Sheese, B. E., & Graziano, W. G. (2005). Deciding to defect: The effects of video game violence on cooperative behavior. *Psychological Science, 16,* 354–357.

Sherry, J. L. (2004). Media enjoyment and flow. *Communication Theory, 14*(4), 328–347.

Sherry, J. L., Lucas, K., Greenberg, B., & Lachlan, K. (2006). Video game uses and gratifications as predictors of use and game preference. In P. Vorderer & J. Bryant (Eds.), *Playing computer games: Motives, responses, and consequences* (pp. 213–224). Mahwah, NJ: Erlbaum.

Sherry, J. L., Lucas, K., Rechtsteiner, S., Brooks, C., & Wilson, B. (2001, May). *Video game uses and gratifications as predictors of use and game preference.* Paper presented at the International Communication Association Annual Convention, Washington, DC.

Sherry, J. L., & Pacheco, A. (2006). Matching computer game genres to educational outcomes. *Electronic Journal of Communication, 16*(1 & 2). Retrieved from http://www.cios.org/www/ejc/v16n1.htm

Sherry, J. L., Rosaen, S., Bowman, N. D., & Huh, S. (2006, June). *Cognitive skill predicts video game ability.* Paper presented at the International Communication Association Annual Convention, Dresden, Germany.

Sims, V. K., & Mayer, R. E. (2002). Domain specificity of spatial expertise: The case of video game players. *Applied Cognitive Psychology, 16*(1), 97–115.

Sita, A., & Miller, S. B. (1996). Estradiol, progesterone and cardiovascular response to stress. *Psychoneuroendocrinology, 21*(3), 339–346.

Smith, M. E., McEvoy, L. K., & Gevins, A. (1999). Neurophysiological indices of strategy development and skill acquisition. *Cognitive Brain Research, 7*(3), 389–404.

Subrahmanyam, K., & Greenfield, P. M. (1994). Effect of video game practice on spatial skills in girls and boys. *Journal of Applied Developmental Psychology, 15*(1), 13–32.

Svebak, S., Knardahl, S., Nordby, H., & Aakvaag, A. (1992). Components of Type A behavior pattern as predictors of neuroendocrine and cardiovascular reactivity in challenging tasks. *Personality and Individual Differences, 13*(6), 733–744.

Terdiman, D. (2006). What's wrong with serious games? C/net news. Retrieved March 22, 2006, from http://news.com.com/Whats+wrong+with+serious+games/2100-1043_3-6052346.html

Tetris [Digital game]. (1985). Pajitnov, A. Honolulu, HI: Tetris.

Vandewater, E. A., Shim, M., & Caplovitz, A. G. (2003). Linking obesity and activity level with children's television and video game use. *Journal of Adolescence, 27,* 71–85.

von Salisch, M., Oppl, C., & Kristen, A. (2006). What attracts children? In P. Vorderer & J. Bryant (Eds.), *Playing computer games: Motives, responses, and consequences.* (pp. 147–164). Mahwah, NJ: Erlbaum.

Weber, R., Ritterfeld, U., & Mathiak, K. (2006). Does playing violent video games induce aggression? Empirical evidence of a functional Magnetic Resonance Imaging study. *Media Psychology, 8*(1), 39–60.

Wolfson, S., & Case, G. (2000). The effects of sound and colour on responses to a computer game. *Interacting with Computers, 13*(2), 183–192.

Wood, R. T. A., Griffiths, M.D., Chappell, D., & Davies, N. M. O. (2004). The structural characteristics of video games: A psycho-structural analysis. *CyberPsychology and Behavior, 7*(1), 1–10.

Chapter 11

Designing Serious Games for Children and Adolescents

What Developmental Psychology Can Teach Us

Kaveri Subrahmanyam and Patricia Greenfield

Digital games are part and parcel of young people's lives today. Using data from several recent studies conducted by the Kaiser Family Foundation, Roberts and Foehr (2008) report that 50% of households with children younger than 6 years and 83% of households with children 8 to 18 years of age have a game console. Not surprisingly, children spend considerable amounts of time playing these games—in 2004, 8- to 10-year-olds played for 65 minutes per day and 15- to 18-year-olds played for 33 minutes per day. Within this context, Sherry and Dibble's chapter (this volume, chapter 10) presents a timely review of the research on the relation between digital games and development. Unfortunately, we are severely limited in the conclusions that we can draw from these studies. A limited number of studies on a topic, a small number of subjects in those studies, with only a few of them focusing on children—these are only some of the problems with this body of work. Regardless, what we learn from the chapter is that digital game playing does have an effect on a variety of dimensions including physiological measures, attentional processes, and learning. It is the expectation of such effects that has fueled the serious games movement.

