Chapter 9
On the Need for Developmental Perspectives in Research on the Potential Positive and Negative Health Effects of Digital Games

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Abstract As digital games become increasingly ubiquitous via mobile applications and other widely-used media platforms, game-based health applications and mobile health monitoring technologies are promising tools for eHealth and mHealth. Given the importance of older people as an audience for eHealth and mHealth applications, it is problematic that much research on users and effects of digital games largely neglects developmental approaches and variables. This chapter reviews research on effects of digital games, particularly the health effects of digital games on older people, and suggests how more focus on developmental approaches could guide research on health applications of digital games and game-based eHealth and mHealth tools for older populations.

Digital games represent a promising eHealth tool and mHealth tool, particularly with the growth of mobile game-based health applications and mobile health monitoring technologies. After reviewing the general state of research on positive and negative effects of digital games, this chapter addresses how much of the prominent research on digital games research largely neglects developmental approaches and variables. The chapter summarizes research dealing specifically with the health effects of digital games on older people. Next, the chapter suggests how developmental approaches could be effective in guiding research on the potential health effects of digital games for older populations, then finally calls for more reliance on development as a key aspect in research of digital games' effects, as well as in design of game-based eHealth and mHealth applications.

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9.1 Research on Effects of Digital Games: Positive and Negative Potential

The booming commercial and cultural impact of digital games has been accompanied by similarly grand speculation and claims about the health impacts of the medium on its users. Over the past few decades, the most prominent academic discussions about digital games and their possible health effects have dealt with potential negative outcomes, particularly the potential negative social consequences of violent content in digital games (Anderson et al. 2010; Ferguson 2007a, b) and the medium's potential for problematic overuse ("addiction") (Griffiths, 1997, 2008). There has, however, also been ample discussion about the potential positive effects of digital games. Such potential positive outcomes have ranged from improvements in coordination and perception (Green and Bavelier 2006; Kuhlman and Beitel 1991) to developments of advanced social skills (Yee 2006) and to protection against cognitive decline from aging (Basak et al. 2008; Maillot et al. 2012). Granic et al. (2014) describe several potential benefits of gaming, including cognitive, emotional, and social benefits. Game playing may stimulate cognitive skills such as problem-solving skills, spatial skills, and increasing creativity, and may also promote motivation levels among players. There are also emotional benefits of gaming, such as improved mood among players, and social benefits of gaming, such as prosocial skills.

Generally speaking, many of the boldest claims about the existence of powerful positive and negative effects of digital games are likely overstated (Boot et al. 2011; Elson et al. 2014; Ferguson 2010). That said, there is preliminary, if disputed, evidence for a wide range of possible effects of at least some digital games. Digital games are widely and often heavily used by large and diverse audiences, and their engaging and enjoyable features make the medium a likely candidate to serve as an effective vehicle for delivering messages and encouraging rehearsal of behaviors and habits—healthy or otherwise. Therefore, scholars, game designers, and a variety of health advocates are likely to continue to explore the potential effects of games with sustained, or even growing, enthusiasm. Digital games are increasingly seen as a potentially powerful tool for eHealth, the application of technology to provide or enhance health-related services and information (Eysenbach 2001). Increasing ubiquity of mobile devices and mobile health monitoring technology has also made game-based mobile applications a promising tool for mHealth—mobile health—across diverse developmental and socioeconomic populations (Klasnja and Pratt 2012; Lowe and ÓLaighin 2014; Marston and Hall 2016; Miller et al. 2014b).

While digital games have long been stereotypically associated with children, older people have received particular attention as an audience for potential health benefits of digital games. Research has observed that older people express a preference for games as a method for learning (Diaz-Orueta et al. 2012; LeRouge et al. 2013). Given that challenging problem-solving tasks and tests of coordination and visual acuity are two common elements of digital games, researchers have explored the possibility that digital games might be a useful tool for stemming declines in

