

Effects of Violent and Non-violent Computer Video Games on Explicit and Implicit Aggression

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Abstract—The effect of violent media on aggression has always been highly concerned by the public. The effect of violent video game has been studied by researchers for many years, while how the interaction (competition and cooperation) work during video game play is still little known. In present study, the effect of non-violent video games on aggression was tested by experimental design. Participants were assigned to 6 groups to play a violent video game or a nonviolent video game, and he or she played competitively or cooperatively with another participant, or played the game alone. Competitive Reaction Time Task was used to test aggressive behavior. EAST task and SHS scale were used to test aggressive cognition and affect. The results indicated both violent content and competition can arouse aggressive cognition and aggressive behavior. Only violent content can arouse aggressive affect. Cooperation has little effect on explicit and implicit aggression.

Index Terms—Violent Video Game, Competition, Cooperation, Aggressive Behavior, Aggressive Cognition

I. INTRODUCTION.

A. Violent video game

As the development of technology and popularization of electronic products, video game becomes more popular in child and adult. Video games (e.g., personal computer games, on-line games and various small handset device games) have become an important entertainment of our lives. Especially for many adolescents, video games have become an essential part of their life.

Media have important influence on people social aspects and violent media always arouse the public attention. Video game, as a special medium, has a larger effect on people behavior because of its human-machine interaction. In fact, violence with flooding in video games always worries the public. Griffiths (1999) defined 9 kinds of games including sport Simulations, Racers, Adventures, Puzzlers, Weird Games, Platformers, Platform Blasters, Beat 'Em Ups and Shoot 'Em Ups among which the Platform Blasters, Beat 'Em Ups and

Shoot 'Em Ups all belong to violent games, and the first three kinds of games also contain many violent contents. Dietz (1998) pointed out that 80% of the most popular video games were full of violence. In China, the most popular video games such as Counter Strike, Warcraft and Starcraft, all contain many bloodiness, combat, destruction and death.

Many researches showed a large number of the popular games and the most welcomed games are violent ones. Elmer and Dewitt(1993), investigating with sales charts, found out that the top 2 games, Killer Instinct and Mortal Komat, are both violent games. Baidu on-line Game Industry Annual Report, executed by the largest search engine operator Baidu, also demonstrated that the top 3 in 2008 are all combat games.

It is a booming period of game industry since 1995. Players are becoming more and more involved in the games thus the effect of games on the players become larger and larger as a reason of the popularization of on-line games recently, variation of game format, emulation of contents, explicit plots and personal interaction in the games. Nowadays, the on-line games are employing personal interactive mode in form of team combat or competition between players rather than human-machine interaction. Such interaction connects the real and fictional game world, thus the level of the negative effect on players can't be predicted.

The popularization of violent games among the public especially in adolescents cause more public attention on its negative effect. Many researches showed that long time game-play can lead low academic performance and negative behavior. The public began to associate the increase of adolescent crimes with violent games. In fact, the survey indicated violent games can increase players' aggressive behaviors in a possibility of 13% to 22% (Anderson et al, 2000).

B. Effect of Violent Games on Aggression

The hypothesis that the violent media can increase aggression is identified more clearly as the advancement of the social and science researches. The numerous observations and researches studied the relationship between violent game-play and aggression: aggression at school was relevant to the frequency of violent game-play (Lin & Lepper, 1987). Many recent lab

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researches proved that violent games can increase aggressive behavior (Leyens et al, 1973; Russell et al, 2002; Christopher et al, 2008). Researches also found that violent games can increase aggressive cognition, aggressive affect and physical arousal. Lots of studies indicated that violent video games can start aggressive thought (Russell et al, 2002; Nicholas et al, 2007), can lead a higher rivalrous attribution bias which lead person to attribute the world to be a more dangerous environment (Buchman et al, 1996), can change the association between self-concept and aggression (Chen, et al, 2005; Eric, et al, 2004), can increase hostility, irritability, and also can increase heart rate and the blood pressure of players (Steven, et al, 2003; Ballard, et al, 1996). Anderson et.al studied the effect of violent games on aggression and related variables during the past 20 years, and they confirmed the conclusion that violent games can increase aggressive behavior, cognition, affect and physical arousal (C. A. Anderson, et al, 2000, 2001, 2004). Recent studies focus mainly on violent contents and competition.