Our goal in this chapter is to go beyond current research to inform the development of serious games for children and adolescents. Our starting point is Sherry and Dibble's correct assertion that research on these topics needs to adopt a developmental perspective. This lack of a developmental perspective is perhaps one of the biggest limitations of work they reviewed in their chapter. Most of the studies are on young adults, typically introductory psychology students. Very few studies have included children and adolescents and very few to none systematically compared participants of different ages. Yet we know from developmental theory and research that timing is all-important in development. For instance, timing has been found to be important in diverse aspects of development including the effects of teratogens (e.g., drugs and alcohol) in prenatal development (Hogge, 1990), the effects of poverty during childhood (Duncan & Brooks-Gunn, 2000), and the learning of a second language (Johnson & Newport, 1989). To our knowledge, the few digital game studies that

have used such an approach have yielded unequivocal results. For instance, the Blumberg (1998) study cited in Sherry and Dibble's chapter suggests that children of different ages focus on different aspects of a game; when asked about the features of game they had played, 11-year-olds were able to describe the goals of the game, whereas 8-year-olds focused on evaluative assessments of the game. However, another study which examined the effect of digital game playing on mental rotation skill found no differences in the effects between fifth, seventh, and ninth grade students (McClurg & Chaille, 1987).

Thus, we have no way of knowing whether the effects of game playing that have been reported to date are specific to the age group of the participants in the study, whether the effects may generalize to players of other ages, and how developmental trends might mediate these effects. Yet they must be taken into account when designing serious games, if they are supposed to be seriously effective for a broad cross-section of the child population. In the absence of such developmental research, we turn to recent theoretical and empirical work to present a theoretical framework for understanding the effects of digital games, as well as to present some other important considerations for designers of serious games.

A Developmental Framework for Understanding the Effects of Digital Games

We start with our developmental framework of media understanding and use that we have described in detail elsewhere (Maynard, Subrahmanyam, & Greenfield, 2005; Subrahmanyam & Greenfield, 2008). This theory draws from the Russian psychologist, Lev Vygotsky's (1962, 1978) proposal that the tools (e.g., abacus, language, and mathematics) provided by a culture enable individuals to develop their higher mental functions. Extending this idea we suggested that using the particular tools provided by a culture elicits and develops particular sets of cognitive skills (Maynard et al., 2005). On this view, digital games are tools provided by our culture and one would expect them to influence our thinking and learning. In this chapter, we argue that understanding how these influences come about is key for designers of serious games.

To understand how media such as radio, television, and digital games influence learning, we have suggested that a distinction must be made between the formal features of a medium, such as the audiovisual production features that characterize it, and the content it presents, such as the topic of a software program. In the following we will first focus on how formal features might affect learning and will then discuss the role of content.

The Role of Formal Features: What is Internalized?

The formal features of a medium are independent of content and consist of symbol systems that a user must decode to understand the content of the message. Different media use different symbol systems. A solid body of work has identified the formal features of television, including action, pace, visual techniques, such as camera zooms, cuts, and visual special effects, and auditory features such as music, dialogue, and sound effects (Wright & Huston, 1983). Television also uses other symbol systems such as text, pictures, and diagrams, both stationary and in motion (Kozma, 1991). In Subrahmanyam and Greenfield (2008), we pointed out that digital games are even more complex than television when it comes to presenting two-dimensional representations of three-dimensional space. Most digital games use action and pace, are dynamic, have multiple, often simultaneous, things happening at different locations and utilize a variety of attentional, spatial, and iconic representations.

But how do the formal features of a medium bring about a change in our thinking and learning? Saloman (1979) has proposed that the symbol systems utilized by a medium become internalized by the user, leading to changes in his or her representations. Greenfield (1993) has called this process *cognitive socialization*—it is the process of internalization by which cultural tools such as digital games come to influence users' processing skills. There are several studies that have demonstrated that digital game playing can influence specific cognitive skills such as attention as well iconic and spatial representational skills (see Subrahmanyam & Greenfield, 2008). Sherry and Dibble refer to some of these studies in their chapter as well. Most of the studies reviewed by Sherry and Dibble under *attention* and *learning* actually deal with the effect of the formal features of games.

