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Testing the Effect of Autonomy-Supportive Instructions During Yoga on Autonomy, Competence, and Affective Response

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A Dissertation

entitled

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by

Bree A. Geary

Submitted to the Graduate Faculty as partial fulfillment of the requirements for the Doctor of Philosophy Degree in Psychology

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An Abstract of

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This early-phase intervention development project tested the effect of autonomy-supportive instructional cues during a single yoga session on affective response, perceived autonomy, and perceived competence. Using a between-subjects experimental design, participants were randomly assigned to either an autonomy-supportive intervention condition or a mindfulness-based control condition. During the 30-minute online pre-recorded yoga sessions, affective response was measured immediately before the yoga session, at peak, pre-savasana, and post-savasana. Perceived autonomy and perceived competence were measured immediately after. Multilevel models tested the effects of the autonomy-supportive intervention on primary outcomes (affective response, perceived autonomy, and perceived competence) and secondary outcomes (yoga practice intentions and self-reported yoga behavior), considering the potential moderation by yoga experience. The intervention increased perceived autonomy but did not lead to more positive affective response or higher perceived competence. Unexpectedly, the control group reported higher intentions to practice yoga, but this did not translate into increased practice. Further research is needed to identify the types of yoga instructions that can decrease barriers and increase engagement in yoga practice.

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This dissertation is dedicated to my beloved dog Brando, who was my constant companion and provided comfort and encouragement during the countless hours I spent writing. Brando, this one is for you.

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Introduction

Despite the well-established evidence of yoga's health benefits (Evans et al., 2009; Pascoe et al., 2021; Tran et al., 2001), factors contributing to a sustained yoga practice need to be better understood. Similar to other health behaviors, including cardiorespiratory physical activity, cognitive awareness of a behavior's benefits does not lead to behavior change. Therefore, research is needed to investigate the specific elements of yoga sessions that predict sustained yoga practice (Cagas et al., 2020; Jeter et al., 2015; Park et al., 2016; Wieland et al., 2021).

Yoga is distinct from other forms of physical activity because it includes breath regulation and mindfulness in addition to physical activity (Govindaraj et al., 2016). It is a system rooted in ancient Vedic tradition that includes a variety of practices developed throughout history (Pascoe et al., 2021). In Sanskrit, yoga means to 'yoke' or to 'unite' the mind, body, and spirit (Salmon et al., 2009). For many, yoga is a process of self-discovery, a spiritual evolution, and an art of personal development. In Western culture, modern yoga focuses on physical postures (asana) while integrating breath regulation techniques (pranayama) and meditation/mindfulness (C*handa*) (De Michelis, 2005). In this proposal, I also define yoga as physical postures (*asana*) while incorporating breath regulation techniques (pranayama) and meditation/mindfulness (C*handa*).

There is emerging evidence of the positive impact of yoga on anxiety, depression, and other mood disorder symptoms (Balasubramaniam et al., 2013; Cramer et al., 2013; Gong et al., 2015; Uebelacker et al., 2010, 2014). Other benefits of yoga include improving muscular strength, muscular endurance, flexibility, cardiorespiratory endurance, interoceptive awareness, breath awareness, and mindfulness (Evans et al., 2009; Pascoe et al., 2021; Tran et al., 2001). American College of Sports Medicine (ACSM) categorizes yoga as a neuromotor exercise or functional fitness training because it involves motor skills (balance, coordination, agility, and proprioception training). ACSM guidelines recommend two to three days per week of 20-30-minute sessions for a total of $\geq$60 minutes of neuromotor exercise per week (Garber et al., 2011; Liguori & Medicine, ACSM, 2020). According to a 2022 National Institutes of Health survey, only about 15.8 percent of adults practice yoga (National Center for Complementary and Integrative Health, 2022), and do not meet recommended neuromotor exercise guidelines (National Center for Health Statistics, 2018).

As research emerges on the benefits of yoga with concurrent low engagement in regular yoga practice, it is essential to consider barriers and facilitators to yoga practice. Cagas and colleagues (2020) scoping review found that the some of the most commonly cited barriers to yoga practice were anticipated or previous negative experiences (previous experiences with a challenging class, feelings of discomfort, overexertion, frustration, or embarrassment), fear or perceived high risk of injury, lack of interest or motivation, and lack of self-confidence. Yoga can be intimidating and overwhelming. People may have difficulty in certain poses or may find specific poses more accessible than others. The way your body responds to a pose can also vary from day to day.

The delivery of yoga can vary tremendously, and some approaches may be more beneficial for initiating and motivating ongoing yoga practice. Many types and styles of yoga vary primarily based on the style and frequency of verbal instructions, also known as cues, provided by the yoga teacher (Park et al., 2020). For example, some yoga teachers may provide direct, specific instructions and encourage everyone in the class to hold the pose for the instructed amount of time. In contrast, others may offer multiple variations of the pose and encourage people to “listen to their body”, take breaks, or make adjustments at any point based on how they are feeling, also known as autonomy-supportive yoga instructions. Therefore, it is helpful to understand if certain styles of yoga instructions lead to continued yoga practice compared to others.

Based on self-determination theory (Deci & Ryan, 2008; Teixeira et al., 2020), autonomy-supportive yoga instructions may target specific psychological mechanisms, such as perceived autonomy, that are central to long-term behavior change. Self-determination theory is a broad theory of human motivation that suggests motivation exists on a continuum from amotivation (lack of any motivation to practice yoga) to autonomous motivation (motivation to practice yoga for internal reasons including enjoyment, personal interest, or inherent satisfaction). Autonomously motivated behavior is more likely to be maintained over time (Deci & Ryan, 2008; Teixeira et al., 2012). The three basic needs of autonomously motivated behavior are autonomy, competence, and relatedness. The need for autonomy refers to the need to engage in self-direction and perform a behavior volitionally with a sense of choice. Strategies that promote autonomy include using non-controlling language, providing choice, and encouraging the person to experiment and self-initiate behavior (Teixeira et al., 2020). Therefore, autonomy-supportive yoga instructions utilizing non-controlling language, providing choice, and encouraging self-initiation and experimentation throughout the yoga session may increase perceived autonomy.

Within the broader physical activity literature, providing more autonomy during physical activity can increase autonomous motivation and future behavior (Mossman et al., 2022; Teixeira et al., 2012). Within the sport and exercise literature, autonomy support includes a variety of instructor or coach-led behaviors that create an environment of support, care, and choice. Specifically, as described in Mossman et al.'s (2022) meta-analysis on autonomy support in sport and exercise settings, autonomy support coaches and fitness instructors provide more choices in their verbal instructions, acknowledge variability in feelings and perspectives, provide non-controlling competence-based suggestions, and avoid attempts to control individuals' behavior. Based on SDT, autonomy support aids in internalizing or increasing autonomous motivation by allowing for more volitional and self-regulatory behaviors within the physical activity setting (Mossman et al., 2022). Therefore, the research on the benefits of autonomy-support within other forms of physical activity suggests that autonomy-supportive instructional cues may also be beneficial for increasing engagement in yoga.

Yoga instructors often provide various types of instructions or cues throughout yoga sessions. More autonomy-supportive yoga instructions, for example, encouragement to modify poses by listening to their body, may lead to a more positive experience during the yoga class, thus increasing their autonomous motivation. If yoga participants have more energy or a particular pose feels more accessible that day, autonomy-supportive instructional cues offer the option to increase the depth or duration of the pose. Autonomy-supportive instructions encourage curiosity and exploration of what the body needs at that particular moment. Offering modifications, supporting the choice to take breaks, and encouraging adjustments to increase or decrease the depth and duration of poses may also promote confidence in poses. Autonomy-supportive instructions can also encourage exploration of the differentiation between feelings of discomfort and feelings of pain. If they feel pain, autonomy-supportive instructions offer the option to decrease the depth or take a break from the pose altogether. By encouraging adjustments of poses when they feel pain, these instructions may also decrease the fear of and perceived risk of injury. Therefore, the common psychological barriers to yoga of anticipated or previous negative experiences and fear of injury may be addressed through autonomy-supportive instructional cues during yoga.

