CYBERPSYCHOLOGY & BEHAVIOR
Volume 7, Number 4, 2004

Effects of Age on Associating Virtual and Embodied Toys

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ABSTRACT

Technologies such as videos, toys, and video games are used as tools in delivering education to young children. Do children spontaneously transfer between virtual and real-world mediums as they learn? Fifty-six children learned facts about a toy dog presented through varying levels of technology and interactivity (e.g., video game, stuffed animal, picture books). They then met a similar dog character in a new embodiment (e.g., as a stuffed animal if first met the dog as video character). Would children spontaneously generalize the facts they learned about the dog character across mediums (dynamic and static environments)? Results indicate that younger children were more likely to generalize facts across mediums. Specific aspects of the level of technology and interactivity had little effect.

INTRODUCTION

RECENTLY, there has been a growing concern regarding potential confusion between virtual/technological and real worlds, particularly in the form of media violence. Most of the research on media violence addresses middle school, adolescence, and young adulthood, since aggression at these ages can result in greater problematic outcomes compared to in the preschooler ages. This is because the media has linked violent TV viewing among adolescents and young adults to subsequent aggressive acts and antisocial behavior. However, it is not clear if the confusion has to do with the interactive nature of engagement, the differing dynamic and static environment, or the developmental stage of individuals.

Is there any other influence the media may have on children besides violence? Presently, most parents, educators, and the public are more concerned about the impact of media violence on children and adolescents. Most feedback given to the general public focuses on the link between media aggression and crime. However, it is important to note that the media is known to affect children at a wider range, both positively and negatively.

Paik and Comstock[1] looked at the effects of television violence on antisocial behavior of children and adults from 3 to 70 years, with 85% of the sample between 6 and 21 years. The analysis revealed a significant correlation between television and aggressive behavior regardless of age. The greatest effect size was found in preschool children, even though, by the nature of their age and size, their aggression was less problematic. However, there is danger in dismissing these results, especially when the potential long-term consequences and subsequent behavior could be troublesome for individuals and society.

A 20-year review by Dietz and Strasburger[2] summarizes the multiple effects of television on child and adolescent cognition and behavior. Topics range from cognitive development, obesity, aggressive behavior, violence, drug use, suicide, sexual activity, and promotion of stereotyping. These earlier findings of the effects of television on children have provided the basis for much of the recent research toward content analysis and viewing patterns. This has led to the widely accepted premise that children gain knowledge, learn behaviors, and have their value systems significantly shaped by exposure to the media. It is essential to look at this issue

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not only from content or viewing patterns, but also the features that accompany the content, such as interactivity, different medium, and age, when the long-term consequences and effects on subsequent behavior are apparent.

This study focused on whether or not young children transferred what they learned about a toy character from one medium to another (e.g., stuffed animal to computer game) and whether the interactivity of the toy and/or the age of the child had an effect. This study explored the following two questions: (1) How are children's abilities to accurately link information to a toy character affected by the interactive nature of the toy? (2) Does the child's age influence the information they generalize between media? There is reason to believe that young children's understanding of the relation between video and reality is far from complete, and there is a high possibility that several factors may influence the transfer of information from one medium to another. Ideally, this form of research can generate information to assist in the design of developmentally appropriate educational toys for young children.

Children's perceptual and conceptual development

Among the factors that have been associated with how children gain knowledge and how media impacts children in behavior and cognition, the area of perceptual and conceptual development during the preschool years is very important. The importance of this age period can be seen in the work of Paik and Comstock,[1] which shows that the preschool age has the largest effect in the correlation between television and aggressive behavior. Because this is a critical age period where a child's conceptual and perceptual knowledge develop, it is crucial to see how young children distinguish between technological and real worlds, and to explore the possible difficulties and confusions they may have. Meltzoff[3] showed that children as young as 14–24 months were able to make sense and learn from a two-dimensional video image and suggested that young children can accurately map information to the toy represented in the video, as well as transfer and apply that knowledge appropriately in the real world.