Unfortunately, existing studies have not systematically analyzed the formal features of games as has been done with television (see Subrahmanyam & Greenfield, 2008, for a review of some of this research). Similarly, most studies of game effects have not separated the effects of formal features from those of game content. One way to address this issue is by holding one feature constant and systematically varying the other to assess how symbols and content might interact to bring about the effects of digital games on cognitive skills. Such an approach was used by Salomon and Cohen (1977) to assess the effects of television grammar; they showed children the identical television content, but varied formal features such as zoom in and zoom outs, fragmented spaces, logical gaps, and close-ups. They found that the children were more knowledgeable about the relation between parts and whole when they viewed the version with close-ups, but showed better comprehension of logical structure and continuity when they viewed the version with logical gaps. Such an approach would be a first step toward understanding the symbolic grammar of digital games.

A related issue is that because of individual differences in processing style (e.g., Childers, Houston, & Heckler, 1985), there may be individual differences in users' ability to process and internalize different symbol systems. Sherry and Dibble (this volume, chapter 10) report that game players prefer games that require "cognitive skills consistent with their own cognitive strength." Thus, it is not only important for game designers to recognize that formal features of

games have effects on users, but also that there are differences across users in how they are able to process these features and internalize them.

Developmental Factors Affect the Processing of Formal Features

Bruner (1966) has distinguished three different kinds of representation appearing in a developmental order: enactive representation through action, iconic representation through images that resemble their referent, and symbolic representation through symbols that bear no resemblance to their referent, are arbitrary, and are therefore established by social agreement or convention. That enactive representation develops first implies that even very young children will be able to use a mouse, a prerequisite for any type of digital game, serious or not. Using a mouse involves creating an action representation on the part of the user, so it makes developmental sense, in terms of Bruner's representational theory, that children who are quite young should be able to master the basics of this technology. The 2003 (Rideout, Vandewater, & Wartella) Kaiser Report, Zero to Six, found that 64% of children between 4 and 6 years of age know how to use a computer mouse to point and click (Rideout, Vandewater, & Wartella, 2003). In doing so, they are integrating their own enactive representations using the mouse with the icons and iconic representations they find on the screen.

We have recently developed a theoretical proposal that the more real-world perceptual and cognitive cues a media representation makes available, the less mental transformation it will require and the earlier it will become accessible and usable to a child (Subrahmanyam & Greenfield, 2008). This is really an extension of Piaget's emphasis on mental transformation as a hallmark of cognitive development (Gruber & Voneche, 1977). As game design has moved to increasingly realistic (dynamic, three-dimensional, full color) graphics and sound, and games increasingly look like film or television, they require much less mental transformation to be comprehended and become accessible to increasingly younger audiences. Indeed, the Kaiser Report (2003) indicates that the age for using digital games is declining rapidly. Parents report that 14% of their 6-month to 3-year-olds and 50% of their 4- to 6-year-old children have played a digital game. A casual exploration of games available for this age group on the Internet shows that games such as those on the Nickelodeon Junior Web site are utilizing multimodal cues and realistic graphics, including a voice to tell the child every move to make with the joystick. Clearly such formal features make serious learning games accessible to ever-younger children.

However, there can be costs as well as benefits to this early accessibility of digital games. Sigel uses the term *distancing* to refer to "a class of cognitive demands that serve to activate a separation of self cognitively from the here and now" (Sigel, 1993, p. 142). Digital games are one manifestation of the fact that children are increasingly growing up in a virtual world. This means that

they are spending less and less time in face-to-face interaction, in physical activity, and interacting with solid objects. To use Sigel's terminology, digital games, whether serious or not, are a medium that serves to separate the child both cognitively and socially from the here and now. The reduction of a relationship to the real is a cost of the expansion of virtuality to serious games for child and adolescent development.