Aside from the broad theoretical support for autonomy-supportive yoga instructions eliciting perceived autonomy, there is also emerging support in the yoga literature. A recent qualitative study on experiences with yoga suggests that an accepting and supportive instructor may strengthen participants' motivation to practice yoga (Cox et al., 2021). During the semi-structured interview, participants emphasized the desire for autonomy over their bodies and modification options from the instructor. Participants also described negative feelings towards instructors who cued too fast and did not offer modifications (Cox et al., 2021). To date, one study has investigated the impact of autonomy-supportive yoga instructions, which included Yogi's Choice as the primary intervention component designed to promote autonomy (Allison et al., 2021). Yogi's Choice was a segment of the yoga session where participants were asked to choose one of two poses and practice independently. In the interview, multiple participants identified Yoga's Choice as their favorite part of the intervention. Of note, these study conclusions are limited by the small sample size (n = 8), lack of a control group, and perceived autonomy measured via a semi-structured interview after eight weeks of twice-weekly yoga. Therefore, studies with a larger sample size, a control group, and an improved assessment of perceived autonomy are needed to conclude if autonomy-supportive yoga instructional cues can increase perceived autonomy.

Autonomy-supportive yoga instructional cues encourage a sense of choice and ownership over decision-making. For example, autonomy-supportive instructions offer volitional choice to engage in the next progression of a pose, remain in the current stage of the pose, choose a more supportive option, or perhaps take a break in child's pose. By offering choices and encouraging autonomy, individuals may feel more independent and autonomous over both their body and their yoga practice. Targeting perceived autonomy is important because it is an underlying mechanism of long-term maintenance of health behaviors (Teixeira et al., 2012). The combination of self-determination theory's theoretical support (Teixeira et al., 2012, 2020), evidence of autonomy-supportive interventions within other forms of physical activity (Mossman et al., 2022), and preliminary yoga research (Allison et al., 2021; A. Cox et al., 2021) suggests that autonomy-supportive instructional cues during yoga through non-controlling language, offering choice, and encouraging self-initiation and experimentation may increase perceived autonomy.

Autonomy-supportive yoga instructional cues may also target perceived competence, another psychological mechanism fundamental to long-term health behavior maintenance based on self-determination theory (Biddle & Nigg, 1970; Fortier et al., 2007; Ryan & Deci, 2000; Teixeira et al., 2012). Perceived competence refers to the need to feel effective and perceive sufficient capacity to perform mentally or physically challenging tasks. Strategies that promote competence include addressing obstacles to change and self-monitoring (Teixeira et al., 2020). By encouraging individuals to self-select the depth and duration of yoga poses, they may feel more capable and stronger (Puente & Anshel, 2010). When feelings of discomfort arise, autonomy-supportive instructions offer a break in child's pose or a more supportive pose. Meanwhile, when feelings of strength and confidence arise, autonomy-supportive instructional cues encourage volitional engagement in the next progression of the pose. Therefore, autonomy-supportive instructions enable participants to feel more confident in their stronger poses. Additionally, they can support themselves with modifications in more challenging poses. These instructions may facilitate self-knowledge and self-trust, leading to increases in perceived competence.

In addition to perceived autonomy and perceived competence, autonomy-supportive yoga instructional cues may also lead to more positive affective response to yoga. Affective factors are also a critical determinant of engagement in physical activity (Kiviniemi et al., 2007; Lawton et al., 2009; Rhodes & Kates, 2015). For many years, guidelines for physical activity prescriptions have revolved around effectiveness and safety rather than enjoyment. More recently, research has shifted towards acknowledging the importance of pleasure and affect to create a sustainable habit based on hedonic theory. The hedonic theory proposes that individuals tend to repeat pleasurable behaviors and avoid unpleasant activities (Johnston, 2003; Mellers, 2000). This suggests that the better you feel during physical activity (or more positive affective valence during), the more likely you are to engage in future physical activity (Zenko et al., 2020). The Affect and Health Behavior Framework proposes that different types of affective factors can influence physical activity (Stevens et al., 2020). This framework includes affective response, defined as core affective valence measuring how much pleasure or displeasure one feels during and immediately after completing physical activity, as an important determinant of future physical activity (Stevens et al., 2020; Williams, 2008; Williams et al., 2012).

The amount of autonomy provided is related to how one feels during physical activity. When given the autonomy to self-select the intensity of physical activity, people tend to choose an intensity with a positive affective response (Ekkekakis & Lind, 2006; Vazou-Ekkekakis & Ekkekakis, 2009; Williams, 2008). Instead of recommending heart rate ranges, Ekkekakis (2013) recommends "the intensity should be such that it does not cause a significant decrease in pleasure" (p. 1430). Prompting exercisers to maximize their pleasure and enjoyment during physical activity leads to a more positive affective response during (Zenko et al., 2020) and greater physical activity minutes, particularly for those with poor conditioning (low cardiorespiratory fitness) (Baldwin et al., 2016). Additionally, Ekkakakis and Lind (2006) found that providing autonomy through choice of intensity during physical activity led to a more positive affective experience (Ekkekakis & Lind, 2006). Perhaps providing autonomy and choice during yoga will lead to a more positive affective experience as well. To date, this has not been tested in the yoga literature.

Affective experience is integral to yoga practice. Through mindful instructions, yoga instructors often encourage students to direct their attention to the present moment and to notice their breath and physiological sensations. In addition, some practitioners explicitly provide autonomy-supportive instructions by encouraging awareness of any (presumably unpleasant) sensations by noticing their breath and encouraging adjustment of poses accordingly. Smith (2007) argues that this mode of self-inquiry, autonomy, and interoceptive awareness with the body and mind distinguishes yoga from purely physical exercise. Vazou-Ekkakakis and Ekkakis' (2009) research also suggests that affective response is more positive when the behavior is autonomous compared to when the behavior is controlled externally. Therefore, instructions that encourage autonomy-supportive of the depth, duration, and modification of yoga poses may positively influence affective response to yoga.

The utility of an intervention critically depends on early-phase development. The experimental medicine approach emphasizes the importance of testing the engagement of theorized underlying mechanisms of action (i.e., perceived autonomy, perceived competence, and affective response) before conducting a full randomized controlled intervention trial (Birk et al., 2023; Davidson et al., 2020). The NIH Science of Behavior Change program encourages researchers to begin behavior change intervention research by following these three steps: 1) identifying the intervention target, 2) developing measures of the target, and 3) engaging the target through experimentation or intervention prior to testing the degree to which target engagement produces the desired behavior change (Riddle & Science of Behavior Change Working Group, 2015). For this study, research on hedonic theory and self-determination theory have demonstrated affective response, perceived autonomy, and perceived competence as promising intervention targets. There are existing measures of these underlying mechanisms, specifically the Feelings Scale (Hardy & Rejeski, 1989), which measures affective response, and subscales of the Psychological Need Satisfaction in Exercise Scale (Wilson et al., 2006) which measure perceived autonomy and perceived competence. Therefore, this study takes action on the third step by attempting to engage the underlying mechanisms through intervention. This study applied the experimental medicine approach by testing if a single 30-minute session of autonomy-supportive yoga instructional cues (intervention) increased (more positive) affective response, perceived autonomy, and perceived competence (underlying mechanisms), which are the primary outcomes of this study. If the intervention increases the mechanisms, more resource-intensive studies can be done with additional yoga sessions and more robust measurement of subsequent yoga practice behavior (e.g., yoga class attendance, accelerometer).

Overall, autonomy-supportive yoga instructional cues may increase affective response, perceived autonomy, and perceived competence. Interventions to facilitate regular yoga practice can draw from behavioral change theories, such as self-determination theory, emphasizing the importance of autonomy and competence (Deci & Ryan, 2008; Teixeira et al., 2012). Additionally, affect is emerging as a critical determinant of physical activity (Ekkekakis & Brand, 2019). Therefore, affective response, perceived autonomy, and perceived competence are promising mechanisms of action for interventions designed to increase yoga practice. Using the experimental medicine framework to guide this early-phase intervention development study, this study aims to test the initial effect of autonomy-supportive yoga instructions on affective response, perceived autonomy, and perceived competence (see Figure 1).

Current Study

The purpose of this study was to test the effect of autonomy-supportive instructions during a single yoga session on perceived autonomy, perceived competence, and affective response to yoga. Utilizing a between-subject experimental design, participants were randomly assigned to one of two instructionally manipulated yoga classes delivered online: (1) mindfulness-based + autonomy-supportive intervention condition, or 2) mindfulness-based control condition. In addition to the mindful instructions, the mindfulness + autonomy-supportive intervention condition utilized non-controlling language, offered choice, encouraged self-initiation and experimentation within poses at an intensity that "feels good," and encouraged modifications if they felt any pain or unpleasant sensations in poses. The dependent variables were affective response (FS) during yoga (peak, pre-savasana, post-savasana), perceived autonomy, and perceived competence. Intention to practice yoga and self-reported yoga practice in the subsequent two weeks was also measured. For the primary outcomes, I hypothesized that affective response during yoga (Aim 1), perceived autonomy post (Aim 2), and perceived competence post (Aim 3) would be higher, or more positive, in the autonomy-supportive intervention yoga condition compared to the mindfulness-based control yoga condition. As secondary outcomes, I tested the effect of the autonomy-supportive yoga intervention on intentions to practice yoga (Aim 4) and self-reported yoga practice in the subsequent two weeks (Aim 5). As a form of a manipulation check, I tested condition differences in state mindfulness, hypothesizing that if the intervention worked as designed, both conditions would report similar levels of state mindfulness. In addition, I explored the extent to which these hypothesized effects differed by amount of yoga experience.