Based on Meltzoff's results,[3] in this study there are two dependent measures. The first is "Accuracy," which evaluates if a child remembers the facts presented about a toy presented by the experimenter. The second measure, "Transfer," indicates when a child uses the information given about a toy character in one embodiment (e.g., a stuffed animal) and applies it to the character in another embodiment (e.g., video game).

Interactive media: computer–human interaction

Violent TV and violent video games have led people to blame video game violence for real-life violence, and research findings from Anderson and Bushman[4] have shown that playing violent video games not only increases aggressive behavior, but is also linked to aggressive cognition and affect, physiological arousal, and decreased prosocial behavior. Recent events, most prominently the highly publicized school killings, have drawn attention to the volatile confluence of media culture and developmental psychopathology. Commentaries and news stories have made a possible link between recent killers and video games, saying that the killing is committed by individuals who habitually play violent video games. The focus is now starting to shift from TV to video games.

The main difference between the video games and TV is that one is an interactive media, and the other is not. The negative influence may have progressed from an observation stance to an active participant stance due to the incorporation of interactive media. In TV watching, you are receptive to violence (you see people shooting), where the relation is in one direction: "video game violence to real-life violence" taking shape in the form of aggressive behavior. In video games, you receive, act on, manipulate and control violence (you see and shoot people). Video games offer a two-way interaction.

As McGee and DeBernardo[5] mentioned, not only are video games interactive, they allow information to flow back and forth between the technological and the real world. In other words, a child can take out real-life frustrations and fantasies into the technological world by acting them out in video games. That experience may either stay in the virtual world, or be applied back into the real world as real weapons or acting out on false information. The rising number of school shootings and crimes by young children may be the result of such an inconsistency or gap between the overlapping mediums. Interactivity is important because interactive media has become a feature in various play, toys, games, educational devices, and social settings, which are areas that can greatly influence a child's everyday life. It is important to study the effect of interactivity on children, because this feature allows the child to experience active engagement with an object or environment by bringing all sensory experiences to-

gether. Because the interactive component will amplify the realistic component of the experience, it is crucial to find out how interactivity may influence the child in ways other than violence.

According to Weizenbaum,[6] interactivity can go as far as to make a person believe they are talking to another person when in fact they are interacting with a computer program. With a program called "Eliza," people have formed compelling bonds with the programs. "Eliza," created by Weizenbaum,[6] was the first computer program to create a conversation with a human who takes the role of a psychoanalytic Rogerian therapist. Users shared deep conversations for hours, believing that they were interacting with a human, when in reality it was a conversational agent (often referred to as a chatterbot). Seeing such powerful compelling bond between the user and computer program, psychologists coined the term "Eliza effect" to describe how people have a willingness to see dumb objects with the full attributes of intelligence. Weizenbaum mentioned how an "extremely short exposures to a relatively simple computer program could induce such powerful delusional thinking in quite normal people." Interactivity can add to a person's engagement and experience to a point that, it becomes so real, it can create delusional thinking.

Weizenbaum's quote reflects the impact Eliza had on "normal people." One of the possible reasons why interactivity may have such a powerful influence may be the population it addresses. Before, when computer access was limited to skilled users and the user interface was difficult to operate, interactivity was not a feature that came easily. Presently, with the accessibility of computers and a friendly user interface designed for the general public, response time and quality have led to a more natural interaction, which subsequently diminishes cues that people may have used to distinguish between real and false information. Because the general public may not be trained to see the basic mechanism behind the program, they may easily be tricked into thinking that a program such as "Eliza" is intelligent, while experienced users with some background can easily unmask the mechanism behind the program, seeing it as a simple unintelligent program that just rephrases incoming statements from the user. Interactivity may have veiled many key features or cues that may have helped users in the past to see and distinguish what is real and virtual. While the skill to unmask the veil may come with time, it is clear that the majority of adults as well as children may not have the skills and knowledge necessary to do this. Thus, interactivity has positive influences, which encourage engagement and provide active experiences, but also negative influences, such as masking information, diminishing cues, and causing delusional thinking. This makes us wonder about the kind of influence interactivity may have on young children. It is important to study the influence that interactivity will have on children since interactive media has become an important feature in the typical child's everyday life. Such areas include various forms of play, toys, games, educational devices, and social settings.