Last but not at all least, serious games will be able to build upon the skills in processing particular kinds of formal features that entertainment games develop. One such skill is the use of iconic imagery. Experimental study has demonstrated that experience with a digital game can shift representation from the symbolic toward the iconic (Greenfield, Camaioni, et al., 1994). For university students in Los Angeles and Rome, iconic representation was also correlated with better understanding of Robinett and Grimm's, *Rocky's Boot* (1982), a learning game designed to teach about the logic of electronic circuitry. Generalizing from this finding, we see that serious games to teach science and engineering can, because of the prevalence of entertainment games, utilize iconic representation as a teaching tool with confidence that basic skill in processing this formal feature has already been developed through experience with digital games for entertainment.

Serious games can utilize the development of other visual skills that nonserious action games develop—skills such as interpreting a two-dimensional display in terms of three dimensions (Greenfield, Brannon, & Lohr, 1994) or monitoring multiple locations on a computer screen (Green & Bavelier, 2003; Greenfield, DeWinstanley, Kilpatrick, & Kaye, 1994). The widespread experience with the entertainment games of today means that children and adolescents will be better able to process visual features such as iconic imagery, three-dimensional representation, and action at multiple locations when these formal features are used for serious learning processes. Unknown at this point is how formal features of a game might interact with game content, the topic we turn to next.

The Role of Game Content: What is Learned?

We define game content as the topic area or message conveyed by the formal features; for example, a game's thematic focus (e.g., geography, algebra). Research on game content has mostly consisted of studying games that teach specific academic skills (such as reading or mathematics) or subject content (e.g., science, math, personal health). Although it appears that games may promote health behavioral changes (Christen, LaPointe, Kato, Marin-Bowling, & Cole, 2006; Lieberman, 2001), research has yielded very little evidence that their use in the classroom yields consistent benefits. Kafai (2006) wrote that "a survey of the past 20 years of educational publications reveals a rather sparse bounty, in particular if one is interested in hard-core academic benefits rather than motivational or social aspects of playing games for learning" (p. 37).

Furthermore, Sherry and Dibble (this volume, chapter 10) point out that the idiosyncratic nature of the studies make it very difficult to draw any conclusions and generalizations.

More promising in our opinion is an effort that provided students with an opportunity to design games for learning. Relevant here is Kafai and colleagues' research in which students were provided with the opportunity to construct their own games; for instance in one study students were given the opportunity to create their own games (with their own worlds, characters, storylines, etc.) to teach fractions to a group of younger students in their school (Kafai, Franke, Ching, & Shih, 1998). By analyzing the games designed, the authors hypothesized that designing games helped the students develop more sophisticated and complex representations of fractions. Making games for learning seemed to allow learners to develop new understandings of content knowledge.

This work points out the importance of analyzing in detail learners' representations of a content area. In particular, when designing serious games for children, game designers must start with learners' representations of the content matter. They must proceed systematically by examining how these representations differ among children of different ages, at different levels of cognitive development, and at different levels of expertise in the content area. Only then can we design games that will be effective in bringing about change in those representations. In the next sections, we identify some themes that should be kept in mind when designing games for children.

Gender and Games

Gender differences have consistently emerged from research on children and games, and the chapters by Sherry and Dibble (this volume, chapter 10) as well as Kafai (this volume, chapter 14) address this issue. Relevant to us are two findings: that more boys play digital games and do so for more time than girls; second there seem to be differences in game preferences between boys and girls. Getting girls to play games is not an inconsiderable challenge—when we conducted our digital game study in the late 1980s (Subrahmanyam & Greenfield, 1994), we found it very difficult to recruit girls to participate in the study and to keep them engaged in the game training we provided. The gender disparity in game playing has remained and is even found in online games (Griffiths, Davies, & Chappell, 2003).

As Kafai notes, the challenge for designers of serious games is to create games that are appealing and accessible to all players, whether boys or girls. A similar goal motivated the Girls' Games movement and Kafai (this volume, chapter 14) has discussed this along with several games (e.g., *Barbie Fashion Designer, Rockett's New World*) that were produced as part of this effort. Here we discuss our work on the *Barbie Fashion Designer* game (Subrahmanyam & Greenfield, 1998). To understand girl appeal in digital games, we analyzed the

game as well as gender differences in other aspects of children's lives, such as their play and their media (television) preferences. Our analysis suggested that girls like nonaggressive play activities that allow them to create fantasies set in familiar settings with familiar characters, compared to boys who seemed to prefer more aggressive and fantasy based activities. These preferences were also mirrored in the virtual world—boys dove into action games with their aggressive and fantasy-based content, whereas girls overwhelmingly rejected violent action games and instead took to an electronic game that allowed them to construct real life themes in the virtual world. In other words, we found that girls' and boys' preferences in electronic play mirrored their preferences in real-life play and media (e.g., print and television).

