Casual Games, Cognition, and Play across the Lifespan: A Critical Synthesis

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Games, including video games have long been associated with both rhetorics of progress and frivolity, simultaneously recruiting efforts to employ games toward furthering cognitive skills, while also eliciting concerns about the decadence of players. Casual games, defined as games with a low barrier to entry and quick play sessions often focus on cognitively-oriented challenges and are perceived by many players to promote cognitive, social, and emotional benefits. Research on the cognitive, social, and emotional impact of casual games now spans games marketed as entertainment, "brain games," and digital therapeutics; despite these games sharing similar qualities, the bodies of research literature on them remains largely distinct. This review finds little support for the cognitive benefits of playing casual games, with exception of the elderly or those with dementia. This research synthesis finds evidence for the social and emotional benefits of casual games when they are sought for these purposes, played mindfully, and within robust social contexts. However, the same games, when played in different contexts can have negative consequences, consistent with findings from the mindset literature more broadly. Researchers thus should take seriously the context of game play, perhaps treating the emergent phenomena of play as the unit of analysis, rather than the media artifact.

CCS Concepts: • **Applied computing** → **Computer games**;

Additional Key Words and Phrases: Casual games, well being

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The global surge of video game play may not be the most important consequence of the COVID-19 pandemic, but it has been striking nonetheless. In the United States, over 225 million people regularly play games, with 74% of parents gaming with their children on a weekly basis [Entertainment Software Association 2021]. Games have long been associated with the rhetoric of learning, progress, and growth, but meaningful empirical demonstration has remained somewhat elusive [Sutton-Smith 1992]. Empirical studies do demonstrate specific cognitive benefits of playing games, such as an improved ability to track moving objects on screen [Green and Bavelier 2006, 2007] but such findings do not address concerns such as the aging brain, emotional wellness, self-regulation, or even stress. Cognitive training, or so called "brain games," are designed toward these more pressing outcomes, but their actual benefits remain hotly debated; studies of

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brain games report increased cognitive performance [Gates et al. 2020; Hardy et al. 2015], but critics observe that some titles may be little more than cognitive test prep, producing increases not in meaningful, transferable skills but only in routinized and narrowly defined laboratory tasks [Max Planck Institute for Human Development and the Stanford Center on Longevity 2014].

Casual games, now nearly two-thirds of the games market [Entertainment Software Association 2021] have witnessed broad adoption by players, both young and old, with many convinced of their cognitive benefits. In one survey study, over 70% of older players reported cognitive benefits from casual gameplay and almost half reported social and emotional benefits such as self-confidence and social connectedness [Kaufman et al. 2020]. Gameplay is indeed positively correlated with well-being, perhaps due to such reported emotional and cognitive benefits [Johannes et al. 2021]. At the same time, however, concerns about problematic gaming patterns, such as addiction, social isolation, low academic achievement, and poor coping skills persist [Rho et al. 2016; von der Heiden et al. 2019]. Are casual games something to concern us? Are they beneficial?

This critical synthesis of research on the cognitive and emotional benefits of casual games sorts through contradictory claims. Using an interpretive synthesis method (see Howard et al. [2021], for an excellent synthetic review of literature on masks and COVID), this review is driven by the question of whether casual games contribute to cognitive, social, and emotional health. We begin by defining casual games and detailing the methods used for identifying and synthesizing the extant research base. We then summarize and evaluate in turn the cognitive, social, and emotional impacts of casual games across disciplines. To contextualize the findings, we examine research on key example titles [*Pokémon Go* 2016; *Tetris* 1984], which have been the focus of most research in this domain. This review examines research on "brain games," casual puzzle games, and non-puzzle games categorized as casual (e.g., *Pokémon Go*) to bring greater clarity to the question of cognitive, social, and emotional effects of casual games. The review concludes for the importance of researchers taking seriously the notion of mindset literature, specifically, that effective interventions may be the result of creating *play*, which is an *emergent* phenomenon arising at the intersection of people, their intentions, the game, and context, rather than simply a feature of the game itself.

Overall, this review finds evidence for social and emotional benefits to casual games when they are sought for this purpose, when they are played mindfully, and when they are used in robust social contexts. This review finds evidence that the same game played by the same people in other contexts (such as when required by a study or after an initial period) can have negative effects on players. Future reviews might seek to reconcile findings from studies of games, addiction, and depression with those finding pro-social benefits to games. The review finds weak to no support for the cognitive benefits of casual games, when compared to other interventions, with the exception of elderly adults or those with specific cognitive impairments, in which case benefits of casual games exist. Studies of cognitive benefits of casual games are fraught with measurement challenges, ranging from games being test preparation, to a mismatch between cognitive skills being tested and the measurements employed.

METHODS

Defining Casual Games

The rise in casual games (marked by a low barrier to entry and quick play sessions, International Game Developers Association [2008]) has been driven by a rise in memetic interfaces (where the player's physical activity matches the gameplay on-screen, such as swinging the controller in *Wii Sports* [*2006*]) and changes in game distribution that streamlined purchasing and installation onto computers, consoles, and mobile phones [Juul 2009]. Some casual games, such as online card games, *Wii Sports* [2006], and *Guitar Hero* [2005], directly remediate earlier forms of play, while

Fig. 1. Illustrative casual games, including (clockwise from top left) *Wii Sports* [2006], *Guitar Hero* [2005], *Candy Crush Saga* [2012], and *Bejeweled* [2001].

other casual games, such as the match-3 genre classics *Bejeweled* [2001] and *Candy Crush Saga* [2012] are unique to the medium (Figure 1).

In this review, we employ a *historical poetics* [Bordwell 1989] approach to understanding casual games, meaning that the definition is derived from the *principles* by which the artifacts are constructed, the means by which they achieve their effects, and their historical evolution. Here, genre becomes a way of fixing an artifact to organize *creators* around principles that guide an aesthetic vision and *audiences* around what they can expect from an artifact or experience [Jenkins 1989]. Our review therefore includes both studies that explicitly defined their object of study as casual games outright as well as studies whose object of investigation met the genre criteria for a casual game (discussed below). Our primary focus is on casual games for mobile devices, although cross-platform games such as *Tetris* [1984] are also considered.

As a genre, a key organizing principle behind casual games is the "eliminat[ion of] any possible barrier to someone enjoying the game" [IGDA 2008, p. 17]. Casual game genre criteria include recognizable theme and premise, low system requirements, attractive visual presentation, appealing audio presentation, accessible controls, low demands on the player, short play sessions, simple controls, and easily learnable mechanics [IGDA 2009; Kapp et al. 2020; Loreto and Gouaïch 2010]. As Megowan [2008] writes, "Problems with multiple solutions, events with multiple outcomes, and the promise that there's something new over the horizon… encourage players to return to the game again and again" (p. 19). Following the success of the Nintendo Wii, these principles have been taken up broadly, most notably for the research literature with *Pokémon Go*, which is

classified within the research literature as a casual game (and considered in this review), but otherwise shares relatively little with casual games with respect to the overarching experience.