Given that the interactivity of certain media are related to increased expectancy and encouraged engagement, could it be possible that such media influence young children's perception and understanding of information across mediums? To see whether interactivity made a difference, two types of toys—"Interactive" and "Non-interactive"—were used. Interactive is defined as a toy where the child can manipulate it (e.g., touching the stuffed animal, controlling dog character in video game). Non-interactive is where the child can only observe the toy. Children either worked with two interactive versions of the toy character or two non-interactive versions (e.g., the picture book, video).

Information transfer across different mediums

The fact that violence in video games and TV overlaps between the game world and real world raises the question: Is it possible for young children to experience confusion when exposed to overlapping mediums? Many nonviolent children's toys such as video games, stuffed animals, action figures, picture books, and comic books are also found in overlapping mediums. It seems unlikely that exposure to such toys by itself will bring about aggressive behavior. However, today's toys overlap in content where a violent movie becomes video games, and is sold as action figures and comics (e.g., G.I. Joe, Spiderman, Batman). Although the toy itself may not be violent, the content does overlap across multiple mediums (e.g., Thomas the Train in the form of a plastic toy, an interactive computer applications of Thomas the Train, pictures of Thomas the Train, and an animated video of Thomas the Train). It is important to understand how young children perceive these similar objects across different mediums, especially when they are a part of the child's everyday play activity.

DeLoache's study[7] showed that age was important in symbolic understanding when applied to problem solving. Even when the symbol (e.g., model of room) used is similar to what it represents, there

was still difficulty in mapping the object from one medium to another because the children did not understand that the object in one medium "stands for" an object in another medium.

Instead of focusing on the application of symbolic understanding to problem solving, this study explored how children used the information from one object in a particular medium to describe a similar object in a different medium. Similar to DeLoache's experiment, similar toy objects were used (stuffed animal dog, picture book, video game, video) with similar features (Golden Retriever) that are indicative of the same type of dog.

Holyoak and Spellman[8] have concluded that transfer depends upon the development of a situational representation that is common both to the original medium and to the transfer medium. This study was interested in whether children would see similarities between physical mediums with static characters and TV mediums with dynamic characters, and whether this would influence transfer. "Static environment" is where physical mediums have static characters, and "Dynamic environment" is where a virtual/technological medium has dynamic characters. Each child heard four facts about the toy character (i.e., name, age, hobby) in a physical medium which is labeled "Static" (i.e., stuffed animal, holding a picture). They also heard four different facts about the toy character seen in a virtual/technological (video) world, which is labeled "Dynamic" (i.e., videotape or video game). The order of presentation was counter-balanced across children. One question was whether children would spontaneously generalize facts across mediums. For example, would they say the video character's name that had only been mentioned when they played with the stuffed animal?

MATERIALS AND METHODS

Participants

Fifty-six children (33–67 months) participated in this study (23 boys, 33 girls), coming from mostly middle to upper class families. The children were European-American (54%), Latino (21%), Asian (16 %), and African-American (9%). For age comparison, children were divided into two groups: younger children were 33–51 months, and older children were 52–67 months.

Design and procedure

This study included a two-by-two mixed model design (Table 1). The within-subject comparison was environment (static versus dynamic), and between-subject comparisons were age (younger versus older) and toy type (interactive versus non-interactive).

The children were assigned to one of two conditions: interactive or non-interactive. They participated in one videotaped 15-min session that was divided into playtime and interview time. Each child played in two different mediums (static and dynamic) and were given a different toy in each medium. The children in the interactive condition worked with a stuffed animal and video game. The children in the non-interactive condition worked with a cartoon drawing of a dog and an animation of a cartoon dog. The order was counter-balanced between children.