Methods

Participants

Participants were recruited from the psychology subject pool at Southern Methodist University (SMU) and received course credit for their participation. The study was advertised as an examination of thoughts and feelings towards a beginner-level yoga class. Before being invited to participate in the study, subjects completed a health status screening assessment to evaluate their risk of engaging in moderate physical exercise according to American College of Sports Medicine guidelines (American College of Sports Medicine, 2013). Specifically, they indicated the presence or absence of (a) known cardiovascular, pulmonary, and/or metabolic disease, (b) signs or symptoms suggestive of cardiovascular, pulmonary, and/or metabolic disease, or (c) CVD risk factors. Those who reported two or more of these risk factors were classified as at least moderate risk and were not eligible to participate. In order to be eligible, participants needed to be (1) at least 18 years old, (2) fluent in written and spoken English, and (3) report less than two risk factors that may limit their ability to safely participate in physical activity, according to ACSM guidelines, (4) report attending less than 50 yoga classes in their lifetime, and (5) answer “no” when asked if they currently engage in a “regular” yoga practice. The sample was limited to those with less yoga experience because this intervention targets barriers to yoga practice, which is common among those with less yoga experience. Additionally, those who have never practiced or do not practice regularly will receive more health benefits by increasing (or starting) to practice yoga compared to those who already practice regularly. All participants provided informed consent, and all study materials and procedures were reviewed and approved by the Institutional Review Board at Southern Methodist University (IRB Protocol ID# 22-148).

Power Analysis

Based on the power analysis completed on http://rmass.org/, I recruited at least 70 participants to complete the study. The power analysis was based on two-time points (pre-and post-yoga session), 14 session groups, an average of 5 participants per treatment cohort, an estimated correlation among repeated measures of .50, an error variance of .80, and a medium effect size of .5. Based on the experimental medicine approach, it is essential first to consider the magnitude of change of the mechanisms in the early phase of intervention development (Davidson et al., 2020). A medium effect size was selected for the power estimation because if there is not at least a medium effect size of intervention on the hypothesized mechanisms, then the intervention, as designed, might not be worth pursuing further. A correlation of .5 was a conservative estimate for the repeated measures. In addition, I assumed the following parameters: two-tailed, alpha = 0.05, and power = 80%.

Procedures

Study Design

Using a between-subjects experimental design, eligible participants signed up for a group appointment time through the SONA systems website. I utilized a randomizer to generate a randomization scheme to randomly assign each class to either the mindfulness-based + autonomy-supportive intervention condition or the mindfulness-based control condition.

Study Administration

The study was completed virtually through the use of secure online platforms, including HIPAA-compliant Zoom and Qualtrics. After participants signed up for the study on SONA, they received an email reminding them of their scheduled study session time, to wear comfortable clothing for yoga, and that yoga mats and blocks are available to borrow. One day before the study session, participants were sent a Qualtrics link via email, including informed consent and baseline measures. Upon joining the HIPAA-compliant Zoom session for the experimental study session, the research coordinator oriented the participants to the protocol, including confirming that participants had their yoga mats and two blocks, instructing them to silence and put away their cellular devices, and to keep their Zoom camera on and audio muted throughout the yoga session. The research coordinator then instructed participants to open the Qualtrics survey link on the computer (not on their cellular devices), complete the T1 set of survey measures (see Figure 2 for list of measures administered), and provide a thumbs up when the word "STOP" appeared on their survey screen. Before beginning the yoga session, the research coordinator explained to participants that at various times throughout the yoga session, the yoga teacher would prompt them to answer a set of questions on their screen and to provide a thumbs up when they were done answering the survey questions. Due to participants completing measures during a yoga session, multiple single-item measures were utilized to minimize distraction and the time needed to complete measures. The item order was also randomized to prevent an order effect. The research coordinator monitored each participant's survey progress to ensure participants were answering the correct survey questions at the correct time.

Participants completed another set of measures at the peak of the yoga session (T2), pre-savasana (T3), and post-savasana (T4). The pre-yoga time point (T1) was immediately prior to beginning the yoga session. The peak of the yoga session (T2) followed the completion of the more rigorous standing poses (e.g., warrior 1, warrior 2, and side angle), which was approximately 16 minutes into the 30-minute yoga session. The pre-savasana time point (T3) followed the completion of all yoga poses, and immediately before savasana, the resting pose typically at the end of yoga that lasts approximately 2 minutes (Forseth & Hunter, 2020). Post-savasana (T4) was directly after completing the resting pose (savasana). Two weeks following the second session, participants were emailed a follow-up survey (T5). All completers were compensated with study credit upon the end of the study. See Figure 2 for flowchart of study procedures.

Intervention condition. The intervention condition was a 30-minute mindfulness-based yoga session with, in addition to the mindfulness-based instructions, specific instructions promoting autonomy-supportive of the duration and depth of poses, encouraging autonomy within poses, and offering a modification or more supportive version of poses (see Table 1). In order to avoid overwhelming participants, only a few choices per pose were offered. This is because offering options is intended to increase a sense of control and not overwhelm participants with multiple options, particularly for novice yoga practitioners (Allison et al., 2021). Both conditions included the same poses. The intervention condition and control condition scripts were reviewed by a 200-hour yoga teacher and first author, who is also a 200-hour certified yoga teacher, prior to data collection.

Control condition. The control condition was a 30-minute mindfulness-based vinyasa yoga class without autonomy-supportive instructions (see Table 1, adapted from Cox et al., 2020). Based on previous literature, mindfulness-based yoga instructions may also increase perceived autonomy and perceived competence (A. E. Cox, Ullrich-French, & Austin, 2020).

Specifically, Cox and colleagues (2020) findings suggest that when individuals become more aware of their physical sensations, they may experience more autonomy and competence in their physical activity because mindfulness-based instructional cues encourage nonjudgmental, open awareness of the present, including bodily sensations. By encouraging present-moment openness to thoughts and feelings, individuals may feel less judgmental and more autonomous, pleasant, and competent in their ability. Therefore, it is essential to differentiate between mindfulness-based and autonomy-supportive instructions' effects on the underlying mechanisms of perceived autonomy, perceived competence, and affective response. By comparing the autonomy-supportive intervention to a control condition with mindfulness-based yoga instructions, the results speak to the effect of adding autonomy-supportive yoga instructions. Further, to assess if both conditions experienced similar levels of state mindfulness, state mindfulness was immediately measured post-yoga session (see Measures section below) as a form of a manipulation check.

Yoga teacher. Both yoga sessions were taught by a 200-hour Yoga Alliance Certified Level 1 yoga instructor. The same instructor taught both the intervention and control conditions to minimize differences in teacher style and thus eliminate teacher effects.

Yoga supplies rental. After signing up for a timeslot on SONA, all participants received an email asking if they had access to a yoga mat and two yoga blocks. If they did not, they could rent a yoga mat and/or yoga blocks as needed.

Yoga session recording and pilot sessions. In order to standardize the yoga sessions, the intervention and control yoga sessions were pre-recorded in the same yoga studio. The yoga teacher memorized the scripts to ensure that both conditions had the intended types and number of instructions. After the initial yoga session recordings were completed, the researcher administered two pilot sessions (one intervention and one control) and elicited feedback from one pilot participant. Based on the feedback from the participant, minor adjustments were made (e.g., the yoga teacher utilized a microphone to provide clear instructions at a high enough volume), and both the intervention and control conditions were re-recorded.

Open science registration. The study overview, participants and procedures, sample size, power, experimental conditions, measures, analyses, and hypotheses were registered with the Open Science Framework (osf.io) on January 31, 2023, before data collection began on February 6th, 2023.