C. Factors for Aggression: Violent Contents or Competitive Environment

Violent contents refer to destruction, shooting, aggression, bloodiness and death in the games. Competitive environment refers to rivalrous contest or competition in the games. According to Berkowitz's (Russell, 2002) definition, there must be two essential factors for a competitive situation: firstly, there must be two or more teams contest for one reward; secondly, an increase of the reward for one team will lead to a decrease of the reward for another team. Violent contents and competitive situations, as important parts of the games, are both likely to increase aggression.

There are many researches about violent contents. Studies showed larger amount of bloodiness increase aggressive behaviors of game players (Christopher et al, 2008). Anderson's recent study in 2009 also confirmed that the violent content can increase aggression.

Competition is also a probable factor increasing aggression, and researches about competitive situations also have some important conclusions though not many. Anderson (1995) attested competitive and cooperative instructions could affect aggression of different levels. Yet, Anderson's study focused mainly on competitive and cooperative thoughts rather than real within-game competition and cooperation. Russell's study (2002) using non-violent games finding out that subjects competing with computer got a higher aggressive score compared to subjects competing with person certified the effect of competition in games. Different opponents and different competitive situations triggered aggressions of different levels. So competition may be an important variable affecting aggression.

The Frustration-aggression hypothesis, a popular explanation for how competition affect aggression, regards that aggression is a result of frustration. Actually, according to the General Aggression Model (Anderson, 2004), competitive situations will lead to a higher assessment of danger level for the outside environment

or other people, a higher evaluation of aggression, a closer association of self-concept and aggression, a higher enmity towards others, and higher heart rate and blood pressure, compared with cooperative environment. In a word, competitive environment changes the state of aggressive cognition, aggressive affect and physical arousal, thus it increases aggression.

Recently, games involve more and more personal interactions as the popularization of the large-scale on-line games. This study aims at separating violent content and interaction modes (competitive/cooperative) to discuss the mechanisms and effects of violent content and interaction modes on aggression respectively, then the conclusion about which factors in the games really affect the aggression of the players can be made. The goals of this study include whether different interaction modes influence players' aggression, and the mechanisms of these modes in the violent or non-violent games. Thus this study puts forward the following hypotheses: 1) the competitive situation can increase aggressive cognition, aggressive affect and aggressive behavior alone; 2) cooperative situation does not work in non-violent games; cooperative situation and non-interactive situation lead to a low aggression.

II. METHOD

A. Participants

Sixty two male undergraduate students from Beijing Normal University, aged from 18 to 24, participated in exchange for token payment. All of them played video games less than 1.5 hours per day in the past 6 months, with normal or corrected-to-normal vision, without color vision disorder or auditory disorder. Before the experiment, participants were asked to fill Aggression Questionnaire to test their personality trait of aggression. All of them have a low or middle level of aggression personality. An Internet Addiction Scale was also used. None of them was addictive to internet games. Based on their aggression level and self reported skill level of the game used in this experiment, participants were equally assigned to different groups.

B. Design and materials

The study design was a 3(interaction style: competitive, cooperative, non-interactive situation)X 2(game violence: violent, nonviolent) between groups design. Aggressive behavior, aggressive cognition and aggressive affect were tested. Participants were randomly assigned to one of six video game groups: competitive situation, cooperative situation, non-interactive situation in violent or non-violent video game.

A violent video game (Cadillac and Dinosaurs) and a non-violent game (New Tetris) were used. The violent video game has a singles version and a doubles version (shown in Figure 1), and can be played in three ways. In the singles version, participants control one character and try their best to play until the character was beat to death. In the doubles version, each participant controlled one main character, and they were required to play either competitively or cooperatively. Two competitors

competed with each other to gain more props to maintain their lives and get more grades, while two cooperators distributed the props according to demand to maintain both of their lives and gain more grades together. They cooperate well to fight against enemies.