During playtime, the researcher provided information about the toy. The child was introduced to the toy and told that he or she could play with the toy while the researcher shared information about it (e.g., name of toy, age of toy). Four facts were given per toy (Table 2). After the information was delivered, the researcher put the toy away and introduced the child to the second medium (e.g., a dog video game). The researcher shared four different facts about the second toy. After the information was delivered, the researcher put the toy away. The facts involved could only be derived from listening, not from the appearance of or interaction with the toy. During the interview, the researcher showed the first toy and asked a total of eight questions (about the four facts told only for the first toy and four facts for the second toy) while showing

TABLE 1. TWO-BY-TWO MIXED MODEL DESIGN

Between subjects		*Within subjects environment*	
Age	*Toy type*		
Younger	**Interactive**	Static (stuffed animals)	Dynamic (video games)
	Non-interactive	Static (picture)	Dynamic (video movie)
Older	**Interactive**	Static (stuffed animals)	Dynamic (video games)
	Non-interactive	Static (picture)	Dynamic (video movie)

TABLE 2. INFORMATION GIVEN AND QUESTION ASKED

Information set 1	*Information set 2*
Name (e.g., The dog's name is Carmel)	Favorite food (e.g., The dog's favorite food is cereal)
Age (e.g., The dog is 3 years old)	Talent (e.g., The dog is good at playing hide and seek)
Gender (e.g., The dog is a girl)	Favorite color (e.g., The dog's favorite color is green)
Siblings (e.g., The dog has one brother)	Habitat (e.g., The dog sleeps by the fireplace at night)
Questions asked	
1. What is the doggie's name?	
2. What is the doggie's favorite food?	
3. How old is the doggie?	
4. Is the doggie a girl or a boy?	
5. What is the doggie really good at playing?	
6. Does the doggie have any brothers or sisters?	
7. What is the doggie's favorite color?	
8. Where does the doggie sleep at night?	

the first toy (e.g., "What is the doggie's name?"). Next, the researcher put the first toy away, brought out the second toy, and again asked the eight questions. The questions purposely overlapped in content.

Measures

The two dependent measures are accuracy and transfer. The accuracy measure evaluates the child's memory in relation to a specific toy. The transfer measure shows if children take information from one toy and apply it to another. This enables us to ensure that the lack of transfer is not due to a lack of memory. Accuracy was obtained by the sum of correctly remembered facts associated with the right toy. The transfer score was obtained by the number of facts associated with the wrong toy. Thus, a child who remembered all eight facts for toy 1 and all eight facts for toy 2 would have an accuracy score of 8(2 toys $\times$ 4 facts), but also a transfer score of 8. For toy 1, if a child only answered the four questions associated with that toy, and for toy 2, the child only answered the four questions associated with that toy, the child would receive an 8 for accuracy and a zero for transfer.

RESULTS

The results are shown in Table 3. There was a significant Age by Score (type: accuracy vs. transfer) interaction ($F = 13.2$, $p < 0.05$). Older children had a higher accuracy score and a lower transfer score compared to younger children, but little difference was found between the two measures in younger children. No other significant results were found. The type of media made no difference. The second part of the table shows the mean comparison of the Interactive and Non-interactive conditions. The third part of the table shows the effects of Static and Dynamic environments. The overall value of the mean is low because it is a comparison by character, and not combined.

To get a closer look at the effect of age, Table 4 shows actual age as a continuous variable in correlation analyses. Older children have better memory overall. Results indicate a significant relationship between children's accuracy scores and age ($r = 0.281$, $p < 0.05$). However, there was little correlation between age and transfer ($r = -0.7$). This is because the older children did not confuse the two toys and hence had lower transfer scores. Because younger children remember less to start with, they have less to transfer.

In Figure 1, transfer is subtracted from accuracy, value is correlated with age, and there is a relatively strong correlation ($r = 0.36$). Younger children are more likely to transfer what they remember. Younger children either perceived the two toys as being equal or had difficulty distinguishing between the two toys. The data also suggested that children around 52–54 months started to distinguish the two toys as being different.