Measures

Outcomes

Perceived autonomy. Perceived autonomy was assessed with an adapted version of the perceived autonomy subscale from the Psychological Need Satisfaction in Exercise scale (PNSE; Wilson et al., 2006). The scale was adapted for yoga by replacing both the word "exercises" with "yoga poses" and the words "exercise program" with "yoga practice" or "practice yoga," as grammatically appropriate in all six items. Additionally, the subscale was adapted to assess their state of perceived autonomy during the yoga session they practiced for the study. Therefore, the verbs were changed to past tense. They also received explicit instructions stating, "Please indicate how much you experienced each of the following during the yoga session you just completed." For example, "I feel free to exercise in my own way" was changed to "I felt free to practice yoga in my own way." Participants responded on a 6-point scale from 1 (*false*) to 6 (*true*). The perceived autonomy subscale of the PNSE has demonstrated good construct validity and internal reliability ($\alpha \geq .90$; Wilson et al., 2006).

Perceived competence. Perceived competence was assessed with an adapted version of the perceived competence subscale from the Psychological Need Satisfaction in Exercise scale (PNSE; Wilson et al., 2006). Similar to the perceived autonomy subscale adaption for yoga, the word “exercises” was replaced with “yoga poses” in all six items. Additionally, the subscale was adapted to assess their state of perceived competence during the yoga session they practiced for the study. Therefore, the verbs were changed to past tense. They also received explicit instructions stating, “Please indicate how much you experienced each of the following during the yoga session you just completed.” For example, “I feel that I am able to complete exercises that are personally challenging” was changed to “I felt that I was capable of trying yoga poses that were personally challenging.” Participants responded on a 6-point scale from 1 (*false*) to 6 (*true*). The perceived competence subscale of the PNSE has demonstrated good construct validity and internal reliability ($\alpha \geq .90$; (Wilson et al., 2006).

Affective response at baseline and during exercise. Affective response during exercise was assessed with the Feeling Scale (FS; (Hardy & Rejeski, 1989), a single item asking participants, “How do you feel?” with instructions stating, “Answer the questions based on how you are feeling right now.” Though the single-item measure limits the variance and sensitivity of the measure, it minimizes participant burden because data collection occurred during yoga. At pre-yoga (T1), peak of yoga session (T2), pre-savasana (T3), and post-savasana (T4), participants rated the single item on from -5 (*very bad*) to +5 (*very good*) with verbal anchors at zero (neutral) and odd numbers (see Figure 2 for timing of measures).

Rating of Perceived Exertion. The single-item measure Rating of Perceived Exertion (RPE; Borg, 1998) was used to assess perceived exertion at baseline, peak, pre-savasana, and post-savasana. RPE was assessed on a 15-point scale from 6 (*no exertion at all*) to 20 (*maximal* *exertion).* Scherr et al.'s (2013) study with over 2500 participants found a strong correlation between both RPE ratings and HR (r = .74) and RPE ratings and blood lactate (r = .83), supporting RPE's construct validity by providing evidence that RPE is measuring physical activity exertion.

State mindfulness. State Mindfulness Scale for Physical Activity-2 (SMS-PA2) was used to assess mindfulness of the body (e.g., I felt present in my body), mindfulness of the mind (e.g., I was aware of different emotions that arose in me), and acceptance of the body (e.g., I acknowledged how my body felt without trying to change it), and acceptance of the mind (e.g., I let my thoughts/emotions just be without fixating on them). SMS-PA2 full scale was calculated as a mean score of all 19 items. The individual SMS-PA2 subscales were calculated as a mean of the items of each subscale, with higher scores suggesting higher levels of state mindfulness. This measure served as a form of a manipulation check to determine if there were any condition differences in state mindfulness. SMS-PA-2 has demonstrated adequate construct validity and internal reliability (α range from .75-.89 for total scale and subscales) (A. E. Cox et al., 2016; Ullrich-French et al., 2022). For this data collection, the alphas for the subscales of the SMS-PA2 ranged from 0.63 – 0.84, average inter-item correlation was 0.25 for the overall scale (with subscale AICs ranging between 0.36 – 0.53).

Intentions to practice yoga. Intentions to practice yoga were assessed via a three-item measure used in other forms of physical activity adapted for yoga. Participants rated the three items "In the next two weeks, I intend to practice yoga," "In the next two weeks, I will try to practice yoga," and "In the next two weeks, I plan to practice yoga" on a scale from 1 (*strongly disagree*) to 5 (*strongly agree*).

Self-report yoga practice. During the follow-up surveys two weeks after the yoga study session, participants were asked, "Have you practiced yoga in the past two weeks?" with yes and no response options.

Baseline Measures

Demographic information. Participant demographic information, including self-reported age, sex, gender, race, and ethnicity, was collected.

Past yoga experience. Participants were asked if they had any prior experience with yoga. If participants report having any prior experience with yoga, they were asked to enter "approximately, how many hours of yoga have you practiced in your life." They were also asked if they practice yoga regularly and, if so, how many hours per week they practice yoga (adapted for brevity from Moliver et al., 2011).

Data Analysis Plan

Primary Outcomes

In order to account for hierarchical nesting (e.g., yoga class groups) and repeated assessments within participants, three-level multilevel modeling was used to examine the effect of treatment condition on affective response during yoga (Aim 1), and two-level multilevel modeling was used to examine the effect of condition on perceived autonomy (Aim 2) and perceived competence (Aim 3). The multilevel models allowed me to address if the nesting factor (e.g., 1:00 pm Tuesday yoga session) affected the rate of change of each outcome (Tasca et al., 2009). Additionally, multilevel models allowed me to address the effect of treatment condition on the rate or shape of change. For Aim 1, affective response and time (level-1) individual participant variables are situated within yoga experience (level-2) that are located within cohort and condition (level-3). The dependent variable (affective response) was measured before yoga, at peak, pre-savasana, and post-savasana.

The following equations represented the base model:

Level 1: $Y_{tij} = \pi_{0ij} + \varepsilon_{tij}$

Level 2: $\pi_{0ij} = \beta_{00j} + r_{0ij}$

Level 3: $\beta_{00j} = \gamma_{000} + \mu_{00j}$

At level 1, Y_{tij} is affective response assessed at time *t* for individual *i* nested within cohort *j*, π_{0ij} is the mean affective response across all time points for individual *i* in group *j,* and ε_{tij} is the deviation of individual *i*'s affective response measured at time *t* from their mean. At level 2, β_{00j} is the average of affective response scores for individuals in cohort *j,* and r_{0ij} is the deviation in affective response of individual *i* from the mean of cohort *j.* At level 3, γ_{000} is the grand mean of affective response across all cohorts, and μ_{00j} is the deviation in mean affective response of cohort *j* from the grand mean. This base model provided an estimate of the total within-person variance.

Next, I conducted an unconditional model that specifies time as a predictor and controls for pre-yoga session affective response. The unconditional model was represented with the following equations:

Level 1: $Y_{tij} = \pi_{0ij} + \pi_{1ij}\,(\text{Time}_{tij}) + \varepsilon_{tij}$

Level 2: $\pi_{0ij} = \beta_{00j} + \beta_{01j}$ (individual prescore) $+ r_{0ij}$

$\pi_{1ij} = \beta_{10j} + \beta_{11j}$ (individual prescore) $+ r_{1ij}$

Level 3: $\beta_{00j} = \gamma_{000} + \gamma_{001}$ (cohort prescore) $+ \mu_{00j}$

$\beta_{01j} = \gamma_{010} + \mu_{01j}$

$\beta_{10j} = \gamma_{100} + \gamma_{101}$ (cohort prescore) $+ \mu_{10j}$

$\beta_{11j} = \gamma_{110} + \mu_{11j}$

The unconditional model at level 1 models within-person rate of change.

Then, I conducted a conditional model three-level model controlling for pre-scores with the following equations:

Level 1: $Y_{tij} = \pi_{0ij} + \pi_{1ij} (Time_{tij}) + \varepsilon_{tij}$

Level 2: $\pi_{0ij} = \beta_{00j} + \beta_{01j}$ (individual prescore) $+ r_{0ij}$

$\pi_{1ij} = \beta_{10j} + \beta_{11j}$ (individual prescore) $+ r_{1ij}$

Level 3: $\beta_{00j} = \gamma_{000} + \gamma_{001}$ (cohort prescore) $+ \gamma_{002}$ (treatment condition) $+ \mu_{00j}$

$\beta_{01j} = \gamma_{010} + \mu_{01j}$

$\beta_{10j} = \gamma_{100} + \gamma_{101}$ (cohort prescore) $+ \gamma_{102}$ (treatment condition) $+ \mu_{10j}$

$\beta_{11j} = \gamma_{110} + \mu_{11j}$

For two-level models testing the effect of condition on perceived autonomy (Aim 2) and perceived competence (Aim 3), the level-1 individual participant variables (perceived autonomy or perceived competence, yoga experience) are located within the level-2 variables (cohort and condition). The dependent variables were perceived autonomy (Aim 2) or perceived competence (Aim 3).