This is a powerful theoretical finding, and one that shows that in seeking to design games that have broad appeal, game developers must be informed by existing research on individual differences in children's play and everyday activities. But more broadly, this finding also suggests that for young people, physical and virtual worlds may be connected; this is an observation that has recently emerged from our own and other people's work on young people and the Internet (Subrahmanyam, Garcia, Harsono, Li, & Lipana, 2009; Subrahmanyam, Smahel, & Greenfield, 2006). Although this work deals with the Internet, we think it is relevant for game designers because it speaks more generally to young peoples' virtual worlds.

Psychological Connectedness of Physical and Virtual Worlds

The psychological connectedness of physical and virtual worlds is becoming apparent via the gender differences that are emerging in online behavior (Griffiths et al., 2003; Subrahmanyam et al., 2007). Although the gender gap that is typically found in digital game playing is not found with regard to Internet access and use (Subrahmanyam, Greenfield, Kraut, & Gross, 2001), some gender differences from the physical world continue to be mirrored in the online virtual world. Thus, among adolescents, males seem to prefer gaming (Griffiths et al., 2003) and females prefer blogging (Subrahmanyam et al., 2009); interestingly, the majority of blog entries written by adolescents contain themes related to peers and everyday life. Another finding refers to social networking sites, and girls report using social networking sites more to reinforce pre-existing friendships, whereas boys report using them to flirt and make new friends (Lenhart & Madden, 2005). These trends seem to parallel the gender differences noted earlier in other areas of young peoples' lives (Subrahmanyam & Greenfield, 1998; Subrahmanyam et al., 2009).

Evidence for the connectedness of the two worlds also comes from studies indicating that young people use instant messaging to communicate with offline friends (Gross, Juvonen, & Gable, 2002) and chat rooms to enact real-life issues such as sexuality, identity, and partner selection (Smahel &

Subrahmanyam, 2007; Subrahmanyam et al., 2006). Closer to computer games, are computer-generated virtual worlds such as *Second Life*, and behavior in these newer contexts appear to mimic off-line behavior, so much so that they may be providing social psychologists with a new way for studying human behavior and complex social interactions (Miller, 2007).

Thus it appears that when given the opportunity to coconstruct their virtual worlds, young people do so in ways that are psychologically connected to their physical life. For designers of serious games this may mean that games and game worlds have to be psychologically connected to users' physical lives to be maximally appealing and effective to bring about learning in young people. There have also been reports in the media that *Second Life* is being used for learning in higher education (Wong, 2006). How successful these efforts will be we do not know as yet. But together they suggest that when designing games for young children, it is important to be informed by what is happening in other spheres of their lives.

Potential Role of Developmental Issues and the Development of Game Understanding

Issues such as sexuality, identity, and partner selection are highly salient at a particular stage of life—adolescence and young adulthood. These stage-specific issues in social development may explain why playing digital games is less popular in adolescence than in middle childhood (Roberts & Foehr, in press), whereas communication functions of the Internet are so dominant in adolescence (Subrahmanyam & Greenfield, 2008).

One clue as to why digital games are increasingly popular through middle childhood lies in Piaget's research on the development of children's understanding of games (Piaget, 1932). Interviewing children about the game of marbles, Piaget found three stages in the understanding of the rules of the game. Up to age 4 to 5, children in Geneva did not really understand rule-bound games at all; they simply engaged in personal exploration and individual ritual acts when given a set of marbles to play with. At this point true games with rules would be futile in the digital game arena. Only software that provided an opportunity for individual exploration without obvious constraints or goals would be functional for this age group.

Around age 5 or 6, children began to see the rules of a game as sacred and unchangeable, given by authorities such as parents or God. In actual play, however, children at this stage tended to play their own individual games rather than trying to compete with each other. This might be the stage at which digital games could first be successful, given that the rules are in fact programmed into the game (therefore given by authority and unchangeable). But because competition is still not understood, games for this stage should not be for more than one player. Indeed, a quick survey of online games for young children indicates that they generally are single-player games. For example, in the online version of *Candyland*, a board game for young children, interaction with the computer is substituted for the social interaction of the offline game. Applying Piaget's findings, we would guess that this change would make this game (or other games) able to be played by younger children than the multiplayer board game versions.