As such, "casual gaming" is as much an orientation toward games as it is a game genre [IGDA 2008]. Is a 65-year-old retiree who plays *Candy Crush Saga* [2012] on her phone via Facebook for a few hours every day, pushing through harder and harder levels, gifting lives with friends, and spending hundreds of dollars annually to make it through the most difficult of levels a casual gamer? Or, is an older couple who plays *World of Warcraft* [2004] for a few hours on weekends, designing characters and pushing through content at their own pace? Casual *players* enjoy simpler, easier-to-learn controls, minimal setup, and brief play sessions [Yee 2018]. They tend to use games to relax, to socialize, or to motivate progress toward real-world goals while *not* identifying as "gamers," *not* preferring violent themes, and *not* embracing specialized hardware [IGDA 2008, pp. 15–16]. To be consistent with the research literature, we focus on *casual games* rather than *casual gaming*, treating "casual" as a media type rather than frame of mind, but future studies may benefit by examining the *activity* rather than the media *artifact* as the phenomenon to be studied.

Literature Collection & Synthesis

Search Strategy. The search for relevant literature was conducted between March and September 2021. To capture a broad perspective of the extant research on casual games in relation to mental health, cognition, and wellbeing, with a particular focus on its effects across the lifespan, the following search terms used were used: "casual gam-," "mobile gam-," "smartphone gam-," and their related permutations AND "cognition," "intergenerational play," "physical health" OR "physical wellbeing," "mental health," "wellbeing," "loneliness," "social isolation," "accessibility," and "older adults" OR "elderly" OR "seniors" OR "geriatrics." Searches were conducted first on academic databases including *Web of Science, Google Scholar, Scopus, Jstor, ProQuest,* and *Academic Search Complete*, and secondarily using the standard Google search engine and the reference sections of articles that had already been included.

Eligibility Criteria. Studies of both educational games and commercial games were included in the data corpus, since there are no inherent differences between the two categories other than their intended purpose; however, studies focused on academic content knowledge are not included. Exergames (exercise-based videogames) that meet casual game criteria are included in this analysis, although their impacts on physical activity alone are not. Studies of game addiction were not systematically included in this review; however, studies that included problematic outcomes were retained. Studies focused solely on aspects of game design such as play mechanics or user interface that do not assess the completed game's final impact on players are also excluded. *Consistent with a research synthesis approach, qualitative empirical research studies were included in the data corpus.*

Selection & Data Collection Process. Together, the first search phase resulted in 691 articles (see Figure 2). We then narrowed the data corpus to include only English-language, empirically based studies of games that very clearly met the genre criteria discussed above (n = 593). All of these articles were retrieved for at least spot review and entered into a spreadsheet for closer analysis. Two members of the research team reviewed all 593 articles against each inclusion criteria. In this review, researchers read abstracts, considered methodologies, and read borderline cases. This analysis resulted in a final data corpus comprising 317 total research articles, chapters, and manuscripts with a median publication year of 2017.

The final set of 317 articles was reviewed and synthesized in four stages. First, three research team members categorized each article based on game type (entertainment, brain game, impact game) and area of focus (cognition, social benefits, mental health) using their abstracts and

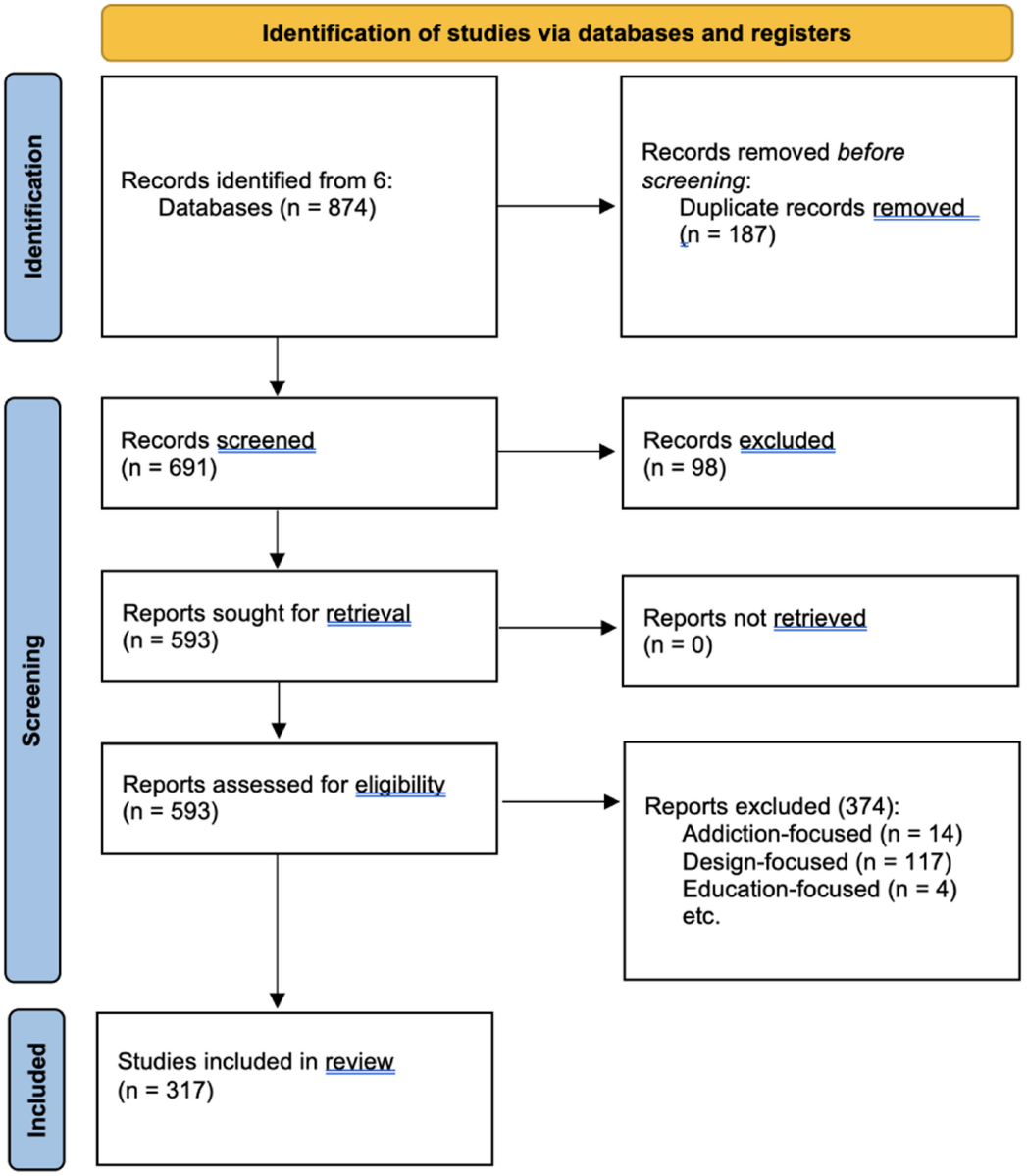

Fig. 2. PRISMA 2020 Chart of Analysis Procedures.

metadata. Next, the lead investigator read each article in the study by category and took detailed notes on the game intervention used, methods of study, size of sample, instruments, and outcomes. Two additional researchers assisted with this process, sorting and verifying themes as they emerged, over a period of 4.5 months. Third and finally, a co-investigator reviewed and discussed the key notes across papers, meeting three times a week over a period of three months with the lead investigator to extract key themes and patterns of findings across the categories of outcomes (reflected herein), drafting the final text that was then reviewed and revised by all team members equally. Finally, references of papers themselves were checked for additional citations.

