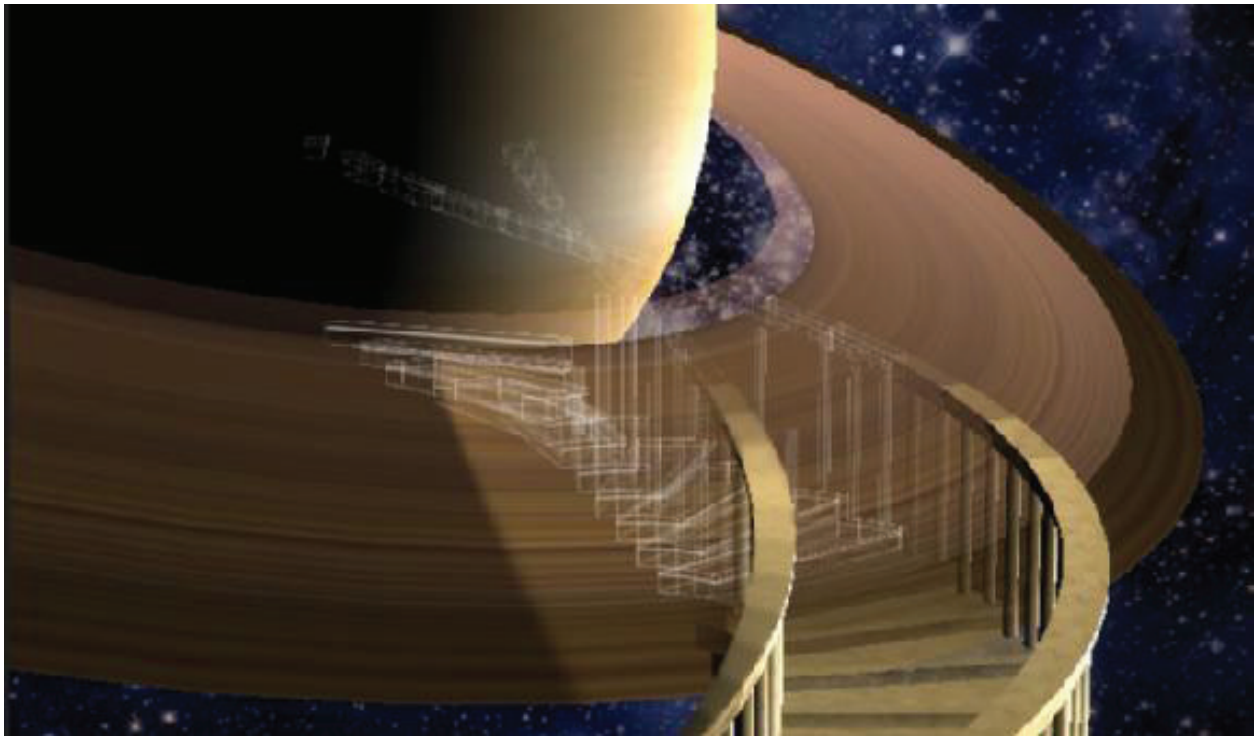
Designing Tenacity

John Binzak, University of Wisconsin-Madison
Mike Beall, Learning Games Network
Craig G Anderson, University of Wisconsin-Madison
David Azari, University of Wisconsin-Madison
Lauren Wielgus, University of Wisconsin-Madison
Jennifer Dalsen, University of Wisconsin-Madison
Kurt Squire, University of Wisconsin-Madison
Constance Steinkuehler, University of Wisconsin-Madison



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The *Tenacity* project is a collaboration between meditation experts and neuroscientists at the Center for Investigating Healthy Minds (Richard Davidson, Director) and game designers and learning scientists at the Games+Learning+Society Center (Constance Steinkuehler and Kurt Squire, Directors). Our goal was to facilitate and support the practice of mindfulness through a digital application and ultimately research the behavioral and neural effects.

Seed

Tell us about your idea or project. What's your vision?

The *Tenacity* project set forth to explore how digital media can foster the self-regulation of attention and to measure how this practice impacts the mind. Doing so required developing an interdisciplinary team of meditation experts and neuroscientists at the Center for Investigating Healthy Minds (Richard Davidson, Director) and game designers and learning scientists at the Games+Learning+Society Center (Constance Steinkuehler and Kurt Squire, Directors). Together we created *Tenacity*, a breath counting app for the iPad to train the self-regulation of attention. Breath counting is a traditional practice of focused attention meditation. Specifically, focused attention meditation involves voluntarily directing one's attention towards a specific object for a sustained amount of time and returning attention to the object when distractions divert attention away (Lutz, Slagter, Dunne, & Davidson, 2008).

