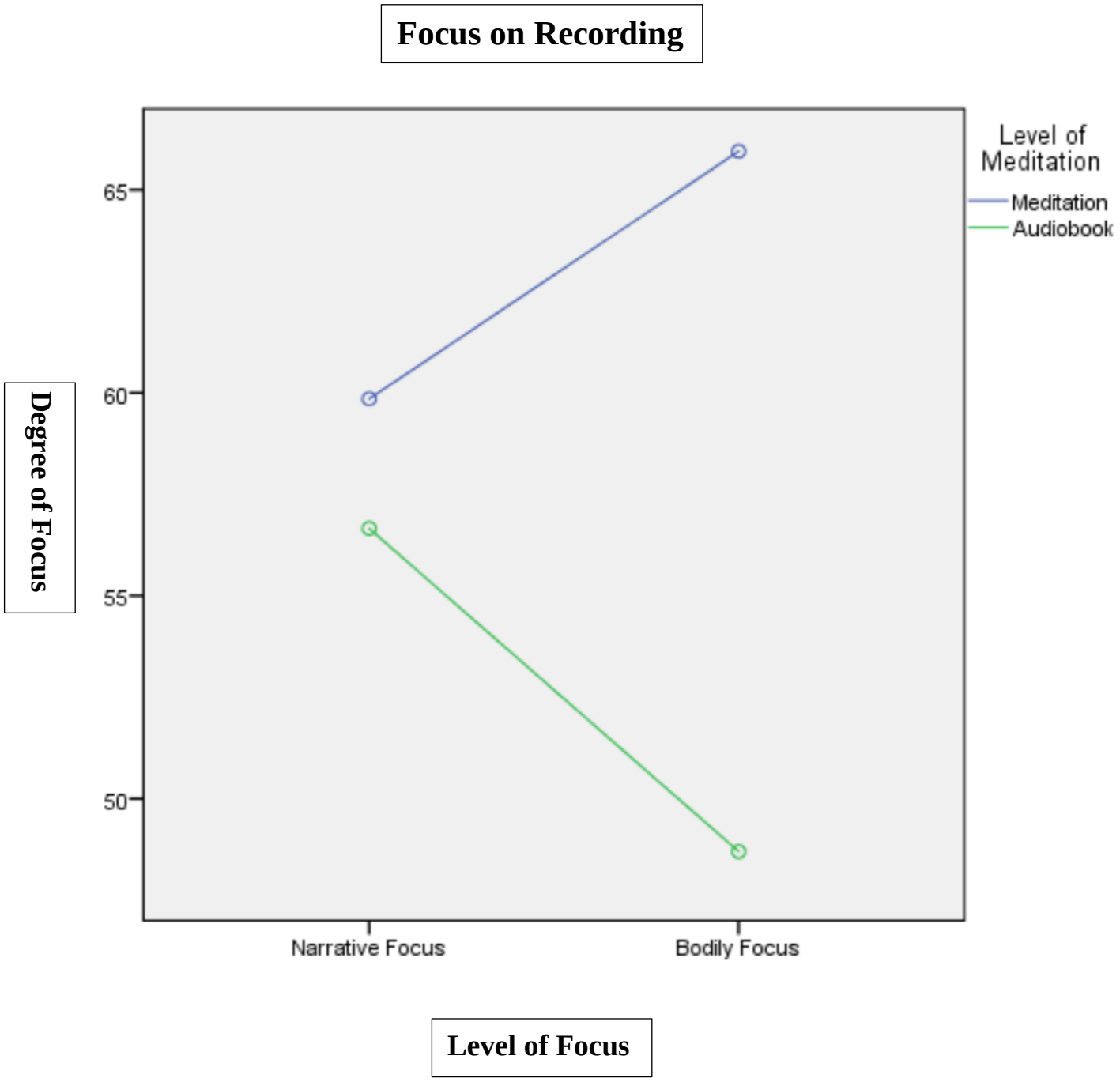

Focus on Recording
Degree of Focus
65
60
55
50
Narrative Focus
Bodily Focus
Level of Focus
Level of Meditation
Meditation
Audiobook

**Table 1**

**Shape Time Trial**

| | Time 1 | Time 2 |
|---|---|---|
| Meditation | $28.178_{b}$ | $23.748_{a}$ |
| Audiobook | $28.843_{b}$ | $26.163_{ab}$ |

Note: means with different subscripts differ at .05 (Fisher's LSD Test)

**Table 2**

**Focus on Recording**

| | Body | Narrative |
|---|---|---|
| Meditation | $65.949_{b}$ | $59.852_{ab}$ |
| Audiobook | $48.700_{a}$ | $56.659_{ab}$ |

Note: means with different subscripts differ at .05 (Fisher's LSD Test)

**Table 3**

**Situational Self-Awareness Scale (SSAS)**

| | Body | Narrative |
|---|---|---|
| Meditation | $42.102_{b}$ | $38.704_{a}$ |
| Audiobook | $39.117_{ab}$ | $41.976_{ab}$ |

Note: means with different subscripts differ at .05 (Fisher's LSD Test)

**Table 4**

**Five-Factor Mindfulness Questionnaire (FFMQ)**

| | Body | Narrative |
|---|---|---|
| Meditation | $123.458_{b}$ | $118.259_{a}$ |
| Audiobook | $117.850_{ab}$ | $123.561_{ab}$ |

Note: means with different subscripts differ at .05 (Fisher's LSD Test)

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