FINDINGS

The findings of this critical review are organized into two broad sections: (1) Cognitive impact and (2) Social and Emotional impact. Findings are presented as an interpretive synthesis [or narrative, see Howard et al. 2021] to address the question, "Does research evidence support claims that casual games are 'good for you'?" Interpretive syntheses (or narrative reviews) enable researchers to consider multiple, interactive variables, compare similar approaches, and view findings in the context of other research (particularly health) outcomes [Greenhalgh et al. 2018]. To contextualize this discussion, the article first considers *Pokémon Go* [2016], which is the subject of multiple meta studies and is perhaps the most thoroughly researched game in history. A similar analysis of *Tetris* is provided to contextualize results from brain games, particularly to raise questions about conceptualization of brain games and their measurement. These findings, together, suggest good evidence for casual games promoting social and emotional well-being for players, but weaker evidence for their cognitive benefits. Indeed, the cognitive, social, and emotional impacts of casual games are interdependent, contextual, and shaped by user *intention* or mindset, which may be the most active aspect to an intervention.

Contextualizing Example: Pokémon Go

Pokémon Go [2016] is a boundary case for casual games; it remediates common play patterns (scavenger hunts), is designed to be easy to play, and is playable in short durations, although it differs greatly from much of the market (particularly after *Candy Crush Saga* [*2012*]. Further, a review of *Pokémon Go* illuminates issues such as motivation, social interaction, affect (mood, depression, anxiety), measurement, and even transfer. *Pokémon Go* has been the subject of 36 research studies to date with a combined total sample of 38,724 participants [Lee et al. 2021] globally including North America, Asia, South America, Europe, and Africa [de Souza e Silva et al. 2021]. A majority (66%) of the studies compare *Pokémon Go* players' physical activity levels to their activity levels prior to playing or to that of non-players. *Pokémon Go* players were more active than non-players in terms of steps, time spent walking, and time engaged in light intensity physical activity. As such, gameplay appears to have benefits for sedentary individuals; however, it did not increase activity for already active players [Wong 2017]. In fact, *Pokémon Go* players had fewer days of vigorous physical activity than non-players, and their exercise did not persist after *Pokémon Go* play ended [Lee et al. 2021]. Thus, playing *Pokémon Go* can increase activity when it is used by otherwise sedentary people for the purposes of exercise, but it ought not replace more dedicated physical activity.

Pokémon Go is linked with improvements in social-emotional states [Lee et al. 2021]. Specifically, it is associated with *decreases* in negative mood, neurotic personality traits, and psychological distress and *increases* in life satisfaction and executive function [Alloy and Carpenter 2020; Ewell et al. 2020; Mattheiss et al. 2017; Watanabe et al. 2017; Williams and Slak-Valek 2019]. Eleven studies report improved social well-being, belonging, or connection through *Pokémon Go*, including better connections with peers compared to those who did not play [Ewell et al. 2020; Lee et al. 2021; Ruiz-Ariza et al. 2018]. Perhaps not surprisingly, playing *Pokémon Go* decreased anxieties about leaving the house, interacting with strangers, and visiting new places [Kogan et al. 2017]. Thus, while the *physical* effects of *Pokémon Go* are somewhat ambiguous, the social and emotional benefits are not.

Motivation and context, however, matter. *Why* players play *Pokémon Go* affects outcomes, and *Pokémon Go* players report a mix of social and physical motivations for engaging. Users who play for social reasons report positive well-being, whereas those who play for escapism or nostalgia reported less positive well-being [Wulf and Baldwin 2020; Yang and Liu 2017]. Other studies underscore the importance of context: During the COVID-19 pandemic, for example, playing *Pokémon Go* (or *Harry Potter: Wizards Unite* [2019], a similar style of augmented reality gameplay built on

the same underlying game engine) "improved physical and mental health through virtual socialization, sustained exercise, temporal routine and mental structure" [Ellis et al. 2020].

Ethnographies of *Pokémon Go* players describe the *means* and *mechanisms* for positive social and emotional outcomes through game play; for example, a grandmother and grandson forging shared interests together through game play that functioned as a "conduit for informal care, wellbeing and social change through playful inclusion and connection" [Richardson 2020, p. 1]. In effect, the intentions behind gameplay shape its outcomes and those who use *Pokémon Go* for connection, for example, often find it.[1]

What, then, might we conclude about the impact of playing *Pokémon Go*? On the one hand, playing *Pokémon Go* leads to increased physical activity. On the other hand, this increase in physical activity was below physically active non-players and did not persist after gameplay ended. Socially, playing *Pokémon Go* is associated with positive mood, well-being, and sociability, although the benefits for those playing nostalgically are not. If the *motivations for play* so heavily influence outcomes, then should research that fails to take into account users' reasons for play be considered when assessing the overall impact of the game? If *why* one plays matters, then how valid are inferences drawn from studies where participants are recruited for extra credit in college courses? Minimally, we must exercise some degree of caution in our interpretation of results across multiple studies in different contexts with different populations, variables, measures, and study designs.

Cognitive Impacts of Casual Games

Exergaming. Exergaming more broadly purports to offer both physical and psychological benefits [Stojan and Voelcker-Rehage 2019]. This review does not examine the physical benefits of casual games; however, physical *exercise* is associated with promoting neuroplasticity [Hötting and Röder 2013], preventing cognitive decline among aging [Lista and Sorrentino 2010], promoting executive control [Colcombe and Kramer 2003], improved learning speed [Grego et al. 2005], and better academic performance among children [Donnelly et al. 2016]. Exergaming, broadly speaking, seeks to wed these benefits of regular exercise with the motivational and satisfying elements of games (e.g., increased dopamine, serotonin).

Exergame play is associated with improved mental and emotional states. A recent meta analysis by Xu and colleagues [2020] found strong evidence for exergaming improving physical characteristics (including balance, overall fitness, strength, and gait mobility) as well as executive functioning (working memory, task shifting reaction times, processing speed) [cf. Eggenberger et al. 2015; Eggenberger et al. 2016; Schaïtin et al. 2016]. Structured exergaming *programs* (games and related activities and structured contexts) are also associated with general cognitive benefits, including improvements in emotional well-being, mental health, long-term and short-term verbal memory, and long-term memory [Eggenberger et al. 2015; Eggenberger et al. 2016; Goldstein et al. 1997]. In a meta-analysis of 34 studies with 1,594 participants [Cugusi et al. 2021], exergaming has been found to foster small but significant improvements in quality of life for those living with chronic diseases. Among older adults, exergaming is associated with greater independence, drive, hope, and technological fluency, on the one hand, and reduced negative stereotypes on the other [Loos 2017; Nguyen et al. 2017].

Integrating findings from exergames contextualizes findings from other casual games. Executive functioning, working memory, and verbal memory are all potential areas of cognitive impact for casual games. Moreover, as the findings for exergames highlight, we see again that the

[1]Those familiar with the mindset literature will not be surprised by this finding; even something as simple as our beliefs about a milkshake will influence the hormones your body uses to process food, and then by logical extension, the nutrients one extracts from the food itself [Crum et al. 2011].

activities and context surrounding gameplay can impact outcomes. To what extent the positive impacts of exergames arise through their cognitive aspects (e.g., attending longer to a given task leads to increased executive control) versus their physical aspects (since physical exercise fosters many of the same outcomes) is unknown. However, one review [Basak and Qin 2018] did find that exercise programs that include virtual components lead to greater gains in executive functioning than physical training exercise programs alone, suggesting that the cognitive components of the digital stimulus may contribute positively to results. Overall, improvements to quality of life through exergaming are relatively small, but, as critics observe, experimental research in the domain may well entirely miss important mental, physical, and emotional benefits.