By around age 10, a third stage was reached in Piaget's research on the game of marbles. At this point children no longer saw game rules as sacred, laid down by external authority. Instead, they saw them as established by mutual consent; rules could therefore be changed by agreement among the players. For the first time, children had the concept that they themselves can construct and coconstruct the rules of a game. The implications of this progression would be that multiplayer games with changeable rules might be the best way to provide learning experiences through digital gaming at this last stage. In addition, the idea that that they themselves can make the rules of a game would allow children, at this point in development, to program and construct their own games for the first time. In the light of this general developmental stage in game understanding, it is undoubtedly no coincidence that children between the ages of 9 and 11 were Kafai's choice as designer/programmers of serious games (1996; this volume, chapter 14); this choice of ages must be one reason that the children were so successful as designers of games to teach fractions.

Formal and Informal Contexts of Learning

One final point—in recent years, developmental psychologists have begun to recognize that learning is not restricted to the formal context of the classroom, but can also occur in the informal contexts of everyday life, such as museums, at home, in the kitchen, when interacting with peers, and in after-school settings (Rogoff, 1990; Scribner & Cole, 1973). In contrast to the direct instruction from an expert that is characteristic of the learning in a typical classroom, learning in informal settings is characterized by the learner's active participation as well as collaboration between people with different levels of knowledge and expertise (Rogoff, 1990). Anecdotal observation of digital game playing in the home suggests that these characteristics are present when children play games, particularly in the company of their peers.

Unfortunately, research on the effects of digital games has not systematically examined game effects using the theoretical distinction between formal and informal learning. We do not as yet understand the informal learning mechanisms that take place during game playing or how the setting itself can influence whether learning takes place or not. Another thorny issue is that of transfer, a topic that Sherry and Dibble address in their chapter in this volume. Do children transfer the skills/knowledge gained when playing games to the formal setting of the classroom, and do skills learned in the classroom transfer to game contexts? What game features are more likely to ensure such transfer? Evidence that the online worlds coconstructed by young people are

psychologically connected to their physical lives leads us to speculate that transfer might be more likely to occur when game worlds are similarly connected to players' offline lives. In the absence of systematic research to support or refute our contention, the very least that game designers can do is to keep these issues in mind when designing games for children.

Conclusions

In conclusion, although research to date suggests that playing digital games may have effects on our learning and thinking, many questions remain as to the factors that mediate these effects. In the absence of such research, we have used developmental theory and research to provide some considerations and themes that should be kept in mind when developing serious games for children and adolescents. Our analysis suggests that when designing games, designers should pay attention to the formal features of games as separate from content, look to young people's offline lives, and take into account the context in which the game will be used.

References

Barbie Fashion Designer [Digital game]. (1995). El Segundo, CA: Mattel.

Bruner, J. S. (1966). On cognitive growth. In J. S. Bruner, R. R. Olver, & P. M. Greenfield (Eds.), *Studies in cognitive growth* (pp. 1–67). New York: Wiley.

Childers, T. L., Houston, M. J., & Heckler, S. E. (1985). Measurement of individual differences in visual versus verbal information processing. *The Journal of Consumer Research, 12*, 125–134.

Christen, P., LaPointe, E., Kato, P. M., Marin-Bowling, V. M., & Cole, S. (2006). Model for developing and evaluating video games or other technology-based solutions to improve the health and quality of life of young people with cancer or other chronic illnesses. *Cyberpsychology & Behavior, 9*, 665.

Duncan, G. J., & Brooks-Gunn, J. (2000). Family poverty, welfare reform, and child development. *Child Development, 71*, 188–196.

Green, C. S., & Bavelier, D. (2003). Action video game modifies visual selective attention. *Nature, 423*, 534–537.

Greenfield, P. M. (1993). Representational competence in shared symbol systems: Electronic media from radio to video games. In R. R. Cocking & K. A. Renninger (Eds.), *The development and meaning of psychological distance* (pp. 161–183). Hillsdale, NJ: Erlbaum.

Greenfield, P. M., Brannon, C., & Lohr, D. (1994). Two-dimensional representation of movement through three-dimensional space: The role of video game expertise. *Journal of Applied Developmental Psychology, 15*, 87–103.