Secondary Outcomes

I also used three-level multilevel modeling to examine the effect of treatment condition on intentions to practice yoga (Aim 4). Intentions and time (level-1) individual participant variables were situated within yoga experience (level-2) that were located within condition and cohort (level-3). The dependent variable, yoga practice intentions, was measured at baseline, immediately following completion of the yoga session, and two weeks post yoga session. I also utilized GLMM to examine the effect of condition on self-reported yoga practice measured two weeks post (Aim 5).

Exploratory Outcomes

As a form of manipulation check, state mindfulness was measured immediately following the yoga session's completion to determine if there were any condition differences in state mindfulness. Similar to above, I utilized three-level multilevel modeling to examine the effect of treatment condition on state-mindfulness of physical activity.

Across all analyses, effect sizes were calculated using Wilson's web-based effect size calculator, which computes Cohen's *d* from unstandardized regression coefficients from the multilevel models accounting for clustering effects (Wilson, n.d.).

Results

Sample Characteristics and Descriptives

The sample was 86% female and 78% White, with an average age of 20 years old (see Table 2). About 1/5 of the sample had never practiced yoga before, and, on average, they had about 14 hours of yoga experience in their lifetime (see Table 3). There were no significant condition differences in any of the descriptives. Therefore, demographic variables were not included as covariates in any of the analyses.

Individuals were recruited and enrolled in the study between February 2023 and April 2023. Of the 147 students who completed the initial study screener, 112 (76%) were considered eligible and invited to participate. Of the 35 individuals ineligible to participate, the most common reason for ineligibility was lifetime experience of 50+ yoga classes (29%) and current regular yoga practice (23%). Overall, there was minimal attrition. After completing the baseline surveys, only one individual (1.35%) withdrew from the study due to difficulties with the time commitment, thereby missing data for the experimental yoga session and follow-up. All participants who were randomized completed both the experimental yoga session and the two-week follow-up. See Figure 3 for participant consort diagram and attrition**.**

There was not a main effect of condition on ratings of perceived exertion (b = 0.16, SE = 0.43, 95% CI [-0.74, 1.06], d = 0.07, p = .712), meaning both conditions reported similar levels of perceived exertion or physical activity intensity (M = 11.73, SD = 2.30), as intended.

As a form of a manipulation check, the conditions did not differ in state mindfulness of physical activity, measured by the full-scale mean. Additionally, the conditions did not differ on any of the state mindfulness subscale scores (see Table 6 for detailed statistics). Correlations between all study outcomes and yoga experience are reported in Table 7.

Primary Outcomes

Affective Response

As shown in Table 4, there was not a main effect of condition on affective response. There was a small main effect of time on affective response, indicating that affective response significantly increased over time across both conditions (d = .31). The interaction of time and condition was not significant, indicating that the slope of time does not significantly differ between conditions. None of the other interaction terms were significant either, so they were dropped from the model.

Perceived Autonomy

As shown in Table 4, there was a large main effect of condition on perceived autonomy post-yoga, indicating that participants in the intervention condition reported significantly higher perceived autonomy than participants in the control condition (d = -1.27). Descriptives are also included in Table 5. None of the interaction terms were significant. Therefore, they were dropped from the model.

Perceived Competence

There was not a main effect of condition on perceived competence indicating that participants in the intervention and control conditions reported similar levels of perceived competence (see Table 4). None of the interaction terms were significant and they were dropped from the model.

Secondary Outcomes

Yoga Practice Intentions

There was a small main effect of condition on yoga practice intentions, but in the opposite direction from what I predicted (d = .35; see Table 4). Specifically, the control condition reported higher yoga practice intentions compared to the intervention condition, as seen descriptively in Table 5. The interaction of time and condition was not significant, indicating that the slope did not significantly differ between conditions. None of the other interaction terms were significant either, so they were dropped from the model.

Yoga Practice Behavior

As shown in Table 4, the main effect of condition on self-reported yoga practice two weeks post (yes/no) was not significant. Similar to previous aims, none of the interaction terms were significant, so they were dropped from the model.

Moderation of Yoga Experience

When testing the moderating effect of yoga experience, none of the interactions between yoga experience and condition were significant (p values all greater than .302). However, the there was a small main effect of yoga experience on multiple outcomes, specifically perceived autonomy (d = .08) and yoga practice intentions (d = .11) This suggests that across conditions those with more yoga experience reported significantly higher perceived autonomy and yoga practice intentions. See Table 1A in the Appendix for additional details.

Discussion

In this early-phase intervention development study, autonomy-supportive yoga instructions increased one of the three hypothesized mechanisms, perceived autonomy, but did not increase perceived competence and lead to a more positive affective response. In addition, the autonomy-supportive yoga instructions did not increase intentions to practice yoga or self-reported yoga practice in the subsequent two weeks. Contrary to my hypothesis, the mindfulness-based control condition reported significantly higher intentions to practice yoga; however, both conditions reported similar levels of yoga practice. Regarding yoga experience, those with more yoga experience reported higher levels of perceived autonomy and yoga practice intentions across conditions. All other findings were not moderated by yoga experience.

As hypothesized, participants in the intervention condition reported significantly higher levels of perceived autonomy. These results affirm that participants in the intervention condition felt they were provided with the autonomy to modify, deepen, or skip poses as intended. It also confirms that they were paying attention to the autonomy-supportive instructions. This demonstrates that it is possible to increase perceived autonomy in a yoga session by altering the verbal instructions provided by the yoga teacher. These results are similar to findings in the education field, which have demonstrated that increasing autonomy-supportive instructions from teachers in the classroom increases students' perceived autonomy (Edmunds et al., 2008).

Contrary to the original hypotheses, those who received the autonomy-supportive intervention condition did not feel more positive throughout the yoga session or more competent afterward. There are multiple explanations for autonomy-supportive yoga intervention not increasing affective response, including possible personal preferences for certain types of yoga cues. Perhaps individuals with certain personality traits (e.g., lower openness, higher conscientiousness) prefer more direct instructions and/or dislike being told to actively decide between two variations of a pose during yoga (Sivaramakrishnan et al., 2017). Additionally, offering multiple pose variations may have been overwhelming or even anxiety-provoking for some, which may have decreased affective response during the autonomy-supportive yoga session (Magnan et al., 2013). Based on the exercise literature, affective response is closely linked to intensity (Ekkekakis & Brand, 2019). Both conditions reported perceived exertion scores in moderate intensity range at the peak of the yoga session. Therefore, similar moderate intensity levels experienced across conditions may have also contributed to similar valence of affective response.

There are also several possible explanations for why the autonomy-supportive intervention did not increase perceived competence. Rated on a 6-point scale, the average self-reported perceived competence score for both conditions was above 5. This young and healthy sample may have already felt competent participating in a yoga session. Unfortunately, we do not have baseline or prior yoga session data to observe within-subject changes. However, the high average suggests a potential ceiling effect. Additionally, the 30-minute yoga session may have needed to be more challenging or longer to observe variability in perceived competence within this young and healthy sample. The lack of condition differences in perceived competence is inconsistent with prior research demonstrating that when exercise instructors included more autonomy-supportive instructions during college-level physical education classes, students reported higher perceived competence (Puente & Anshel, 2010). However, Puente & Anshel's (2010) autonomy-supportive intervention instructions included individualized positive encouragement and constructive feedback which may have more directly targeted perceived competence compared to offering choice.

One additional aspect of the results that warrants explanation is that perceived autonomy was not correlated with yoga practice intentions or self-report yoga practice two weeks later, contrary to the literature on the positive relationship between perceived autonomy and physical activity intentions and behavior (Mossman et al., 2022). The autonomy-supportive intervention may require more than one 30-minute yoga session to increase yoga intentions and yoga practice. If the theorized dose-response relationship exists between perceived autonomy and sustained yoga practice, it may require two to three sessions per week for multiple weeks, or even, months to observe the expected positive correlation (Cox et al., 2021; Fortier et al., 2007; Mossman et al., 2022). Another explanation for the lack of correlation may be the sample's limited yoga experience. In contrast to other types of physical activity, such as walking, for almost 20% of the sample, this was their first-time practicing yoga. Learning a new skill utilizes more cognitive resources compared to practicing a learned skill (Russell et al., 2020; Sweller, 2011). Therefore, those new to yoga may want and/or need more direct instructions without offering choices. Additionally, it may be more challenging to decide to deepen, modify, or skip a pose if you have never practiced any variations of the pose before.