Cognition in Gameplay and Its Neural Correlates. Consensus is now emerging on the key cognitive functions associated with gameplay and their neural correlates. In a review of the neuroscience literature on games (defined broadly to include all genres), Palaus and colleagues [2017] identify five: *attention, cognitive control, visual spatial skills, cognitive workload*, and *reward processing*. Studies include observations of both participants' neural functioning during game play and after game play. Aggregating findings across all game genres and contexts reveals few definitive or noteworthy patterns. Palaus and colleagues [2017] conclude that *attention* and *visual processing* are the visual systems most frequently impacted by game play, but closer analysis reveals conceptual problems. For example, studies of the effects of action games on attention [e.g., Green and Bavelier 2003] often use a second game, *Tetris* [1984], as the *control* condition, creating conceptual problems when one attempts to generalize findings from games to other activities. In fact, a deeper look at the contradictory findings on the cognitive impacts of *Tetris* [1984] illuminates the conceptual and methodological issues germane to the study of casual games.

The Problem of Tetris. Perhaps no game (outside of *Chess*) has inspired as much debate as *Tetris* [1984], the real-time puzzle game developed by former Soviet software programmer Alexey Pajitnov in 1984. Kirsh and Maglio [1994]'s early work on the game demonstrated that *Tetris* players do not simply "mentally rotate" pieces but rather physically manipulate pieces with their controllers to simplify the problem space so the right answers seemingly "appear" before them (while they attend to upcoming moves). In this way, game play in *Tetris*, particularly at the highest performance level, is a series of tight *thinking-actions*, which Kirsh and Maglio describe as *pragmatic actions* in that they are designed to bring players physically closer to a goal of clearing levels, rather than mentally "solve the puzzles" in their heads alone. Their work is now considered canonical in the field of cognition generally, informing theories of distributed cognition in which "cognition" occurs not merely in the head but also distributed across representations, tools, and other people.

Just as *Tetris* has been used to theorize cognition, so, too, has it been used to understand how visual-spatial processing and the brain functions underlying it. Haier and colleagues [2009] assigned 26 girls to either *Tetris* gameplay for 15 minutes per day for three months or similar engagement in a control task, after which their brains were imaged using fMRIs. Here, *Tetris* was used as the stimulus activity given its well-defined problem space, clear metrics for success, and capacity to support the real-time examination of game play. Results from the study showed that *Tetris* players showed increased thickness in two key areas of the frontal cortex as well as cortical activations throughout the brain during play, particularly in areas related to the eye (suggesting training of the perceptual system). Researchers also found *decreases* in other areas of the brain during play but concluded that *structural* changes in one area of the brain do not necessarily result in *functional* changes in brain activity. In other words, simply changing brain structure does *not* inherently mean desirable outcomes.

People often turn to casual games like *Tetris* as a salve during times of stress, boredom, or anxiety. *Tetris* has been used as a treatment post trauma [Holmes et al. 2009] to reduce intrusive

memories [Horsch et al. 2017; Iyadurai et al. 2018] and in moments of uncertainty (such as waiting for a medical diagnosis) to bolster positive emotions and mitigate negative ones [Brühl et al. 2019; Rankin et al. 2019]. A recent study among college students assigned individuals to play *Tetris* or a control program when they experienced unwanted urges and found that playing *Tetris* reduces unwanted cravings [Skorka-Brown et al. 2015]. Such findings are commensurate with studies of non-casual games demonstrating that children with cancer experience less pain and require less pain medication when playing videogames [Puig et al. 2020]. In summary, research supports the use of casual games for short-term relief from stress, anxiety, and physical pain. Less clear, however, is the extent to which those skills developed through gameplay generalize to other activities, whether playing games like *Tetris* have long-term positive or negative cognitive effects, or how playing casual games as a *distraction* affects attentional and emotional self-regulation over the long-term.

A *Tetris* training study in which novice players are tested, trained for several weeks, and then tested again demonstrates growth in visual attention, spatial processing, and executive function [Boot et al. 2008]. However, the *same study* found similar gains for players of real-time strategy games [*Rise of Nations* 2003], first-person shooters [*Medal of Honor* 1999], and even a control condition in which participants played *nothing at all.* Indeed, *Tetris* led to increased performance in mental rotation of 2D shapes but only for shapes that looked like *Tetris* pieces. One explanation of these results is that the increase in visual attention, spatial processing, and executive function detected by the measurement tasks are simply testing effects; repeated measures may simply be training participants to perform better at the test itself. Others include self-selection effects, insufficient exposure to the game intervention, or insufficiently sensitive measurement instruments.

Subsequent studies examined whether *Tetris* skills might transfer to other tasks after enhancement via training. Pilegard and Mayer [2018] gave explicit *Tetris* instruction across four sessions and found no gains on six cognitive tasks drawn from a 1976 Educational Testing Services manual [Ekstrom et al. 1976], even with training designed to enhance transfer. Why earlier studies [Boot et al. 2008] found gains while later studies [Pilegard and Mayer 2018] did not is an open question. However, studies failing to find effects used a paper-based test designed to measure numerical fluency and number recognition (specifically to determine who might make a good accountant), *not* visual attention, spatial processing, or motion tracking. Indeed, one might imagine such measurements more appropriate to a game like *Sudoku* rather than *Tetris*.

Thus, the research on *Tetris* highlights the challenges of drawing definitive conclusions as to whether a given casual game (let alone casual games generally) are good or bad for players. Studies show that *Tetris* can lead to changes in brain *structure* but not necessarily brain *functioning*. Playing *Tetris* after traumatic events or during times of stress can reduce intrusive thoughts and mitigate negative feelings, which makes it an excellent salve. However, what are the long-term effects of "using" games for self-soothing? Does it interfere with developing more durable coping skills? Cognitive gains are most often found through tests that closely resemble the games themselves, which begs questions about what playing *Tetris transfers* to outside of *Tetris*. If learning to play *Tetris* is a skill, then it is not quite clear what this skill generalizes to—not to classic cognitive tests or screen-based visual processing tests, let alone other crucial everyday necessary skills [Pilegard and Mayer 2018]. Yet, a poor match between assessment instruments and target skills could also mean that *Tetris* trains new skills; researchers just are not seeing it.

Brain Games

The potential of cognitive training or so-called "brain games" has generated significant enthusiasm and controversy in equal measure [cf. Max Planck Institute for Human Development and Stanford Center on Longevity 2014]. (1) *Brain games* include products such as *Lumosity* [2007], *Peak* [2021],

Elevate [2015], and *Nintendo Brain Academy* [2005] that are marketed as casual games with the promise of benefiting cognition through gameplay and (2) *therapeutic tools* such as *CogMed* [2021] that consist of goal-driven digital activities with clear challenges and feedback; both meet the criteria for casual games. Synthesizing this research base with entertainment casual games deepens understanding of the potential cognitive benefits of casual games.