Greenfield, P. M., Camaioni, L., Ercolani, P., Weiss, L., Lauber, B., & Perucchini, P. (1994). Cognitive socialization by computer games in two cultures: Inductive discovery or mastery of an iconic code? *Journal of Applied Developmental Psychology, 15*, 59–85.

Greenfield, P. M., deWinstanley, P., Kilpatrick, H., & Kaye, D. (1994). Action video games and informal education: Effects on strategies for dividing visual attention. *Journal of Applied Developmental Psychology, 15*, 105–123.

Griffiths, M. D., Davies, M. N. O., & Chappell, D. (2003). Online computer gaming: A comparison of adolescent and adult gamers. *Journal of Adolescence, 27*, 87–96.

Gross, E. F., Juvonen, J., & Gable, S. E. (2002). Online communication and well-being in early adolescence: The social function of instant messages. *Journal of Social Issues, 58*, 75–90.

Gruber, H. E., & Voneche, J. J. (1977). *The essential Piaget: An interpretive reference and guide*. New York: Basic Books.

Hogge, W. A. (1990). Teratology. In I. R. Merkatz & J. E. Thompson (Eds.), *New perspectives on prenatal care* (pp. 117–122). New York: Elsevier.

Johnson, J., & Newport, E. (1989). Critical period effects in second language learning: The influence of maturational state on the acquisition of English as a second language. *Cognitive Psychology, 21*, 60–99.

Kafai, Y. B. (1996). Gender differences in children's construction of video games. In P. M. Greenfield & R. R. Cocking (Eds.), *Interacting with video* (pp. 39–66). Norwood, NJ: Ablex.

Kafai, Y. B. (2006). Playing and making games for learning: Instructions and constructionist perspectives for game studies. *Games and Culture, 1*, 36–40.

Kafai, Y. B., Franke, M., Ching, C., & Shih, J. (1998). Game design as an interactive learning environment fostering students' and teachers' mathematical inquiry. *International Journal of Computers for Mathematical Learning, 3*, 149–184.

Kozma, R. F. (1991). Learning with media. *Review of Educational Research, 61*, 179–211.

Lenhart, A., & Madden, M. (2005). *Teen content creators and consumers*. Washington, DC: Pew Internet and American Life Project. Retrieved August 9, 2007, from http://www.pewinternet.org/pdfs/PIP_Teens_Content_Creation.pdf.

Lieberman, D. A. (2001). Management of chronic pediatric diseases with interactive health games: Theory and research findings. *Journal of Ambulatory Care Management, 24*, 26–38.

Maynard, A. E., Subrahmanyam, K., & Greenfield, P. M. (2005). Technology and the development of intelligence: From the loom to the computer. In R. J. Sternberg & D. Preiss (Eds.), *Intelligence and technology: The impact of tools on the nature and development of human abilities* (pp. 29–53). Mahwah, NJ: Erlbaum.

McClurg, P. A., & Chaille, C. (1987). Computer games: Environments for developing spatial cognition? *Journal of Educational Computing Research, 3*, 95–111.

Miller, G. (2007). The promise of parallel universes. *Science, 317*, 134–343.

Piaget, J. (1932). *The moral judgment of the child*. London: Routledge & Kegan Paul.

Rideout, V. J., Vandewater, E. A., & Wartella, E. A. (2003). *Zero to six: Electronic media in the lives of infants, toddlers and preschoolers* (Kaiser Family Foundation Report). Menlo Park, CA: Kaiser Family Foundation.

Rockett's New World [Digital game]. Mountain View, CA: Purple Moon Product.

Roberts, D. F., & Foehr, U. G. (2008). Trends in media use. *The Future of Children, 18*, 11–37.

Rocky's Boot [Digital game]. (1982). Robinett, W., & Grimm, L. San Francisco: Learning Company.

Rogoff, B. (1990). *Apprenticeship in thinking: Cognitive development in social context*. New York: Oxford University Press.

Salomon, G. (1979). *Interaction of media, cognition, and learning.* San Francisco: Jossey-Bass.

Salomon, G., & Cohen, A. A. (1977). Television formats, mastery of mental skills and the acquisition of knowledge. *Journal of Educational Psychology, 69,* 612–619.