In *Tenacity* the player is instructed to focus specifically on their breath, counting each exhale by tapping the touch screen with one finger for the first four breaths and tapping with two fingers for the fifth. This breath cycle (tapping to count five breaths) is represented back to the player on the screen with visual feedback for each tap and accuracy feedback at the end of a breath cycle. Utilizing the audiovisual capabilities of the iPad, players can complete the

breath counting exercise in their choice of 7 scenario levels for a variable amount of time (5, 10, 15, or 20 minutes) and variable levels of difficulty (count to 5, 10, 15, or 20 breaths) (see Figure 1). These scenario levels include a tutorial level, two positive reward levels and four distractor levels. Tutorials levels provide instructional support for how to play *Tenacity*. Positive reward levels (Greek Ruins & Egyptian Ruins) present the player with flowers that slowly grow from the ground when the player accurately completes a breath cycle. In distractor levels (High Altitude, Low Altitude, Near Earth and Outer Space) audiovisual stimuli fly across the screen at predetermined time intervals independent of the player's actions. These positive rewards and distractions provide manipulations of interest for assessing how gamification elements may affect behavior in the practice of focused attention meditation.

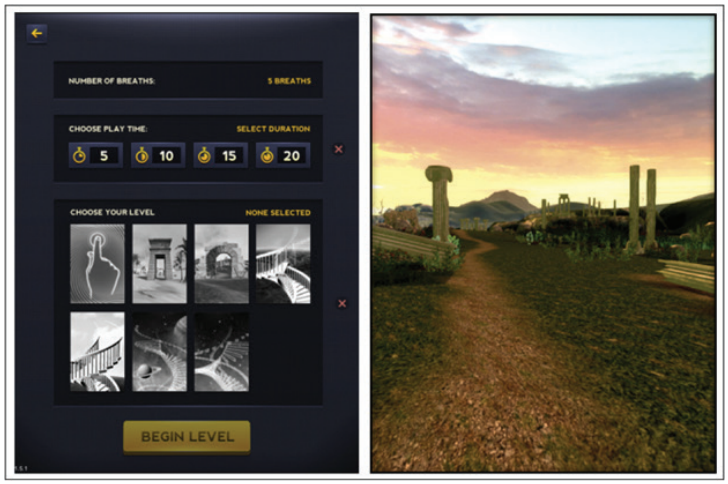

Figure 1: Tenacity menu screen (left) and Greek Ruins scenario screen shot (right).

What problem are you trying to solve and why does it matter

Recent research has shown that increasing self-regulation skills is associated with a wide array of beneficial outcomes. Above and beyond the impact of intelligence and socioeconomic status, attributes of self-control measured in childhood are significant predictors of greater physical health and financial stability, and reduced substance abuse and criminal activity in adulthood (Moffit et al, 2011). Thus, efforts to increase skills of self-regulation, especially in childhood, hold the potential to have a positive impact on many dimensions of wellbeing. Furthermore, neuroscience research has shown that training interventions using traditional attention regulation strategies such as meditation or modern approaches such as games, can enhance skills of self regulation and these changes are associated with measurable differences in attention networks of the brain. In light of these findings the *Tenacity* project was created to extend the empirical understanding of how these interventions impact mental well being by creating a training app based on mindfulness meditation practices for children and adults to cultivate their self-regulation of attention capacities.

Many digital products are advertised for their cognitive benefits or brain-based design, however these products often lack the theoretical foundation and empirical evidence necessary to support these claims. These marketing strategies can mislead parents and children while diminishing the standard for research-based products. In contrast, the *Tenacity* project exemplifies a higher standard of research and development where neuroscience theory, methodology, and data are fundamental elements of the iterative design process. User testing can provide great insights for developing a clean and engaging game, but knowing how design choices affect the mental health of the user requires identifying behavioral changes and measuring the underlying neural mechanisms through careful experimentation. Neuroscience thus provides robust techniques for research and development teams to determine if and how their products lead to their desired effects. However, very few projects have successfully carried out this interdisciplinary practice. To this end, the *Tenacity* project is exploring the exciting space where user game play is combined with neuroscience research to inform the iterative design of games for impact.

The nature of this interdisciplinary work is exciting and groundbreaking, but creating an engaging digital experience that stays true to the practice of meditation comes with its own challenges. Unlike most games and digital applications, the goal of meditation is not easily mapped to standard "win" states common to games. Practicing mindfulness is, in a way, orthogonal to the idea of earning a high score or beating a boss monster. Rather, the goal here is to let go of the win state itself and instead become more self-aware and thus master not the game system but your own mind. As such, designing *Tenacity* is an effort to solve this design challenge.

What are your goals and how will you know if you've achieved them?