The non-violent game *New Tetris* also met the demand of three interactive situations. In the competitive situation, when one player gains more grades, his opponent's situation will become tough according to the game setting. In the cooperation situation, two participants played one special *Tetris*. Each of them controlled one color of blocks, red or blue ones. They must cooperate well to win the game. In the non-interactive situation, one participant played the most common Tetris as usual.



Figure 1. Singles and doubles version of game Cadillac and Dinosaurs

The Extrinsic Affective Simon Task was used to test implicit aggression cognition. An EAST assessing attitudes consists of attribute stimuli (words carrying a clear valence, colored white) and target stimuli (stimuli of which the attitudes are assessed, colored blue or green). Five positive words and five negative words were selected for the attribute stimuli. Five aggressive words and five non-aggressive words were used for the target stimuli. The frequency counts of the words were controlled.

Competitive Reaction Time Task (CRT): The CRT is a widely used and externally valid measure of aggressive behavior. Participants were told that they were competing with another participant to see who can react more quickly. In each trial, the “loser” would have to receive a burst of white noise set by their opponent. (In fact, it was set randomly by the computer). The “winner” can select the intensity level for their opponent from level 0 (65 dB) to level 9 (110 dB). The intensity selections of each participant were recorded by the computer to measure their aggression behavior. This CRT task includes 48 trials, 24 “win” trials and 24 “lose” trials. However, if the reaction time of a participant was longer than 500ms, he would be justified as a “loser” in this trial.

State Hostility Scale (SHS) was developed by C.A Anderson in 1995, which entails rating current feelings

on 35 adjectives, such as “irritated,” “kindly” (reverse scored), and “mean.” (coefficient $\alpha=0.946$ in this study).

C. Apparatus

All the tasks were completed on 19 inch computers. All gamepads and earphones were of the same type.

2.4 Procedures

Participants were randomly assigned to six groups. The two participants in interactive situation the same skills level of playing the game. The two participants didn't know each other.

Participants practiced playing games for 5 minutes before the task. Participants in interactive situation also practiced how to cooperate or compete. The two games were easy to learn. All of them have learned how to play the game before the experiment started.

Participants of six groups were instructed to play violent or non-violent game competitively, cooperatively or alone. The two participants in competition group were instructed to play against each other. They were told that their game score would be recorded and compared with their opponent. The winner would receive extra reward, while the loser would be punished. For the cooperative group, the two participants were instructed to play cooperatively. They were told that their game score would be plus and compared with other groups. The winning group would receive extra reward, while the losing group would be punished. The two participants in each interactive group were required to play on one screen for them to notice the situation of his partner or opponent. Participants in non-interactive groups were asked to play as well as possible during the game time.

After 20 minutes' game play, participants individually fulfill the EAST task. The EAST task included three blocks. In the first blocks, five positive and five negative adjectives were present in white color, twice for each word. Task in this block was to classify these words by pressing the good key (i.e., key F) or the bad key (i.e., key J) according to the meaning of the words. In the second block, aggression and non-aggression words were presented and they were asked to classify these words according to their color by pressing a good key or a bad key. Each word presented twice and once of blue color and once of green color. From the third to six block, white and colored words were presented together. If the word was white, participants were instructed to press the good or bad key according to the word's meaning. If the word was colored, however, they were instructed to press the good or bad key depending on the color of the word. There were 30 trials for each of the test block. If the participant made an incorrect response, a red cross would appear below the word and it would remain on the screen until the participant gave the correct response. They were asked to respond as quickly as possible on the condition of a high accuracy. Half of the participants were instructed to press the good key in response to words in a blue color and the bad key in response to words in a green color. The other participants received the reversed color response assignments.

Next participants were asked to play games under the prior instruction. After 10 minutes play, they were told that they would play another game with one of the participant in the laboratory. And one of the two participants in interactive groups was led into another room to complete the CRT task. Participants played this “game” according to the instruction on screen. After that, participants fulfill the SHS individually. At last, they were asked why they selected the particular intensities for their opponent during the completion of the CRT.