For the secondary outcomes, there was a small effect of condition on yoga intentions in the opposite direction, meaning the control group reported higher intentions to practice yoga. However, this did not translate into higher yoga practice intentions for the control group. There are a few possible explanations for this unexpected pattern of results. Perhaps the instructions in the autonomy-supportive intervention offered too many options. Offering options was intended to increase feelings of control. However, too many options during yoga may have felt overwhelming (Allison et al., 2021). If participants in the intervention condition felt overwhelmed by the number of choices, they may have reported lower intentions to practice yoga and less yoga practice. Additionally, research suggests that autonomy-support interventions may be more important for individual exercise (e.g., walking or swimming) vs. team or group exercise classes (Reynders et al., 2019). Therefore, autonomy-supportive yoga instructions may be more likely to increase intentions and/or yoga practice during individual yoga sessions.

This study was the first to isolate the effect of autonomy-supportive yoga on underlying psychological mechanisms of behavior change. There are only two published studies to date measuring affective response during a yoga session (Follador et al., 2019; Mackenzie et al., 2014). Overall, these findings suggest that additional research is needed on the underlying mechanisms motivating engagement in yoga before further investigating autonomy-supportive instructional cues. Yoga may be a unique form of physical activity. Certain health behavior theories, primarily tested in cardiorespiratory and strength studies, may not directly map onto yoga. Further research is needed to understand if autonomy-supportive yoga instructional cues (e.g., offering pose options, utilizing non-controlling language, and encouraging a sense of choice) impact the underlying mechanisms of a sustained yoga practice. These theoretically grounded findings provide a rationale for further investigation of motivational mechanisms that promote regular yoga practice and thus may help individuals improve both their physical and mental health.

Limitations and Future Research

This study has several limitations. First, the homogenous sample primarily consisted of healthy college-aged White females, which limits the generalizability of the findings. Additionally, the sample size may have been too small to effectively detect moderation effects and interactions. Furthermore, the yoga session was conducted with a novel, pre-recorded yoga video while on Zoom, which may not reflect real-life yoga practice and limited participants' ability to connect with the yoga teacher. Research emphasizes the importance of the connection with the yoga teacher for sustained yoga practice (Cox et al., 2021; Park et al., 2019). Therefore, future studies could explore in-person compared to virtual live yoga classes. Lastly, a single 30-minute yoga session may not have been strong enough to impact intentions. Multiple yoga sessions with a specific type of yoga instruction may be needed to increase an individual's intentions to engage in yoga in the near future. To date, there is not any research on how many yoga sessions are needed to influence yoga practice intentions and behavior.

Based on the findings, future studies need to further investigate how we can increase yoga practice through different types of instructional cues. First, additional research is needed to determine whether perceived autonomy impacts yoga practice intentions and behavior. It is unclear from this study whether feeling autonomous during yoga has as much impact on motivation to practice yoga compared to research on other types of physical activity. In this study, we targeted and measured state perceived autonomy of a single yoga session. To increase intentions and behavior, an intervention needs to increase perceived autonomy more broadly, not only the perceived autonomy experience during that single yoga session. Therefore, an intervention with two to three autonomy-supportive yoga sessions per week over multiple months may be necessary to observe increases in the broader construct of perceived autonomy and, thus, increase intentions to practice yoga. The intervention may also benefit from refinement to determine the optimal number of pose options or variations to enhance autonomy without overwhelming participants, especially for those new to yoga. Additional studies are needed in more diverse samples covering a wider age range with varying levels of yoga experience. It would also be informative to test autonomy-supportive instructions during in-person yoga to allow for tailored feedback and encouragement, as well as connection with the yoga teacher. This is also supported by the preliminary research on the additional benefits of in-person yoga compared to online yoga (Brinsley et al., 2021).

In conclusion, this early-phase intervention study provides initial insights into the effects of autonomy-supportive instructions during yoga on the underlying mechanisms of affective response, perceived autonomy, and perceived competence. While autonomy-supportive instructions successfully increased perceived autonomy, they did not enhance perceived competence or affective response. Additionally, the autonomy-supportive instructions did not lead to higher intentions to practice yoga or increased yoga practice in the subsequent two weeks. Contrary to expectations, the mindfulness-based control condition reported higher intentions to practice yoga, although this did not translate into increased yoga practice. The study highlights the complexity of the motivational mechanisms of yoga and suggests that a single 30-minute yoga session may not be sufficient to impact longer-term yoga intentions and behavior. Future research should focus on refining autonomy-supportive instructions, examining the impact of multiple sessions, and testing autonomy-supportive yoga instructions on a more diverse sample across a wider age range and in various contexts, such as in-person versus online yoga. This study underscores the need for further investigation into the unique aspects of yoga as a form of physical activity and its implications for health behavior theories.

Table 1. *Example Yoga Pose Instructions for Both Conditions*

Pose	**Mindfulness-based control condition instructions (adapted from Cox et al., 2020)**	***Autonomy-supportive* + mindfulness-based intervention condition instructions**
Introduction	Welcome everyone and thank you for being here. I will be guiding your through some different yoga poses for the next 45 minutes. I'll demonstrate, observe, and assist as needed. Towards the middle of the session and before and after the resting pose, I'll ask you to complete three questions in your paper survey packet at the front of your mat. If you have any questions or concerns during the class, just raise your hand and I'll come over to help you. Let's get started!"	Welcome everyone and thank you for being here. I will be guiding your through some different yoga poses for the next 45 minutes. I'll demonstrate, observe, and assist as needed. *Throughout the class, I'll serve as a guide. All cues are suggestions. You are the only person who knows how your body feels and you get to choose what is best for you… If you are experiencing pain or you are having difficulty maintaining a steady breath, try coming out of the pose or taking a break in child's pose. And you have permission to modify or come into child's pose at any point. Do what feels good for you.* Towards the middle of the session and before and after the resting pose at the end of the session, I'll ask you to complete three questions in your survey packet that is placed at the front of the mat. If you have any questions or concerns during the class, just raise your hand and I'll come over to help you. Let's get started!
Downward Facing Dog	Curl your toes under, lift your hips to the sky into downward facing dog. Alternate bending your knees and pressing your heels into the earth to warm up your legs. Notice the feeling of strength in your shoulders and back. Allow thoughts that arise to come and go…. Breathe.	Curl your toes under, lift your hips to the sky into downward facing dog. Alternate bending your knees and pressing your heels into the earth to warm up your legs. Notice the feeling of strength in your shoulders and back. *There is a difference between discomfort and pain. If you feel any pain or pulling on your lower back, try bending your knees more, spreading your feet further apart, or placing blocks under your hands to bring the ground closer to you. Give yourself the option to do what feels good for you.* Allow thoughts that arise to come and go… Breathe.

Pose	**Mindfulness-based control condition instructions (adapted from Cox et al., 2020)**	***Autonomy-supportive*** **+ mindfulness-based intervention condition instructions**
Mountain	Roll up to standing upright in mountain pose, reach your hands to the sky. Root into the earth with your whole foot, hug your legs toward one and another and feel firm in your core to create steadiness as you lift your arms, open your heart, inhaling. Exhaling, bring your hands to heart center and stand in the strength of your foundation.	Roll up to standing upright into mountain pose *as slowly as feels good to you. When you're ready,* reach your hands to the sky. Root into the earth with your whole foot, hug your legs toward one and another and feel firm in your core to create steadiness as you lift your arms, open your heart, inhaling. *You can step your feet wider apart to minimize strain on the lower back.* *You also can rest your hands at your side facing forward or press the palms of your hands together at your heart center. You can try some of these variations with your arms and decide to come to back to reaching your hands to the sky. Experiment and get curious about how these adjustments make you feel.* Exhaling and stand in the strength of your foundation.
Side angle	Plug your elbow into the stability of your knee and feel the connection in side angel. From your foundation of strength, what do you along the right of your body?	Plug your elbow into the stability of your knee and feel the connection in side angel. From your foundation of strength, what do you along the right of your body? *You have the option here to bring your knee down to the mat. If you bring your knee down, you can also play with grabbing your right shin or ankle with your right hand.* *Notice if your breath is shallow or strenuous or if you're holding your breath. If so, this might be a sign to come out of the pose slightly or to bring your knee down to the mat.* *If you would like more of a challenge, you can extend your arms straight out in front. Notice your breath here.*

Note. Text in italics are cues unique to the autonomy-supportive intervention condition.