cognitive, perceptual, and motor skills among older players, as well as promoting mental health and preventing accidents such as falls (Basak et al. 2008; Hall et al. 2012; Maillot et al. 2012). Companies have even marketed some games as beneficial "training" for the brain, though such claims are limited in their empirical support. As with other areas of research on the positive and negative effects of digital games, study findings related to their potential for maintaining the health of older people's bodies and minds is tentative and mixed at best (Boot et al. 2011; Simons et al. 2016). Considering the public health challenges associated with a global increase in the proportion of older people and, consequently, the increase in health concerns associated with older people, the potential health benefits of digital games will likely continue to merit exploration from researchers in search of more conclusive findings about potential positive effects. As research attempts to generate more consistent and conclusive findings regarding the possible positive and negative effects of digital games, with studied outcomes ranging from deviant behavior among children to cognitive skills among older people, one shortcoming of much of this research across its many specific focus areas is limited consideration of developmental approaches, theories, and models as guides for research designs and interpretation of findings.

While much of the research on the effects of digital games is focused very closely on potential effects for age-specific audiences, such as young people potentially made more aggressive by the games' violence or older people potentially aided in thwarting cognitive decline by game tasks, neither the conceptual models nor the empirical designs of much of this research account for the specific developmental characteristics of the populations of interest. In many cases, such research may not even involve participants from appropriate age groups. For example, much research discussing potential negative effects of digital games on children has relied heavily on college student samples (Ferguson 2007a; Sherry 2006).

The tendency for the research on the health effects of digital games to largely ignore the role of developmental stages of life in possible effects mechanisms is a grave oversight. Incorporating developmental perspectives to understand the unique ways that minds and bodies at different stages of life may respond to digital games may be a key to unpacking the currently conflicted and inconclusive bodies of research on various potential effects of digital games. If some possible health effects of digital games are nuanced and conditional, which seems likely given the conflicting findings of much research on the effects of digital games, then developmental approaches may be useful in identifying moderators that show what potential positive and negative effects may be likely among individuals, depending on developmental characteristics such as age. Research on potential benefits of digital games for older people is an area where developmental approaches may be particularly insightful, given that many health concerns that digital games may address among older people are closely associated with specific developmental processes associated with aging.

9.2 The Generally Limited Role of Developmental Approaches in Research on the Effects of Digital Games

The most prominent research dealing with the potential effects of digital games has explored whether digital games influence negative health outcomes in young people, such as aggression and other antisocial behavior (Anderson et al. 2010). The outcomes of this research are mixed, hotly debated, and closely scrutinized (Hall et al. 2011). Several concerns have been raised with the practice and interpretation of the literature on potential negative effects of digital games. One is the presence of flexibility in many studies' measurement of outcomes, which inflates the appearance of significant effects by allowing researchers to sift through multiple versions of an outcome measure to choose a significant version of that measure (Elson et al. 2014). Another issue is a tendency for studies that observe significant effects to be published more than studies that do not (Ferguson and Heene 2012), which inflates the presence of studies observing significant effects in the published literature; this issue has been dubbed "the file drawer problem" (Rosenberg 2005; Rosenthal 1979) in reference to the tendency for studies observing null findings to be relegated to file drawers rather than publication venues. A third issue is the methodological challenge involved in isolating effects of factors such as violent content relative to other factors such as competition (Adachi and Willoughby 2011), which clouds our ability to observe unique effects of violent content. Opinions about the potential negative effects of digital games vary among scholars, and their disagreements are sometimes acrimonious (e.g., Bushman et al. 2015a, b; Griffiths et al. 2016; Hall et al. 2011; Ivory et al. 2015; Markey et al. 2015; Petry et al. 2014; Quandt et al. 2015; Strasburger et al. 2014).

Along with these other issues, however, the research on potential negative effects exemplifies the lack of attention to developmental approaches in the literature on the effects of digital games more broadly, because it has tended to neglect incorporating the role of key biological and psychological changes in adolescence that are closely associated with such negative behaviors (Kirsh 2003). Much of the research on the potential negative effects of digital games is guided by general theories of learned behavior and effects of stimuli on cognitive structures, such as social cognitive theory (Bandura 2001) and the general aggression model (Bushman and Anderson 2002), which acknowledge the existence of individual traits as moderators of effects but do not tend to assign substantial roles to specific developmental factors. As a result, even research targeting implications of the effects of digital games for specific developmental groups, such as children and adolescents, too often fails to include development in its theory or method.