III. RESULTS

A. Aggressive Behavior

High intensity aggression and average intensity aggression was calculated. Levels 7-9 were recorded as high intensity among the selections from levels 0-9. By counting the total number of high intensities selected by the participant across the 24 “win” trials, high intensity aggression was calculated. By averaging the intensity levels selected by participant across the 24 “win” trials, average intensity aggression was got. The average high intensity aggression and average intensity aggression were shown in Figure 2. It seemed that participants in non-interactive situation in violent game and in competitive situation in non-violent game showed the most aggressive behavior. Participants in non-interactive situation in non-violent game behaved the least aggressively. The results were tested in the following part.

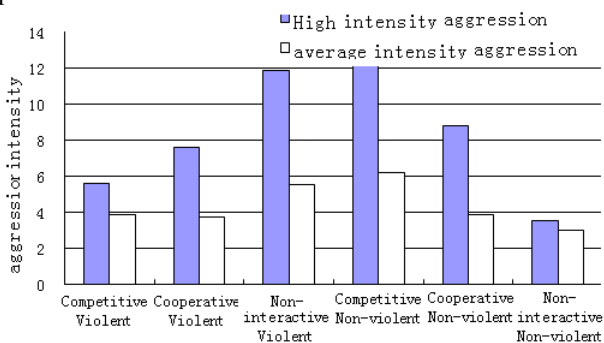


Figure 2. High and average intensity aggression of six groups

We analyzed average intensity aggression by 3(interaction style: competitive, cooperative, non-interactive situation) × 2(game violence: violent, nonviolent) ANOVAS. The main effect of interaction was not significant, $F(2, 52)=0.296, p=0.771$. The main effect of violent content was not significant, $F(1, 52)=0.000, p=0.999$. However, the interaction style × violence interaction was significant, $F(2, 52)=3.382, p=0.042<0.05$, which showed that interaction style acted differently in violent and non-violent games. The interaction effect was shown in Figure 3.

Further simple effect was analyzed. For the violent game, the effect of interaction style was not significant, $F(1, 52)=0.910, p=0.416>0.05$. While for the non-violent game, the effect of interaction style was significant, $F(2, 52)=3.953, p=0.031<0.05$. These results

showed that the effect of interaction style was significant on non-violent game other than violent game. Further post hoc test was conducted among competitive situation, cooperative situation and non-interactive situation in non-violent game, shown in Table 1. As predicted, participants in competitive situation behaved more aggressively than those in cooperative and non-interactive situation.

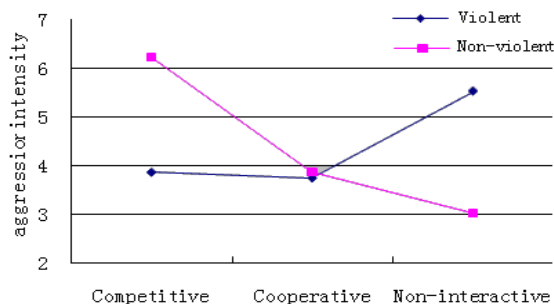


Figure 3. Interaction effect of average intensity aggression

TABLE 1.

POST HOC TEST FOR AVERAGE INTENSITY AGGRESSION OF INTERACTION STYLES IN NON-VIOLENT GAME

	Competitive	Cooperative
Competitive		
Cooperative	2.376*	
Non-interactive	3.216*	0.840

The effect of violence was also different in different interactive situations. For the competitive situation, the effect of violence was significant, $t(18)=-2.235, p=0.038<0.05$, which indicated that the average intensity aggression in non-violent game was higher than that in violent video game. This result was discussed later. For the cooperative situation, the effect of violence was not significant, $t(19)=-0.090, p=0.929>0.05$. It showed that the effect of violence did not affect a lot in cooperative situation. For the non-interactive situation, the average intensity aggression in violent video game was higher than that in non-violent game, while it did not reach a significant level. $t(15)=1.841, p=0.085$.