Scribner, S., & Cole, M. (1973). Cognitive consequences of formal and informal education: New accommodations are needed between school-based learning and learning experiences of everyday life. *Science, 182,* 553–559.

Second Life [Digital game]. San Francisco, CA: Linden Lab.

Sigel, I. E. (1993). The centrality of a distancing model for the development of representational competence. In R. R. Cocking & K. A. Renninger (Eds.), *The development and meaning of psychological distance* (pp. 141–158). Hillsdale, NJ: Erlbaum.

Šmahel, D., & Subrahmanyam, K. (2007). Any girls want to chat press 911: Partner selection in monitored and unmonitored teen chat rooms. *Cyberpsychology & Behavior, 10,* 346–353.

Subrahmanyam, K, Garcia, E. C., Harsono, L. S., Li, J. S., & Lipana, L. (2009). In their words: Connecting online weblogs to developmental processes. *British Journal of Developmental Psychology, 27,* 219–245.

Subrahmanyam, K., & Greenfield, P. M. (1994). Effect of video game practice on spatial skills in girls and boys. *Journal of Applied Developmental Psychology 15,* 13–32.

Subrahmanyam, K., & Greenfield, P. M. (1998). Computer games for girls: What makes them play? In H. Jenkins & J. Cassell (Eds.), *From Barbie to Mortal Kombat: Gender and computer games* (pp. 46–71). Cambridge, MA: MIT Press.

Subrahmanyam, K., & Greenfield, P. (2008). Media symbol systems and cognitive processes. In S. Calvert & B. Wilson (Eds.), *The Blackwell handbook of children, media, and development* (pp. 166–187). Oxford, England: Blackwell.

Subrahmanyam, K., Greenfield, P. M., Kraut, R., & Gross, E. (2001). The impact of computer use on children's development. *Journal of Applied Developmental Psychology, 22,* 7–30.

Subrahmanyam, K., Šmahel, D., & Greenfield, P. M. (2006). Connecting developmental processes to the Internet: Identity presentation and sexual exploration in online teen chatrooms. *Developmental Psychology, 42,* 1–12.

Vygotsky, L. S. (1962). *Thought and language.* Cambridge, MA: MIT Press.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes.* Cambridge, MA: Harvard University Press.

Wong, G. (2006). Educators explore "Second Life" online. *CNN.* Retrieved March 5, 2008, from http://www.cnn.com/2006/TECH/11/13/second.life.university/index.html

Wright, J. C., & Huston, A. C. (1983). A matter of form: Potentials of television for young viewers. *American Psychologist, 38,* 835–843.

Chapter 12

Doors to Another Me

Identity Construction Through Digital Game Play

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> Tell me and I will forget,
> Show me and I may remember,
> Involve me and I will understand. (Confucius, 450 B.C.)

Digital games are all about identity (Gee, 2007). Imagine a 15-year-old boy, who wants to impress his classmates, wants to chase that lovely girl next door, wants to be popular among his friends, and wants to acquire a well-paid job in the future. Where does he look for inspiration? Where can he find examples of how to build and maintain the right "identity" as a popular, attractive, and competent person? Very likely, nowadays, he will acquire a great deal of information through playing digital games, because today's adolescent worldwide plays games intensively (both in frequency and in duration). Therefore, although it is reasonable to expect that game play may influence developmental processes in adolescents, it is thus far an understudied area in game research. To address this, the present paper will discuss how the underlying mechanisms of contemporary digital game play make it so entertaining for adolescents to play them intensively, and therefore, why and how digital games can be used as a tool for learning and adolescent identity development. We will bring together theories from media entertainment (especially those relating to digital game play and television) and developmental psychology (especially regarding adolescence). The purpose of this chapter is to explicate underlying processes of the use of serious digital game characters as role models for the development of an adolescent's identity. We include serious games as well as entertainment games that may have "incidental" impact on learning and development. We assume that similar underlying mechanisms hold for both types of games; processes that enhance learning and development in an entertainment environment will do so in a serious game environment (cf. Ritterfeld & Weber, 2006). Finally, because male adolescents are heavy users of entertainment media (Roberts, Foehr, Rideout, & Brodie, 1999), and more specifically of digital games (Gentile, Lynch, Linder, & Walsh, 2004), the following will primarily hold for adolescent males. While Turkle (1995) believes that digital game play may cause a fragmented self, we believe that game play may help to develop a flexible,