Studies of older players before and after playing brain games find statistically significant improvements in performance, although their practical significance continues to be debated. Gates et al. [2020] reviewed eight studies with randomly controlled trials totaling 1,183 participants age 65 or older and found positive gains in global cognitive functioning directly after brain game play compared to (1) active controls and (2) for episodic memory with inactive controls. No evidence was found, however, for global cognitive functioning 12 months after the program. Hardy and colleagues [2015] also found evidence that brain games improve cognitive performance in a study that compared over 9,000 participants randomly assigned to play at least one 15-minute game session on *Lumosity* five days per week for 10 weeks to those on an active control (*New York Times* crossword puzzles). *Lumosity* participants showed twice the gains on a general neuropsychological measure comprising seven subcomponents: forward and reverse memory span, progressive matrices, go/no go, two-target search, arithmetic reasoning, and grammatical reasoning. These results are among the most positive to date, although the overall gains were relatively small and many of the same shortcomings of previous studies persist.[2]

In sum, experimental studies do find evidence for cognitive improvements through brain games in areas including executive functioning, processing speed, planning, memory, verbal fluency, and reasoning; they do not, however, detect improvements compared to control tasks [Buitenweg et al. 2017]. The gains themselves are modest and do not produce the near or far transfer expected of cognitive flexibility training programs. One explanation may be that the real effects of brain games are in *motivating* individuals to complete the training tasks or in setting the *expectancy* of cognitive benefits [Van de Ven et al. 2017].

Casual Games and Cognitive Aging. Such results raise the question of whether casual games more broadly might produce similar cognitive benefits. Today, many elderly play casual games as a preventative for the natural cognitive declines and disorders associated with aging [Cota et al. 2015; Sayago et al. 2015]. Naturalistic studies of the elderly playing games report largely positive experiences. For example, an ethnographic study of word game play among a retirement community [Nimrod 2011] concludes that such games foster a sense of shared nostalgia that serves as a context for social interaction. Such accounts of game play among the aged again remind researchers that participants' motivations and sensemaking must be considered in evaluations of impact and there may be benefits to playing for those who choose to do so.

Generally, performance on casual games correlates with performance on cognitive tasks. While not all casual games are brain games, casual games often recruit cognitive processes that suggest potential as cognitive assessments. Baniqued and colleagues [2013] found that scores from games

[2]A second large-scale study of over 12,000 game players between the ages of 60 and 80 found evidence for cognitive games as valid *measures* of cognitive performance, an application reminiscent of our earlier discussion of casual games as tools for understanding brain modularity. Bonnechere and colleagues [2018] measured the impact of playing cognitive games matched to arithmetic, word processing, response control, task-shifting, visual attention, and working memory. The authors found, over the first 100 sessions of play, improvements in both game scores and processing speeds and broad *decreases* in performance as age increased. Such findings provide criterion-related evidence for *cognitive games as valid measures of cognitive performance*, suggesting that the casual games used reliably capture performances typically assessed on standard cognitive evaluations (attention, memory, fluency, language, and visuospatial abilities). While the lack of external measures in the study limits the generalizability of the results, additional research may well provide the additional evidence needed to consider such games valid measures of cognitive growth.

that require working memory and reasoning correlate with scores on cognitive tasks of working memory and fluid intelligence, or one's ability to identify underlying rules, structures, or concepts in novel problem-solving domains. In a subsequent study, Kranz and colleagues [2017] found that performance on reasoning and working memory measures, drawn from the Virginia Cognitive Aging Project [Salthouse and Ferrer-Caja 2003], predicted performance on puzzle games. Neither study examined the consequences of playing casual games or how such games are experienced by the elderly, but both provide evidence that particular casual games are cognitively demanding and, as such, (a) provide criterion-related evidence for the validity of casual games as measures of cognitive performance and (b) suggest an inherent cognitive value to some casual games, insomuch as they engage players in cognitively challenging activity.

Evidence exists that casual games may improve *fluid intelligence*. Training working memory through casual games leads to improved performance in fluid intelligence, a possible byproduct of the capacity of well-designed games to hold player attention. Jaeggi and colleagues [2014] found that game-like cognitive training targeting the ability to rapidly process stimuli improved performance on five visuospatial reasoning measures (but not on verbal measures); however, the effect is mediated by participants' belief in the malleability of intelligence. Those who believed that intelligence can be improved showed gains *even among the active control group*. The authors speculate as to whether improvements in fluid intelligence might not be the underlying cause of increases in players' visuospatial skills [cf. Baniqued et al. 2013; Subrahmanyam and Greenfield 1994].

Despite these findings, studies that use casual games as cognitive training interventions largely fail to find significant effects or far transfer. In a more recent study by Ang [2016], the use of casual games to strengthen working memory and reasoning [cf. Baniqued et al. 2013] did *not* lead to significant improvements. Other casual games have also failed to produce results. A 20-hour training program that used Nintendo's *Big Brain Academy* [2007] on participants ages 50–71 to address cognitive declines associated with aging failed to detect any significant gains in fluid intelligence or processing speed compared to a control condition in which participants engaged in 20 hours of directed reading [Ackerman et al. 2010]. The cognitive training benefits of casual game play may be restricted to more complex visually and attentionally demanding games [Basak et al. 2008].

Can casual game play improve players' reaction times? It is well established that playing computer action games (such as first-person shooters) can lead to changes in perception and the control of attention [Bediou et al. 2021], but what about casual game titles? Indeed, casual games, despite their lower demands, can improve reaction times. A study by Stroud and Whitbourne [2015] found that playing 30 rounds of *Bejeweled Blitz* [2009] improved reaction times on visual search measures on near-transfer tasks compared to fewer rounds and no rounds. In a study of action games that used casual games as the control [Van Ravenzwaaij et al. 2014], researchers found that *both game genres* performed equally yet neither resulted in meaningful gains on information processing tasks beyond basic practice effects.

Evidence suggests that casual games may be efficacious for older adults suffering degenerative cognitive diseases such as Alzheimer's. In a study comparing eight weeks of casual game play versus two control conditions (relaxation techniques versus no intervention) [Bonnechère et al. 2018], elderly individuals were found to have less cognitive deterioration as a result of casual game play than the controls, as measured by the Cognitive Subscale of Alzheimer's Disease Assessment Scale and the Clinical Inventory of Self-Concept (but not the World Health Organization Quality of Life Questionnaire). Some casual game titles have even been intentionally designed to combat dementia and concurrent depression. As Groenewoud and colleagues [2017] argue, casual games address three key needs of people living with dementia: (1) They allow individuals to spend time engaged in activity, (2) they create a sense of connection to the world, and (3) they elucidate connections

to past experiences playing similar games (such as card games), which fosters continuity of identity. In one study, an overwhelming majority (85%) of individuals with dementia reported enjoying casual games and had no difficulties navigating a touchscreen [Astell et al. 2016].

In sum, research on the cognitive benefits of casual games remains mixed. Performance on some casual games correlates with other measures of cognitive performance, suggesting their potential role as cognitive measures in their own right. Researchers have successfully used casual games to measure arithmetic ability, word processing, response control and task shifting, visual attention, and working memory [Bonnechère et al. 2018], yet cognitive gains resulting from casual game play fail to transfer to less narrowly defined tasks. Transfer is famously difficult to produce regardless of the nature of the intervention [cf. Lobato 2006], although the limitations of cognitive games even designed to produce results is sobering for the prospect of casual games producing meaningful changes.