Further, laboratory research on such negative effects of digital games has often used adult college students as participants as a matter of logistical convenience (Ferguson 2007a; Sherry 2006), eschewing the younger digital game players of primary interest to the social questions guiding the research. This has led to a situation where, in many cases, research dealing with participants at one developmental stage of life is generalized to youthful participants at another stage of life with very

different biological and psychological characteristics that are relevant to the negative behaviors of interest. Survey studies have more often directly targeted the youthful populations of interest to much research on digital games' health effects (e.g., Gentile 2009).

These studies however, tend to neglect incorporating developmental approaches in their conceptual explanations and predictions or including variables specifically related to development as potential factors in analyses of health outcomes. The net result is that much of the research on the effects of digital games either studies one age group to make claims about another, or studies an age group presumed to be particularly prone to the effects of digital games without exploring why the group might be developmentally prone to effects, or what members of that group might possess developmental traits particularly conducive to effects (Kirsh 2003).

Much of the literature on potential positive effects of digital games similarly lacks grounding in developmental approaches. Like research on the potential negative effects, the research on potential positive effects of digital games is conflicting and disputed (Boot et al. 2011; Simons et al. 2016). The research on potential positive effects of digital games also too often tends to incorporate the same general theories of learning, imitation, and cognitive effects of stimuli as research on potential negative effects, with little more than a passing nod to developmental approaches and factors (e.g., Gentile and Gentile 2008). Research on potential positive outcomes related to cognition and education has also relied in large part on findings from studies using adult participants, despite being touted as having implications for children and adolescents (Blumberg et al. 2013). Thus, while much of the research exploring both optimism about potential benefits of digital games and concerns about potential harms has focused on implications for audiences at specific developmental stages, such as children, too much of that research has failed to incorporate such developmental factors appropriately in both conceptualizations and methodology.

9.3 Existing Research on the Health Effects of Digital Games for Older People

While much of the research dealing with the effects of digital games, particularly on younger people, has been somewhat negligent of developmental issues with those younger people of interest (Kirsh 2003), research investigating potential health effects of digital games on older users has at least more frequently focused on participants from the age group of interest. In fact, research exploring the effects of digital games on older people has tended to include and even compare findings for samples of older people across a range of ages. For example, a meta-analysis of research on the effects of video games on cognitive function among older adults (Toril et al. 2014) found that while there were a limited number of studies on the topic, the available research was conducted with older adults over a range of ages,

and age appeared to moderate some effects on older people. For instance, one study exploring multitasking performance (Anguera et al. 2013) includes participants varying in age from 20 to 79 years. Meanwhile, some populations, such as older people 85 years of age and older, have not been thoroughly examined in social research involving digital games (Marston et al. 2016a).

Reviews of research on effects of game-based health applications for older people have observed a limited number of studies guided by theory (Hall et al. 2012; Hall and Marston 2014). Reliance on conceptual approaches to development and aging has been limited in many cases, and research on varied outcomes of digital game use for older people is not unified under a model incorporating these different outcomes in a broad understanding of health and aging. Efforts exist to provide theoretical frameworks uniquely tailored to game-based health applications (e.g., AlMarshedi et al. 2016), but they are not widely employed. For instance, lifetime digital game playing is associated with bilateral entorhinal cortex, hippocampal, and occipital gray matter volume (Kuhn and Gallinat 2014).

Among older adults (60–85 years old), custom-designed digital games may benefit cognitive control abilities (Anguera et al. 2013). Meta-analyses (Toril et al. 2014) and systematic reviews (Bleakley et al. 2015; Hall et al. 2012) show positive effects of digital game training on cognitive functions such as attention, memory, reaction time, and global cognition, as well as motor functions, physical outcomes, and prevention of injury from falls. Basak et al. (2008), for example, found gain in executive control functions among older adults trained in a real-time strategy digital game. Similarly, Maillot et al. (2012) found that active digital game training programs for older people improved outcomes such as physical function and cognitive measures of processing speed and executive control.