DISCUSSION

The prediction was that that older children will have a higher accuracy and lower transfer score, while younger children will have a lower accuracy

TABLE 3. MEANS OF TOY TYPE, ENVIRONMENT, AND AGE (SD)

	Age	
	Younger (≤51 months)	*Older (≥52 months)*
Accuracy	5.0 (1.6)	6.0 (1.6)
Transfer	5.0 (1.9)	4.5 (2.6)

	Toy type	
	Interactive	*Non-interactive*
Accuracy	5.7 (1.6)	5.4 (1.8)
Transfer	5.1 (2.0)	4.5 (2.5)

	Environment	
	Static	*Dynamic*
Accuracy	2.8 (1.1)	2.7 (1.1)
Transfer	2.4 (1.2)	2.4 (1.3)

score and higher transfer score. As a result, in our study, the age variable had a significant impact on the level of accuracy and transfer. This finding was similar to the results found by Paik and Comstock,[1] where preschool age had a large effect in correlation between television and aggressive behavior. The significant effect found with the preschool age was similar to our study, but different in that their study is linked to aggressive behavior, while this study linked information transfer between two similar objects in different mediums.

The central results in our study show that older children (52 months and above) have a higher accuracy level and lower transfer level, while in younger children (51 months and below) there is little difference between the two. This may suggest that, while older children are able to distinguish the two similar objects as different across both mediums, younger children may perceive the similar objects as being the same rather than different.

The two toy objects that the child interacts with (stuffed animal dog and video game of dog) have similar features (both represent Golden Retriever dogs), but are not identical, in that one is a stuffed animal, and the other is a computer graphics image of a dog. Even though the two toys are not the same, many of the younger children (at or under 51 months) are either confused between the two or perceive them as being the same. This was similar to the findings of Flavell et al.,[9] where children paid

TABLE 4. CORRELATION BETWEEN AGE IN MONTHS BY (TTTRANSF:TRANSFER, TTACC:ACCURACY, AMINUST: DIFFERENCE[ACC − TRANS]), MEAN AND SD

		Correlations			
		EXACTMTH[a]	*TTTRANSF*[b]	*TTACC*[c]	*AMINUST*[d]
EXACTMTH	Pearson Correlation	1	−0.066	0.281	0.361
	Sig. (2-tailed)		0.627	0.036	0.006
	Sum of squares and cross-products	3974.214	−70.143	218.357	288.500
	Covariance	72.258	−1.275	3.970	5.245
	N	56	56	56	56

[a]Exact month in age.
[b]Total Tranfer Score.
[c]Total Accuracy Score.
[d]The difference (Accuracy Score minus Transfer Score).