Casual Games and Academic Understanding. Researchers most often look for improvements in cognitive processes such as working memory or fluid intelligence, but casual games can also sometimes lead to improvements in *academic* domains. One area of research is in physics. The commercial success of the physics-based projectile game *Angry Birds* [2009] and the pendulum game *Cut the Rope* [2010] has led some educators [Daloukas et al. 2012] to consider their potential for learning content. Unstructured play of *Cut the Rope* led to better physics intuitions among middle-school students when compared to control conditions, particularly as measured by concept maps [Sun et al. 2015]. In a second, related study, five-year-olds playing *Angry Birds* for one week developed better intuitive understandings of projectile motion as measured by paper-and-pencil assessments, although four-year-olds did not. Such findings suggest that age and developmental appropriateness may be additional key factors in effectiveness. Additional applications for other casual games, particularly in domains where good intuitions are key to understanding disciplinary content, seem ripe for future research and development.

Although only briefly touched upon in this review, casual games can also be productively integrated into formal learning environments for positive educational gains [Price et al. 2016]. In a study by [Kapp et al. 2020], adding casual games into a learning platform resulted in significantly more log-ins, correct answers, and longer correct-answer streaks than controls. A case study of 10-year-old children using *BrainQuest*, a mobile gaming experience that integrates physical activities, game design, and cognitive challenges, found enhanced executive functioning, including planning, inhibitory control, attention regulation, cognitive flexibility, task scheduling, performance monitoring, motor cognitive functioning, and working memory [Gray et al. 2019]. Researchers found evidence for both cognitive engagement and increased motivation to engage.

Motivation Matters. Motivations to play are contextual, shifting, and highly individual, yet their bearing on outcomes is often overlooked and ignored. Many anticipate a casual game to be more enjoyable than other, more traditional materials, and such expectations have proven beneficial to outcomes in their own right [Onafraychuk et al. 2021]. One survey study [Harrell et al. 2019] found that respondents were willing to spend over 10 minutes a day on brain games even for relatively small gains, with a significant number of respondents willing to play much longer (over 2.5 hours per day) if it meant an additional three years of independence. Participants were motivated by belief in the efficacy of the intervention, openness to experience, and their own self-perceptions of need. A study of the casual game *Bejeweled* [2001] reached similar conclusions: Participant gameplay was motivated by factors including challenge, stress relief, visual aesthetics, and an opportunity to socialize. Among older players, however, the primary motivation was to feel sharper and improve memory, pattern recognition, reaction times, and overall confidence in their cognitive skills [Whitbourne et al. 2013]. A qualitative study with older game players in Belgium and

the United States found that players enjoyed casual games for entertainment, personal growth, and intellectual challenge to combat cognitive decline [De Schutter and Brown 2016]. While such findings complement studies of older gamers' motivations broadly, multiple studies have found differences in game play motivations by age [De Carvalho et al. 2012; Gajadhar et al. 2010; Possler et al. 2017]. Thus, we can extend these varying motivations beyond the aging population alone.

Indeed, research on gameplay motivations reveals that specific game design features increase player motivation, pleasure, and, for those interested in learning, positive outcomes [cf. Clark et al. 2016]. A study of "near misses" in *Flappy Bird* [2013] argues that its appeal may be in creating a strong sense of *want*, whereby the dopaminergic wanting pathways are stimulated, while the "liking-pathways" are not, suggesting interesting parallels to addiction research [Roest and Bakkes 2015]. However, context also shapes motivation and pleasure in gameplay. A study by Yang and colleagues [2018] compared multiple game play conditions that each required a differing degree of physical smiling and found that players enjoyed the game most when they were required to smile (but allowed to rest their face between levels). Here, again, we are reminded of the complexity of disentangling not only player motivations and expectations from game impacts but also contextual variables about which, in the context of many empirical studies, we often know far too little.

Social and Emotional Impacts of Casual Games

Social Benefits. Although videogame players have long been negatively stereotyped as anti-social, research from as far back as the mid-1980s suggests that games connect rather than isolate. Early research on *Atari* in the homes of 20 families found that playing games brought families together in ways similar to earlier board games [Mitchell 1985]. Of course, socialization is highly contingent on the game, the context, and the community, as recent studies of online toxic behaviors show [Gray 2020; Ratan et al. 2015].

Evidence indeed exists for social benefits to casual game play in particular. A study of 190 Korean middle-aged adults [Lee et al. 2021] found that individuals who played with others (co-players) demonstrated greater positive affect, well-being, companionship, and emotional support than non-players or solo players. No differences were found between those who played online and those that played in the same physical settings. Similarly, a qualitative study of motion-based games for mental and physical stimulation among the elderly in a residential care setting [Gerling et al. 2015] found that older adults enjoyed games as source of challenge even when age-related impairments detracted from some players' ability to play in groups. Here, further research is needed to identify the specific game design components and contexts that contribute to social benefits.

Mental Health Benefits. The relationship between games and mental health is complex. Players frequently self-report using games to bolster their mental health and combat mental health problems, with myriad game titles now on the market purporting to promote mental well-being and even combat depression. In a meta-analysis of 13 studies examining the effects of casual games on anxiety, depression, stress, and low mood, Pine and colleagues [2020] found that casual games show real promise for mitigating the entire range of mental health issues examined. However, gaming addiction has recently been identified as a potential disorder in its own right by the World Health Organization [2020], and some scholars worry that people who turn to games in times of trouble fail to develop healthy coping mechanisms of their own. Of course, it is also worth noting here that elderly players embrace cognitively challenging games to counter the emotionally difficult parts of aging, yet few professionals worry about the elderly failing to develop healthy coping mechanisms as a result.

Evidence suggests that game players have an overall stronger sense of well-being than non-gamers. A large-scale survey study of two player bases—*Plants vs. Zombies Battle for Neighborville*

[2019] and *Animal Crossing: New Horizons* [2020]—found a positive correlation between game play and well-being [Johannes et al. 2021]; the more time spent playing for each game, the higher players scored on measures of positive experience and needs satisfaction. Participants who had gamed frequently within the previous two weeks of testing also reported higher well-being, further strengthening the argument that casual games are indeed linked with increased well-being. However, correlation should not be confused with causation; increased gameplay also reflects increased leisure time, which, in turn, could reflect other underlying variables that might contribute to one's overall sense of mental health. Extrinsic motivation was negatively associated with well-being, commensurate with broader research on extrinsic rewards, suggesting that gamified elements such as achievements and rewards may actually detract from these positive impacts.

Indeed, such findings suggest that *play generally*, rather than games specifically, may well be the underlying causal mechanism behind increases in well-being associated with casual games. Object play, or play involving tinkering with objects (including cultural and simulated objects), is a primary method for primates to learn about their environment [Riede et al. 2018; Nahallage et al. 2016]. Social play involving two or more creatures (humans or otherwise) is associated with interpersonal adaptation to social life, flexibility, and creativity in response to novel stimuli [Kellman and Radwan 2022]. Among rats, social play produces key neurotransmitters including opioids, dopamine, cannabinoids, and norepinephrine [Siviy and Panskepp 2011]. The neurological processes involved in social play are only beginning to be understood, but evidence suggests that a *playful mindset* associated with positive well-being *can* be recruited through casual games, but similar to mindset literature more generally, play arises as a function as the person, actions, and objects in context and driven by *intention*, rather than as simply a property of the artifact itself [Güneş 2021].