At the heart of the *Tenacity* project is the goal of creating a powerful experience grounded in rigorous empirical research to improve mental wellbeing and the self-regulation of attention. Meeting this goal required developing an interdisciplinary team to integrate neuroscience, meditation, and game design. Motivations and concerns can diverge across these fields bringing challenges to solve through collaboration and compromise. Thus, from a methodological perspective our goal is to create an effective team that appreciates each other's individual goals in the process of working together. For instance, from a design perspective the goal is to represent attention training through an engaging experience that users enjoy. From a meditation expert's perspective the design must also stay true to the traditional practices of mindfulness. From a research perspective the goal is to discern if and how focused attention training with the app leads to behavioral and neural changes through experimental control and a reliable treatment. During the iterative process of research and design our team has evolved to understand how the goals of designers, meditation experts, and researchers should be balanced to promote the successful training of focused attention.

We can measure the quality of the user's experience by examining changes in performance inside and outside the game and the mind. If *Tenacity* indeed trains focused attention, we expect to see this in the gameplay data. A simple measure of attention is the player's success during a breath cycle. We predict that with successful training, individuals should become more accurate overall and be able to sustain their attention for more accurate breath cycles in a row. Likewise, we predict that individuals should become less susceptible to distractions and accuracy in the presence of distractions should increase as individuals learn to efficiently return their attention back onto their breathing as a point of focus.

More importantly, our goal is for the benefits of training with *Tenacity* to transfer towards demands of attention outside of the app. Whether the player is a student, a teacher, a construction worker, or a nurse, attention is a domain-general ability underlying countless tasks in the world. The ability to focus attention inwards enables individuals to become aware of their mental and physical states, thus supporting the regulation of emotion and interpersonal communication. Evaluating our progress towards this goal requires external measures of attention and the underlying cognitive mechanisms. Together with Dr. Richie Davidson and researchers at the Center for Investigating Healthy Minds, we invited adolescents in the Madison area to enroll in a pre-post fMRI study. Before and after a two week play session, players completed experimental tasks inside and outside of the scanner. These tasks took the form of standardized tests and computer-based experiments completed during an fMRI scan. As with gameplay data, we predict that a successful self-regulation of attention app should promote long-term improvements in these external measures along with biological changes in brain structure, function, and connectivity associated with attention and cognitive control.

It is important to note that improving attention is not a short-term achievement gained by a single play session, but rather it is a gradual process relying on consistent effort. Therefore, results from this initial study provide evidence of the emerging effects brought on by training with *Tenacity*, and only hint at the long-term effects that may develop through persistent engagement. In order to meet these long-term goals, it becomes all the more important to design an engaging, relaxing, and useful application. Individuals interested in meditation can do so without the aid of an iPad. Therefore, in designing the *Tenacity* interface, our goal is to heighten meditational exercises with scaffolding instructions for beginners, graphic feedback to track progress, settings to increase difficulty, and a selection of content-relevant digital environments for players to engage within. We know that we are on our way to meeting this goal from the positive reaction we have received from some of our players, yet there are still drawbacks that we want to address in order to develop a fun experience that is more widely embraced - particularly for younger kids.

Sprout

What interesting patterns or insights have you discovered?

In our primary assessment of *Tenacity*, we gave a group of adolescent boys and girls access to the app and asked them use the app for a least 20 minutes a day for two weeks. While most of the teens complied with the instructions, some clearly became disengaged. The *Tenacity* interface relies heavily on the user to embrace the practice of meditation and truthfully record their breaths, but for some of our adolescent players, this was not the case. Without the internal desire to practice meditation, it is much easier to succeed in the app by simply tapping to win without attending to one's breath. Thus the achievements designed to reward active participation may have provided off task motivation to game the system. Evidence of these behaviors is most easily seen when breath taps are recorded far more quickly than it is physically possible to breathe. From a research perspective, this tap-to-win strategy generates unreliable data that is difficult to distinguish from genuine breath counting. Recognizing this strategy prompted us to remove breath cycle data points that fell far outside of typical respiration and identify the players who most prominently used this cheating strategy. As a result, we were able to analyze the remaining data with greater confidence that it represented valid breath counting.

Even after this data cleaning, the results did not come out the way we expected. For instance, we expected experience practicing with *Tenacity* to be associated with greater breath cycle accuracy. While accuracy did increase over the two weeks for a portion of players, accuracy decreased for a complementary number of players, and the rest showed no change. Across the group, breath cycle accuracy was high both before and after training. As a result the group mean accuracy was not significantly higher after the two-week intervention. This was consistent with the data from the distractor levels. Specifically, practicing within distractor levels was not associated with increases in breath cycle accuracy. From these results, we have drawn two conclusions. First, in line with the issue we identified where some players were more interested in tapping to win than practicing the exercises, it is impossible to know which players carried out these cheating strategies but did so in a way that appeared to be valid. Future data collection needs an external observation of player behavior and breathing to validate their in-game performance. Second, and equally important to interpreting our results, breath cycle accuracy was near ceiling during the first 30 minutes of game play. Therefore, if a player's capacity to self regulate attention increased through practice, comparing breath cycle accuracy before and after training may not be a sensitive enough measure to identify these effects. To address these ceiling effects, it will be important to design more difficult challenges and more distracting distractors. Doing so stands to improve the variability in the data generated from app as a research tool and hopefully increase player interest by introducing a more compelling challenge to master.