Table 2. *Demographics by Condition*

Variable	Intervention *n* = 36		Control *n* = 37		Full Sample *N* = 76*		Condition Differences
	M or *n*	*SD* or %	M or *n*	*SD* or %	M or *n*	*SD* or %	
Sex							*p* = .467
Female	30	83.3%	33	89.2%	65	85.5%	
Male	6	16.7%	4	10.8%	11	14.5%	
Gender	30	83.3% F	33	89.2%	65	85.5%	*p* = .467
Female	30	83.3%	33	89.2%	65	85.5%	
Male	6	16.7%	4	10.8%	11	14.5%	
Race (White)							
White	27	75%	29	78.4%	59	77.6%	
Asian	5	13.9%	4	10.8%	9	11.8%	
Black	3	8.3%	4	10.8%	7	9.2%	
American Indian or Alaskan Native	1	2.8%	0	0%	1	1.3%	
Native Hawaiian or Pacific Islander	0	0%	0	0%	0	0%	
Ethnicity							*p* = .353
Not Hispanic or Latino	27	75%	31	83.8%	60	78.9%	
Hispanic or Latino	9	25%	6	16.2%	16	21.1%	
Age	20.08	1.57	19.54	1.19	19.76	1.40	*p* = .063

Note. There were no significant differences in baseline characteristics between the intervention and control condition. Dichotomous outcome differences were analyzed with chi-square. All other outcome differences were analyzed utilizing multilevel models. *Of the full sample size of 76, three participants were not randomized to condition.

Table 3. *Descriptive Statistics at Baseline*

Variable	Intervention *n* = 36		Control *n* = 37		Full sample *N* = 76*		Condition differences
	M or *n*	*SD* or %	M or *n*	*SD* or %	M or *n*	*SD* or %	
Yoga Ever							$p = .213$
Yes	27	75%	32	86.5%	62	81.6%	-
No	9	25%	5	13.5%	14	18.4%	-
Meditation Ever							$p = .291$
Yes	20	55.6%	25	67.6%	48	63.2%	-
No	16	44.4%	12	32.4%	28	36.8%	-
Yoga Lifetime Hours	10.61	15.03	15.84	12.56	13.58	14.38	$p = .675$
Yoga # of Years	1.04	.50	2.24	2.41	1.65	2.15	$p = .265$
Intent Baseline	3.21	1.95	3.66	1.43	3.47	1.75	$p = .196$
Feeling Scale Pre	1.64	1.94	1.54	1.66	1.59	1.79	$p = .903$
Rate of Perceived Exertion Pre	7.86	2.59	9.00	3.48	8.44	3.11	$p = .118$

Note. There were no significant differences in baseline characteristics between the intervention and control condition. Dichotomous outcome differences were analyzed with chi-square. All other outcome differences were analyzed utilizing multilevel models. Intention Baseline was rated from 1 = strongly disagree to 7 = strongly agree, Feeling Scale Pre was rated from -5 = very bad to 5 = very good, Rating of Perceived Exertion Pre was rated from 6 = no exertion to 20 = maximal exertion. *Of the full sample size of 76, three participants were not randomized to condition.

Table 4. *Effects of Autonomy-Supportive Yoga Instructions on Study Outcomes*

	Estimate	*SE*	95% *CI*	*p*-value	*d*
Affective Response (Aim 1)					
Intercept	2.15	.24	[1.66, 2.64]	<.001***	-
Condition	-.32	.48	[-1.30, .66]	.507	-.17
Time	.57	.07	[.42, .71]	<.001***	.31
Condition*Time	.13	.15	[-.15, .42]	.376	.07
Perceived Autonomy (Aim 2)					
Intercept	4.77	.09	[4.59, 4.94]	<.001***	-
Condition	-1.39	.13	[-1.64, -1.14]	<.001***	-1.27
Perceived Competence (Aim 3)					
Intercept	5.12	.15	[4.80, 5.42]	<.001***	-
Condition	.11	.21	[-.33, .35]	.625	.13
Yoga Practice Intentions (Aim 4)					
Intercept	3.94	.14	[3.65, 4.24]	<.001***	-
Condition	.60	.28	[.01, 1.20]	.005**	.35
Time	.26	.14	[-.01, .53]	.058	.15
Condition*Time	.002	.27	[-.53, .54]	.995	.01
Yoga Practice (Aim 5)					
Intercept	.03	.40	[-.76, .83]	.933	-
Condition	-.76	.58	[-1.91, .39]	.193	-.42

Note. Multilevel modeling. Aim 1 and Aim 4 include time because the outcomes (FS and yoga practice intentions) were measured multiple times, see Figure 2 for specific timepoints. For Aim 1, time was centered at peak of the yoga session (see Figure 2, peak of yoga session is labeled as T2). For Aim 4, time was centered at post yoga session (see Figure 2, post yoga is labeled as T4). For Aim 1 and Aim 4, condition was centered at .5 or the average of the two condtions. For condition for Aim 2 ,3, and 4, 1 = control, 0 = intervention. Aim 2, 3, and 5 do not include time because the outcomes (perceived autonomy, perceived competence, and yoga practice) were only measured once. *SE* = standard error, *CI* = confidence interval *d* = Cohen's *d* effect size, *$p < .05$, **$p < .01$, ***$p < .001$.

Table 5. *Descriptives of Outcomes by Condition*

Outcomes	Intervention M (*SD*) or *n*, %	Control M (*SD*) or *n*, %
FS (peak)	1.64 (1.94)	1.92 (1.62)
FS (pre savasana)	2.17 (2.01)	2.84 (1.48)
FS (post savasana)	2.86 (1.82)	3.32 (1.67)
Perceived autonomy	4.77 (.88)	3.37 (5.21)
Perceived competence	5.10 (.94)	5.21 (.84)
Intentions post	3.89 (1.71)	4.89 (1.41)
Intentions follow-up	3.75 (1.80)	4.23 (1.45)
Yoga practice		
Yes (*n,* %)	12, 33.3%	19, 51.4%
No (*n,* %)	24, 66.7%	18, 48.6%

Note. FS = Feeling scale. FS ranges from -5 (*very bad*) to +5 (*very good*). Perceived competence ranged from 1 (*false*) to 6 (*true*). Intentions ranged from 1 (*strongly disagree*) to 5 (*strongly agree*).

Table 6. *Condition Differences in State Mindfulness of Physical Activity-2 (SMS-PA2)*

Outcomes	Intervention M (*SD*)	Control M (*SD*)	Full sample M (*SD*)	Condition differences*
SMS-PA Full Scale	3.60 (0.54)	3.67 (0.45)	3.64 (0.50)	$b = 0.06$, $SE = 0.12$, 95% CI [-0.20, 0.31], $p = .660$
Subscales	-	-	-	-
Monitoring mind	3.11 (0.86)	3.08 (0.66)	3.10 (0.76)	$b = 0.05$, $SE = 0.20$, 95% CI [-0.47, 0.37], $p = .801$
Monitoring body	4.19 (0.65)	4.16 (0.64)	4.18 (0.64)	$b = -0.04$, $SE = 0.16$, 95% CI [-0.36, 0.29], $p = .828$
Accepting mind	3.02 (0.88)	3.19 (0.85)	3.11 (0.86)	$b = 0.16$, $SE = 0.20$, 95% CI [-0.24, 0.56], $p = .429$
Accepting body	3.91 (0.72)	4.16 (0.77)	4.04 (0.75)	$b = -.26$, $SE = 0.18$, 95% CI [-0.09, 0.61], $p = .139$

Note. * = all condition differences also ran with yoga experience as moderator. None of the interactions between condition and yoga experience were significant. However, the main effect of yoga experience on state mindfulness of physical activity was significant for the full scale mean and for all subscales.

Table 7. *Correlation Matrix Between Study Outcomes*

Variable	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
1. FS pre	-									
2. FS peak	.710**	-								
3. FS pre savasana	.754**	.820**	-							
4. FS post savasana	.658**	.742**	.874**	-						
5. Autonomy post	.231*	.277*	.110	.072	-					
6. Competence post	.204	.339**	.354**	.230*	.055	-				
7. Intentions post	.213	.243*	.267*	.368**	.034	.176	-			
8. Intentions follow up	.132	.121	.046	.160	.020	.077	.666**	-		
9. Yoga prac[a]	-.058	-.027	.056	-.071	-.029	-.182	-.345**	-.581**	-	
10. Yoga exp[b]	-.099	.008	.081	.124	-.019	.207	.304**	.026	.018	-

Note. FS = Feeling Scale. Post = immediately following yoga study session. Follow-up = two weeks after yoga study session. Prac = practice. Exp = experience.