Casual Games and Depression. While concerns about gaming addiction and resulting depressive feelings persist [Rho et al. 2016], new studies of games and depression show surprising patterns. A recent study of teenage boys playing videogames (both casual and otherwise) revealed that frequent game players report lower depression scores than non-players, particularly for those with low physical activity [Kandola et al. 2021]. The study of South Korean youth also found that individuals who game on *both* computers and phones exhibit more depressive symptoms than those who play on only one platform [Paik et al. 2017]. In game addiction research, mindset matters: Need frustration, or the extent to which one's expected needs are not necessarily met through games, is a predictor for addictive behaviors [Chamarro et al. 2020].

Casual games have also been linked to positive changes in mood. In a laboratory study by Russoniello and colleagues [2009], individual stress levels were monitored via **electroencephalography (EEG)** and heart rate variability during game play on three causal games titles (*Bejeweled 2* [*2004*], *Peggle* [*2007*], and *Bookworm Adventures* [*2006*]) compared to a control condition in which individuals simply browsed the web. The results showed that individuals playing casual games evidenced greater relaxation and reduced stress and reported greater enjoyment than those in the control condition. Each of the three games had different mood lifting effects: Whereas *Bejeweled 2* [*2004*] decreased left alpha brain waves associated with depressive behaviors, *Peggle* [*2007*] increased right alpha brain-wave associated with stimulated behaviors and *Bookworm Adventures* [*2006*] increased the stability of alpha brain waves across brain hemispheres. Such findings demonstrate the neural and biological pathways by which casual games positively affect mood.

Separate lines of research using different measures converge on the same overall finding that casual games reduce symptoms among the clinically depressed individuals. In an experiment by Fish and colleagues [2014], participants were screened for depression and then randomly assigned to one of two conditions: an experimental condition in which individuals played casual videogames

for 90 minutes per week over the course of one month or a control condition in which individuals were asked to browse the National Institute of Mental Health's web page on depression. The casual game playing group exhibited significantly more reduction in depression. Subsequent analyses of the data found that the most depressed participants experienced the greatest reduction in self-reported depression symptoms, with the greatest positive changes exhibited by young males [Russoniello et al. 2013]. A replication study [Brown-Bochicchio 2020] found that participants in the casual game play condition showed significant decreases in self-reported depression symptoms but none that were directly measured. In a similar study [Kühn et al. 2018], clinically depressed individuals assigned to play a fast-paced action game for six weeks showed reduced depressive symptoms in terms of higher subjective cognitive ability and lower self-reported rumination at posttest compared to controls. In fact, one study [Stanhope et al. 2016] even found that casual games performed as well as meditation and better than guided relaxation in terms of physiological arousal, perceived control, and confidence—and outperformed both in terms of improving mood.

Similar findings are seen when game-based *interventions* are used to alleviate depression (for a meta-analysis, see Li et al. [2014]). Studies include not only casual games but also virtual reality games, exergaming, and custom-made game-based interventions. The extant literature converges on at least three contributing factors: (1) positive cognitive and emotional effects of play tied to a playful mindset [Güneş 2021]; (2) specific dopamine increases from games' goal-action-reward cycles of games that engender a feeling of achievement [Granic et al. 2014], and (3) an escape from ruminating thoughts [Kühn et al. 2018]. One persistent challenge across studies, however, is the confounding of alleviation of *symptoms* versus *causes*. To be sure, alleviating *symptoms* has inherent value to those suffering from depression; however, alleviating the underlying causes of depression to change default network states of the brain is surely also and equally vital. Here, games may have relatively less to offer [Han et al. 2016; Kühn et al. 2018].

The demonstrated efficacy of casual games designed specifically to alleviate depression is worth special mention. Several such games for impact have been developed and studied, to positive effect. *Symphony*, a game designed to alleviate depression symptoms, resulted in higher positive mood changes that were corroborated by therapists [Mendes 2021]. *SPARX*, a similar game but specifically for adolescents, was found to perform as well as typical treatments for depression, resulting in drops in measures of depression after only three months of play [Merry et al. 2012]. *EVOTM*, a mobile game originally developed for older adults suffering with late life depression, reported positive outcomes related to depression that were on par with therapy and additional positive outcomes for working memory, attention, and negativity bias [Anguera et al. 2017]. Finally, the game *Hit the Cancer* [2016] reduced depression as measured by both self-report and neural imaging (fMRI), showing changes in functional connectivity between the brain regions in the default mode network and salience network [Kim et al. 2018]. Studies that link games' efficacy to both self-report on psychological inventories *and* changes in brain activity offer compelling evidence for games to curb depression.

Casual Games and Anxiety. Casual game play is both positively and negatively correlated with higher anxiety. Casual games are positively correlated with higher anxiety when individuals commonly turn toward casual or "cozy games" during times of stress and anxiety [Squire 2021], leading to a positive correlation between gameplay and anxiety. A survey of *Animal Crossing* players during the COVID-19 pandemic [Waszkiewicz and Bakun 2020] found that increased gaming indeed positively correlated with increased anxiety as well as loneliness when playing solo (and decreased loneliness when played socially).

However, casual game play is shown to *reduce anxiety* for those already reporting symptoms. Rupp and colleagues [2017] conducted a study in which participants completed a vigilance task

and then were randomly assigned to one of three conditions: the casual game *Sushi Cat 2* [2012], a relaxation activity, or a simple break. Affective and cognitive assessments were administered at the beginning of the study (baseline), after the vigilance task, and at the end of the final activity (posttest). Participants who played *Sushi Cat 2* [2012] showed greater engagement and affective restoration than the relaxation condition. Negative affect and worry decreased, although feelings of distress and working memory were roughly the same as the active control. And unlike previous studies [Kuschpel et al. 2015], they found no decline in cognitive performance. Fish and colleagues [2014] conducted an experiment among participants with depressive symptoms and found that individuals assigned to casual game play for one month showed significant *decreases* in anxiety compared to a control in which participants only read about anxiety treatment options. Indeed, such positive gains for casual games hold even when compared to *medication-based* interventions. In a subsequent investigation, Fish and colleagues [2018] compared casual game play on *Plants vs. Zombies* [2009] for 30–45 minutes, four times a week over a one-month period (experimental condition) to anxiolytic medication prescribed by a psychiatrist for depression (control) and found that the casual game play condition significantly decreased anxiety while the medication did not. The authors conclude that the lack of side effects or stigma associated with playing *Plants vs. Zombies* [2009] makes it a more attractive and effective alternative to medication.

Casual games designed for mindfulness suggest how such media might be productively designed to maximize their social, cognitive, and emotional benefits. Such titles are rarely considered in isolation but rather in combination with other activities, materials, and treatment strategies. One such project, *MindMax*, a multi-game application developed by researchers in conjunction with the Australian Football League [Cheng et al. 2018], combines the in-app games *Crappy Birds* (based heavily off of the popular *Flappy Bird* [2013]) and *Flick Footy* with a mindfulness training regimen, a journaling interface, and social features to support interaction within a single integrated application. By combining features for different types of mental health experiences, *MindMax* supports users across a broader range of therapeutic tasks. Vella et al. [2018] found that participants spent the most time on the mindfulness training features, particularly during evenings, followed by engagement in the casual *Flick Footy* football game. Such a mix of features could address challenges involved in engaging users' interests and providing symptom relief while also promoting more demanding mindfulness practices at the same time [Persa et al. 2020].