Have your initial concepts/designs changed? Why have they changed? Show us how they're being refined and iterated.

The initial design efforts involved finding the most appropriate representation of breath counting to act as an attention training exercise as well as an engaging digital experience. Practices of focused attention meditation are simple and often carried out with little more than the mind and a point of focus, therefore every element of gamification seemed to disrupt the simplicity that our meditation experts hoped to maintain. Standard design elements that make a game engaging were, over repeated iteration in this project, reined in or stripped out entirely so as to stay true to the main "verb" within the game – self-regulation of one's attention rather than seduction by a well-designed and "sticky" digital stimulus. Once our builds reached the hands of our adolescent participants, however, engagement was fairly lackluster. Even when we reframed the builds as "gamified apps" with an achievement system but no core game mechanics per se, our target audience of teen- and tween-agers wanted something more recognizable, engaging, and sticky. Our newest build of *Tenacity*, now titled *Zenjuvo*, aims to address these critiques by introducing more challenges and player options that increase difficulty and personalize the experience. For example, in *Tenacity* players could tap anywhere on the screen to count each breath, whereas in *Zenjuvo* players must tap on active visual elements on the touch screen (see Figure 2). In the Koi Pond scenario, players count each breath by tapping a Koi fish swimming across the screen, while also monitoring distractors (dragonflies, flowers, or bubbles) to earn achievements. By increasing the ways in which the player directly interacts with the app, we hope to increase the player's motivation to actively participate in the targeted training exercises. This example illustrates how our initial conservative design approach has broadened to embrace more of the features that we love about games and digital apps. Effective training will still rely on the player's intrinsic motivation to complete the exercises, but providing a more compelling and fun environment will hopefully invite more individuals to try the app and enjoy the experience.

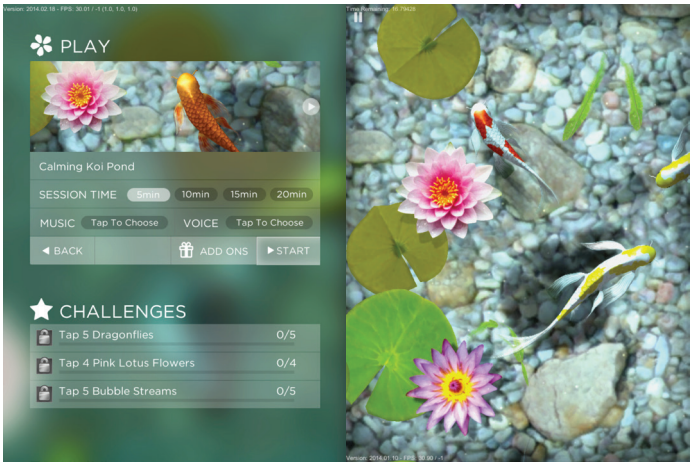

Figure 2: Zenjuvo menu screen with new challenges and options (left) and Calming Koi Pond scenario screen shot (right).

How will you make sure that this thing you're creating will be adopted by your audience?

Developing the *Tenacity* app for the right audience has involved reconceptualizing whom our target audience is. Theoretically, the practice of focused attention meditation can have beneficial effects for all ages. Driven by the goal of providing the greatest impact in an important population, our initial design efforts were directed towards adolescent boys and girls. However, our experience working with this unique population has shown us that warping a mindfulness product to fit a disinterested population is not the most efficient way to create an extraordinary app. For instance, the ideal experience to train the self-regulation of attention may be fundamentally different across ages. Based on our research data with adolescents, we modified *Tenacity*'s breath-counting exercises in our current build, *Zenjuvo*, to increase the challenges, enrich the user feedback, and motivate valid participation. These updates stand to enhance the experience for an ideal audience of individuals who are eager to become more mindful. However, these updates may not change how some children and adolescents find mindfulness practices fundamentally disinteresting. Inspiring younger populations to practice focused attention training will likely require a completely new approach that frames the traditional mindfulness exercises within more modern gaming elements such as social media integration, multiplayer competition, or a role playing narrative. Furthermore, we hope that testing *Zenjuvo* with an adult population will illuminate the elements of our current design that successfully maintain interest and strengthen the app as effective intervention tool.

References

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