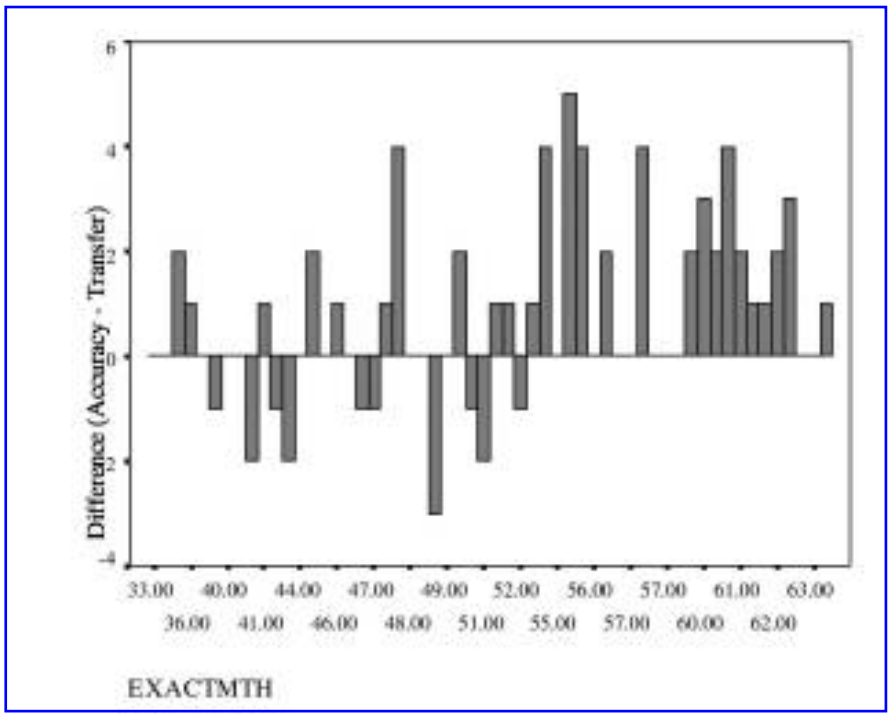

FIG. 1. Difference (accuracy − transfer) by age in months.

more attention to the referent of image than to the actual image itself. The two studies are different in that the children only made a referent by confusing the two objects, or seeing them as the same, but did not make any referent of action or movement to the image. A possible explanation for this difference may simply be a developmental issue in memory, where the older children had better memory than younger children. To clarify this, additional experiments need to be done.

Results from our experiment showed no significant difference between interactive and non-interactive toys, suggesting that interactivity had no effect on the information obtained in the different mediums. It was possible that several factors have contributed to the results. One possibility is how the effect was measured. The effect is measured by using the accuracy and transfer measures, but what determines the score was the information given about the toy during playtime. In this experiment, the information about each toy is intentionally neutral from the toy object itself, to avoid the possibility that children will use perceptual information to respond to the questions. Perhaps this strategy is overly cautious, and may explain the lack of significant effect or relationship of the toy type on the measure. To begin with, there is little if any strong link between the toy type and the content of the information given, which may have contributed to the insignificant result.

The study tests whether overlap in the different mediums contribute to any gaps or inconsistencies in young children. The hypothesis is that the medium would have a significant impact on the retrieval and application on the information of an object across multiple mediums. The results showed that medium was not a significant factor in the accuracy and transfer of information. Several factors may have contributed to this result. One possibility is the way the information was carefully controlled so that there is no link between the environment and the information given. In this study, little emphasis is put on linking the content of the information to the environment, or linking the interaction to the medium. Because the information and interaction is so neutral to the environment, it is not surprising that there is no significant relationship between the two. For transfer to occur, there is a need to create a common situational representation across multiple environments, but from the results, it seemed that that is not enough, and content and interaction may also be a key factor.

Contribution to other areas

Another area of contribution this basic research may have is in designing virtual reality therapy, intervention, and educational applications. Many successful virtual reality therapy applications have appeared for phobia treatment, ADHD, eating disorders, and pain management, but little focus has been made on exploring which specific factor or technology contributes to the success. Finding out whether it is the interactive nature of engagement, the differing dynamic and static environment, or the developmental stage of individuals, can contribute to the design and development of an effective virtual therapy application for specific age groups. The Cyber Therapy Model[10] proposes a model where real life factors and therapy methods are combined with information technology (IT) to create a virtual environment (VE) friendly therapy method. In the model they mention how some Real Life Therapy Methods (RTM) with certain characteristics may need to undergo modification to be VE friendly. The model refers to these characteristics as being either IT friendly or unfriendly. Exploring the impact of different factors (Interactivity, Age, Dynamic/Static environment, Narrative Plot, Presence, Immersion) through basic research can help identify which characteristics are IT friendly/unfriendly, and how one might find a way to modify old methods, or create new therapy methods that are most effective in the virtual environment.

CONCLUSION

Dietz and Strasburger[2] summarized that the effects of television on children's behavior can appear in cognitive development, obesity, aggression, drug use, and stereotyping. These findings have led to the widely accepted premise that children gain knowledge, learn behaviors, and shape their values through media and technology.

Whether in play or study, technology will be used in learning tools at children's schools and home settings. It is important to know whether children relate what they learn to other mediums, for good or bad. This study found that younger children are more likely to assume a similarity across mediums than older children, and that the specific media did not change this pattern. Thus, to prevent young children from confusing media and reality, it will be necessary to find explicit ways to help them mark the differences.

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