That said, much of the research on the effects of digital games on perceptual and cognitive skills has been identified as possibly plagued by methodological flaws that limit conclusive interpretation of that research (Boot et al. 2011). A review of research on cognitive training games conducted by Simons et al. (2016) found that while such applications tended to improve performance on the specific tasks involved, there was less evidence for similar improvements in other tasks or general cognitive performance. Similarly, systematic reviews by Molina et al. (2014) and Miller et al. (2014a) found mixed evidence for the effectiveness of digital games as a tool for physical rehabilitation of older people.

Therefore, much of this research is not only lacking conceptual synthesis in terms of understanding the role of the effects of digital games in a comprehensive model of the aging process, but stronger conceptual guidance is needed to produce individual findings that can be conclusively interpreted. Further, researchers have found that age may moderate many effects of digital games on older players (Toril et al. 2014), indicating the importance of a nuanced conceptual and methodological approach to developmental factors in effects of games on older people rather than treating older people as a single homogenous developmental stage group.

9.4 Relevant Developmental Approaches to Aging and Their Potential Application to the Health Effects of Digital Games

Definitions of successful aging have evolved over the years. Initially, literature centered on the biomedical model, which focused on freedom from illness as well as the deficit model of aging, which centers on age-related decline (Tam 2013). More recent approaches account for individual perceptions of aging, such as the model of selective optimization with compensation (see Baltes and Baltes 1990), which aims to understand developmental change across the life span, whereby people select domains to focus their resources, optimize their gains and acquire new skills, and compensate for limitations. While past approaches on aging were one dimensional, newer approaches are more multidimensional and account for the broader dimensions which encompass the aging process, such as social, psychological, and physical aspects.

Young et al. (2009) describe aging as an individual process where each individual ages differently and that successful aging can be achieved when compensations are made for physiological limitations which occur via psychological and social means. They propose successful aging can be measured through a multidimensional model integrating physiological, psychological, and social domains of health. Somewhat similarly, Bronfenbrenner (1993) proposes an ecological model of human development, which stresses that a person's development across the life span needs to be understood in the context of the entire surrounding system. The ecological model proposes five subsystems comprising this ecological system, from the microsystem made up of the person's proximal social environment to the macrosystem made up of broader influences, such as social customs and economic factors.

While these developmental approaches, and others, exhibit some differences in their levels of focus and conceptual mechanisms, each provides a framework of key concepts to be taken into consideration when proposing theoretical and practical applications of digital games to healthier aging. For example, a multidimensional approach to the health benefits of digital games for aging audiences can be rooted in psychological, physiological, and social dimensions of aging, when considering possible outcomes of digital game interventions, possible individual moderators of the effects of games, and possible constraints to use that need to be accounted for in designing games for an older audience. Moreover, research that explores the multidimensional aspects of conceptualizations of aging in concert will be well-suited to synthesize existing research programs on varied dimensions of the effects of games, while also modeling key moderating variables that might define conditional effects. It is also important that digital games meant to educate the elderly and elicit behavior change take into account health behavior models and theories. For instance, Kececi and Bulduk (2012) note that the four health behavior models used most often with the elderly in education, health, and behavioral science articles published during the 2000s include the Theory of Reasoned Action/Planned Behavior, the Health Belief Model, Social Cognitive Theory, and the Transtheoretical Model.

Incorporating such health education-related models in research on game effects for older users would leverage their demonstrated applicability to health education.

Along with accounting for the role of developmental and health concepts in the effects of digital games, researchers also need to account for developmental factors in motivations for playing digital games, in order to better understand why people may choose to engage with games at different points in their life span and what needs and gratifications they use the games to address (Sherry 2013). As Granic and colleagues (2014) state, "We also need information on whether different types of games are not only beneficial but also appropriate to play at specific developmental stages and whether there are specific benefits that are obtained during specific developmental windows and not others" (p. 75). Similarly, elements of game mechanics and challenges most conducive to effective health outcomes must also be modeled. An important learning principle of effective video games is appropriate difficulty level (Eichenbaum et al. 2014). This is a particularly important consideration of video game effects on older players, akin to Vygotsky's (1978) "zone of proximal development" which describes "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (Vygotsky 1978, p. 33).