In sum, evidence suggests that casual games do at least temporarily boost mood, reduce anxiety, and increase cognitive performance compared to alternative interventions including even medication. Indeed, some researchers have theorized that the underlying causal mechanism may be the induction of cognitive flow states [Fish et al. 2018; Pallavicini et al. 2021], or in the case of *Sushi Cat 2* [*2012*], the power of *kawaii* (or cuteness) [Nittono et al. 2012]. However, such findings should be taken with caution, as social and cultural context, choice, habits, and the presence of alternatives all likely play a key role in mood and anxiety. In at least one study, participants *chose* casual game play over medication. Moreover, perceptions of the efficacy of games differ by age and culture [Razak et al. 2017] and one's expectations and motivations impact outcomes. Finally, it must be noted that, while simply reducing anxiety has clear benefits, most clinicians recommend holistic approaches that address underlying causes directly [Hofman et al. 2010]. Still, the capacity of casual games to at least temporarily elevate mood and ameliorate stress and anxiety may well have a vital role to play in overall treatment plans.

CONCLUSIONS

This review finds some evidence of the cognitive benefits of casual games, but the overall results are relatively weak, somewhat contradictory, and difficult to draw inferences from. The key cognitive functions that show small but significant improvement as a result of casual gameplay

include attention, visual processing, executive functioning, working memory, verbal fluency, fluid intelligence, and reasoning depending on the game used. Brain games for aging populations show promise, although the overall gains are relatively small and rarely stand up to controlled comparisons. Such lackluster results may be due to common threats to internal validity, including testing effects, self-selection effects, insufficient exposure to the game intervention, and insufficiently sensitive measurement instruments. When participants' beliefs are measured, they mediate effects, suggesting that casual games may do more to motivate individuals than to "brain train" them; while speculatory, this would also explain the lack of clear transfer of measured gains to outside tasks. Casual games do appear to be efficacious for older adults with Alzheimer's, and like their more intensive action game counterparts, they appear to improve reaction times.

Here, how and why players game matters deeply. Looking across the research on casual games and cognition, we see evidence for positive cognitive benefits to gaming when a (typically older) individual is looking for new challenges, novel experiences, or a way to connect with others—particularly when the individual approaches the activity with the expectation of positive growth. Such findings have little to say, however, about youth playing casual games in between classes, for example, or college students playing a casual game for course credit. Future research investigating more realistic and specified motivations for play and contexts of use would be a significant contribution to our understanding.

This review also uncovers significant evidence of social and emotional benefits of casual games. Casual games are associated with lower depressive symptoms, lower anxiety levels, and improved mood (at least temporarily) and their use as an intervention outperform medication in some studies. Although comparative studies are relatively sparse, casual games like *Sushi Cat 2* [2012] compare favorably to alternative relaxation techniques, although less is known about how they compared to basic exercise. Like play, games are associated with a host of mood-enhancing neurotransmitters. Like pharmaceutical interventions, casual games may show only temporary alleviation of symptoms. The fact that casual game play holds few to no substantive risks and no stigmatization makes them an exciting alternative to other forms of treatment.

Limitations

This research synthesis has sought to understand the effects of casual game play on cognitive, social, and emotional health across the lifespan. Several key limitations found across the extant research base are worth mentioning. First, examination of the effects of casual games raises important questions as to what constitutes a "casual game" in the first place. While the construct holds together as a market category and members of the category do indeed share important family resemblances, "casual," myriad games can be played more or less casually, depending on the orientation of the player and the context of play. *Tetris* [1984] is an illustrative case in point; across studies, we see the game used as a causal game, an action game, and even a control condition in the study of other games. Which is it exactly? And by what logic? Much of the extant research base treats casual games as a single coherent category of intervention, thereby blackboxing key game design features—from art and aesthetics to in-game mechanics to the average duration of play. Research in the domain would benefit from increased specificity as to the features of the games used and their relative contribution to effects seen. Such details indeed matter.

Second, questions persist about the close relationship between game play as intervention (independent variable) and measurements of cognition (dependent variable). Several studies reviewed herein measure outcomes with a cognitive task or two that match the game play intervention closely—but still fail to find evidence for transfer. Brain games in particular benefit from these isomorphisms between intervention and outcome measurement, at times appearing to train players to do well on just those specific tasks used to measure more general and valued outcomes.

Other studies define target outcomes such as "improved mood" in broad strokes, but then measure those outcomes on specific, constrained tasks and instruments that bear little resemblance to the actual target outcomes (and themselves correlate closely with multiple other tests). Researchers might benefit from thinking more deeply about the ways we operationalize those outcomes we care most about. Measurement of real-world human cognitive (let alone social and emotional) phenomena requires investigation of a wide variety of variables, not all of which can be captured by simple pen and paper, computer, or digital three-dimensional tasks, as Gibson [1986] reminds us. Such weaknesses in the research base are certainly not limited to the study of casual games but rather, at times, seem to plague some psychometric work more broadly.

Third, this review also uncovers relatively consistent gains for active control conditions compared to experimental (game) conditions, consistent with the mindset literature more broadly [Crum et al. 2011]. When participants are primed to expect gains from a given intervention, they commonly do. Thus, studies of the benefits of casual games need active control conditions against which to compare gameplay to factor out mindset effects as a confound.

Finally, we also find some evidence within the literature taken as a whole of the so-called "file drawer" effect [Rosenthal 1979], whereby studies that find no significant outcomes are placed in a file drawer rather than shared via publication. Multiple studies included in this review employ a wide variety of instruments to measure outcomes yet report on only those outcomes that prove statistically significant. The cumulative effects in the research base are an overestimation of positive impacts due to underreporting of null results. In the case of cognitive benefits of casual games in particular, the number of studies that fail to uncover substantive gains lends credence to concerns that cognitive benefits of casual gameplay are overstated [Pilegard and Mayer 2018].

A deeper question for this body of literature surrounds longer-term effects. This synthesis touches on research on game addiction and depression caused by overgaming, but it does not examine this literature exhaustively. Thus, questions persist about other activities that game play may well replace. Turning to games as a form of recreation, entertainment, and social connection is positive; indeed, insomuch as game play may have deeply positive effects to the extent to which it is social. However, when games become a vehicle to avoid confronting one's feelings or addressing underlying issues, game play may well prove much more problematic. One issue warranting further research is the "come down" after game play; emerging research on homeostasis in the body (e.g., Sterling [2020]) suggests that the body's response to the return to normal dopamine levels after a gaming session could be dramatic and have longer-lasting effects.

More broadly, studies of the effects and consequences of games would benefit by continuing to take gamers' own perspectives into consideration. Both the mindset and addiction research suggest that *motivation* and *context* crucially shape game play experience and outcomes. Naturalistic studies of gamers uncover a variety of motivations for play and a broad range of situated use. Studies of other forms of pattern behavior such as religious and cultural ritual [Tian et al. 2018] reveal that actions with no discernible purpose from the outside can dramatically benefit those engaged. From this perspective, if a person finds that play a game of *Wordle* [2021] each morning helps them focus and increases their mood, then it does, yet the same morning ritual for another individual with no such expectations or beliefs or who is coerced into game play or who has simply grown bored has little to no effect. So, while this research synthesis uncovers some evidence for the cognitive benefits of casual games and moderate to strong benefits for their social and emotional benefits, we are also reminded of the contextual nature of such findings and within it, a human propensity to evade measurement, categorization, and objectification in ways easily overlooked in formalized experimentation, quantification, and laboratory observation.

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