[a]Yoga practice was also measured two weeks after the yoga study session. It was measured dichotomously (0 = no did not practice yoga in past two weeks and 1 = yes practiced yoga in past two weeks).

[b]Variable was transformed to reduce skewness for computing correlations (also transformed in the multilevel model analyses). All correlations are correlation coefficients.

*$p < .05$, **$p < .01$

Figure 1. *Hypothesized Effects of Autonomy-supportive Yoga Instructional Cues on Target Mechanisms of Affective Response to Yoga, Perceived Autonomy, and Perceived Competence*

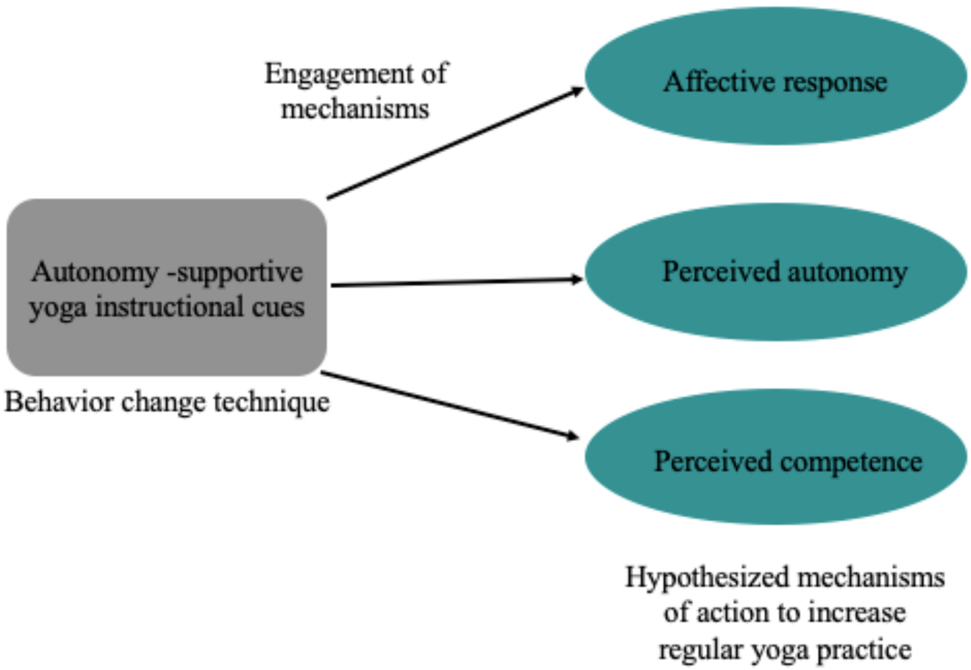
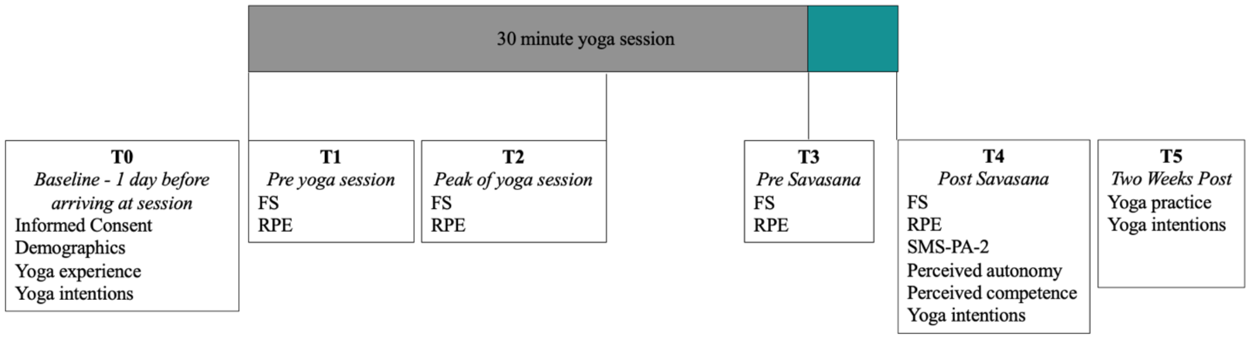
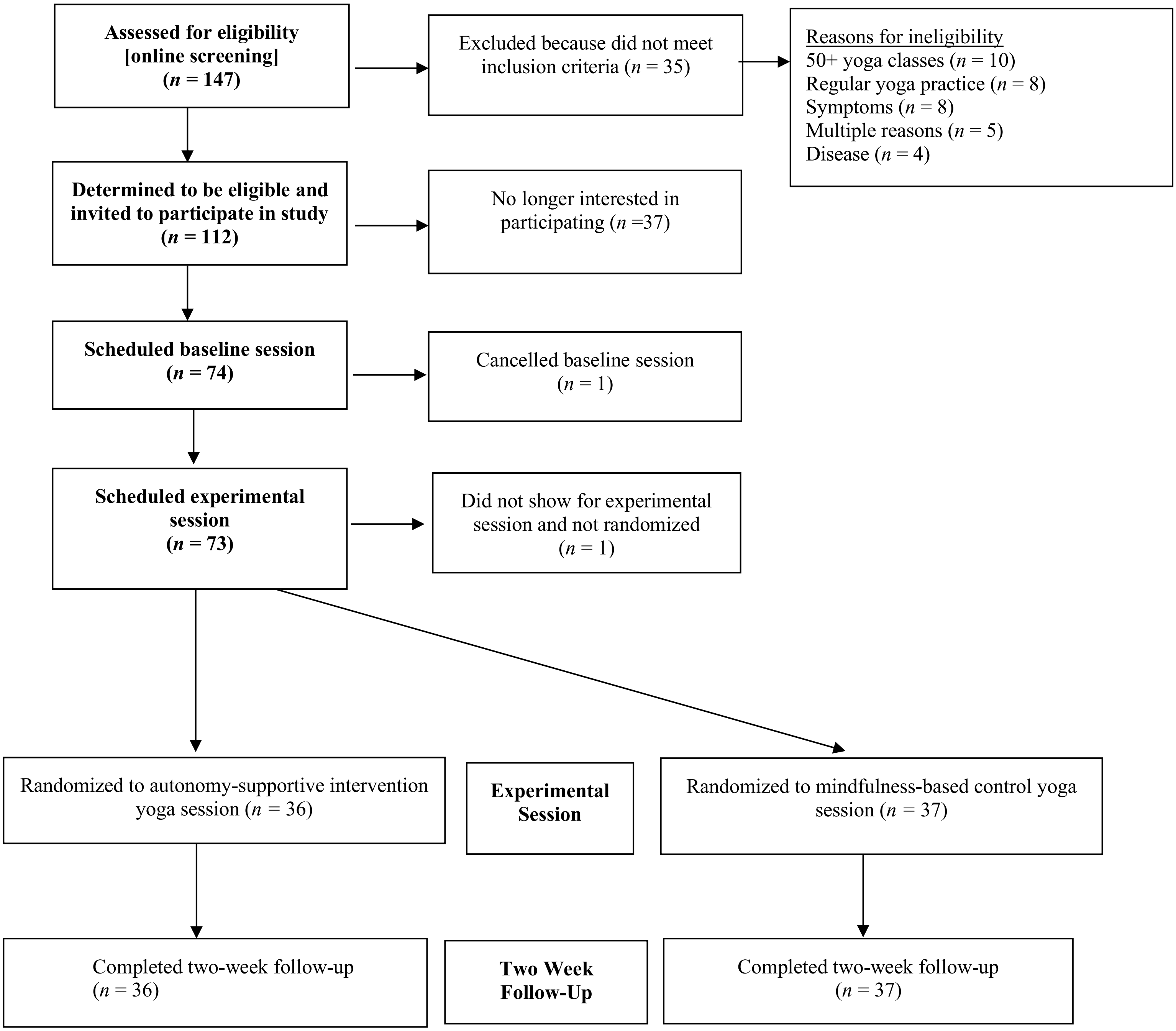


Figure 2. *Flowchart of Study Procedures*



Note. SMS-PA2 = State Mindfulness Scale for Physical Activity-2, FS = Feeling Scale, RPE = Rating of Perceived Exertion, T0-T5 = Timepoints.

Figure 3. *CONSORT Diagram Depicting Participant Recruitment and Attrition*



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