That is, good games should allow an equilibrium between appropriate levels of difficulty and resultant aggravation and achievement and subsequent satisfaction. Relevant to this equilibrium is the concept of flow (Csikszentmihalyi 1975), which can be understood as a focused and enjoyable state where a user's skill and a task's challenges, including physical exertion (Mueller et al. 2011), are well matched. Flow experiences have been explored in multiple studies examining health applications of games for older people. Robinson et al. (2015) found that self-report measures for some flow experiences were higher among older people using an exercise game-based balance training intervention than among others taking part in traditional balance training. Marston et al. (2016b) measured flow experiences of participants 65 years of age and older, using an established flow measure for older adults (Payne et al. 2011), in their research on a digital exercise game designed to prevent falls.

Marston (2013) similarly measured flow experiences among older people using commercial games on the Nintendo Wii and Sony PlayStation PS2 consoles, finding that flow experiences varied across consoles as well as specific games played. Further, Whitlock et al. (2014) conducted a study that found individual differences and social setting also influenced flow experiences along with game content and challenges. While these studies' findings indicate the importance of flow experiences to older people's responses to digital games and applications, more research is needed to identify optimal challenge and game experience dimensions for older users. Further study examining content of games targeted to older adults may facilitate motivation levels and appropriate levels of difficulty. Examining related experience dimensions such as positive and negative affect using established measures (e.g., Watson et al. 1988) may also provide further insights as to the ideal experience dimensions for game-based digital eHealth and mHealth applications.

Additionally, future research on the effects of digital games at different points in the life span will need to more carefully incorporate developmentally appropriate assessment strategies in operationalization of outcome measures. Measures assessing outcomes such as motor and cognitive function should be designed and applied with circumstances that vary across developmental stages, such as memory and dementia. Much behavioral research with digital games relies on self-report questionnaires, which may not be appropriate to measure some outcomes at all developmental stages.

Validity and feasibility of outcome measures has been a concern in reviews of research related to game-based health applications for older people. (Granic et al. 2014; Miller et al. 2014a; Molina et al. 2014; Wiloth et al. 2016). For some older populations, development of unique measurement instruments may ensure more valid assessment of outcomes from digital games. For example, Wiloth et al. (2016) note problems with the validation of some game-based training outcomes in previous research, particularly for individuals with dementia, and present validation evidence for assessment of motor and cognitive training outcomes using an original "Physiomat" game-based training device for individuals with dementia. Similarly, health outcome measures in research on digital games' effects across the developmental life span should be carefully validated in terms of dimensions such as construct validity, test-retest reliability, and responsiveness to change for developmental groups of interest, as is best practice with clinical and psychometric instruments (Beaton et al. 2001; Portney and Watkins 2015; Wiloth et al. 2016).

Research and theory related to health and development also need to be more consistently integrated into the design of game-based health applications for older people. For instance, Payne et al. (2015) conducted a content analysis of application of health behavior theories in physical activity and exercise mobile game applications. They found that many of the applications included limited application of health behavior theories. As a result, they recommend more collaboration between behavioral health experts and mobile health game application designers. Kececi and Bulduk (2012) describe several potential barriers to the education of the elderly, which include sensory losses (i.e., hearing, touch, and vision deficits), mental illnesses, and chronic diseases. Game designers should take such barriers into consideration, and in-game feedback for players as well as assessment strategies by practitioners and academics should consider these barriers when making learning assessments.

9.5 Conclusion

While the extant literature on the effects of digital games is often problematic in its relative neglect of developmental approaches, there is a strong base of research on the effects of digital games on older players that has employed appropriately aged samples and identified the importance of developmental moderators of such potential effects, even within the broader older population. There is, however, room for more thorough incorporation of multidimensional approaches to psychological,

social, and physical processes of development and aging in the conceptualization, methodology, and interpretation of research exploring how games may affect individuals throughout their life spans. Given the wealth of developmental theory and research that is available, we urge scholars exploring the potential effects of digital games on users of all ages to incorporate developmental approaches and variables more thoroughly in future research, and we urge game designers to integrate developmental and health behavior theory and research findings in game-based eHealth and mHealth applications. More attention to important conditional developmental factors may shed some light on the currently cloudy picture of the potential societal effects of digital games—both positive and negative. Developmental approaches are critical to understanding not only how individuals respond to games throughout the life span, but also why they choose games at different points in their lives and what role game experiences play over the course of their developmental stages.

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