B. Aggressive Cognition

The test trials on which colored words were presented were analyzed. Only the reaction time and accuracy of the first response were recorded. Reaction times less than 300 ms or more than 3000 ms were recoded to 300 ms and 3000 ms respectively, and reaction times were log-transformed according to Jan De Houwer, 2003. Then we calculated the mean log-transformed reaction time and the accuracy for trials on which an aggressive word was presented and an extrinsically positive response was required, trials with an aggressive word and an extrinsically negative response, trials with a non-aggressive word and an extrinsically positive response, and trials with a non-aggressive word and an extrinsically negative response. We also calculated the EAST scores d for aggressive and non-aggressive words

separately by deducting the mean log-transformed reaction time on trials with an extrinsically positive response from the mean log-transformed reaction time on trials with an extrinsically negative response. A positive *d* showed a positive attitude, and a negative *d* showed a negative attitude. The original reaction times and *ds* of six groups were shown in Table 2. "A" stands for aggressive and "NA" stands for non-aggressive words.

TABLE 2.

REACTION TIME AND *D* FOR AGGRESSIVE AND NON-AGGRESSIVE WORDS OF SIX GROUPS

	N		Positive	Negative	<i>d</i>
Competitive-violent	9	A	808(212)	825(324)	-.0025
		NA	754(110)	791(183)	.0144
Cooperative-violent	7	A	767(211)	717(104)	-.0228
		NA	731(179)	777(271)	.0163
Non-interactive-violent	8	A	722(158)	736(164)	.0066
		NA	643(103)	800(155)	.0922
Competitive-nonviolent	9	A	741(146)	774(133)	.0200
		NA	781(112)	760(130)	-.0131
Cooperative-nonviolent	11	A	755(158)	740(112)	-.0040
		NA	735(187)	808(216)	.0398
Non-interactive-nonviolent	10	A	708(143)	672(133)	-.0214
		NA	630(133)	727(190)	.0584

A 3(competitive, cooperative, non-interactive situation) X 2(violence: violent, nonviolent) X 2(aggressive or non-aggressive) X 2(extrinsic positive or negative response) ANOVA with repeated measures was conducted. The results were shown in Table 3. These results showed that the main effect of stimulus valence was not significant. $F(1, 48) = 3.666, p = 0.061 > 0.05$, which indicated that participants' reaction times to aggressive and non-aggressive words were the same. Participants reacted a little quicker for positive response than for negative response, while it did not show significant difference. $F(1, 48) = 3.666, p = 0.061 > 0.05$. Of greatest interest was the stimulus valence X extrinsic response interaction, which was known as the EAST effect. We can see that the tendency of participants' positive or negative responses for aggressive and non-aggressive words were different. Further analysis was conducted later. The interaction of stimulus valence X extrinsic response X interaction was also significant, which showed that the EAST effects were different in different interactive situations. Further simple effect analysis was conducted later

TABLE 3.

RESULTS OF A FOUR-FACTOR ANOVA IN EAST

Factors	F
stimulus valence	0.072
stimulus valence × violence	0.245
stimulus valence × interaction	0.168
stimulus valence × violence × interaction	0.288
extrinsic response	3.666
extrinsic response × violence	0.065
extrinsic response × interaction	1.371
extrinsic response × violence × interaction	0.877
stimulus valence × extrinsic response	7.686**
stimulus valence × extrinsic response × violence	0.374
stimulus valence × extrinsic response × interaction	3.586*
stimulus valence × extrinsic response × violence × interaction	0.362

The effect of stimulus valence X extrinsic response interaction was shown in Table 4. For aggressive words, the positive response was as quick as the negative response, which indicated that participants' attitude to aggressive words was unclear. They did not regard aggressive words as negative ones. While for non-aggressive words, participants reacted significantly faster when asked to do a positive response than a negative response. This showed that participants' attitude for non-aggressive words was positive. For the interaction of stimulus valence X extrinsic response X interaction, stimulus valence X extrinsic response was known as EAST effect. The simple effect of EAST effect (*d*) X interaction was shown in Table 5. There was a significant difference among three interactive situations for non-aggressive words. A post hoc test was shown in Table 6. The EAST effect in competitive situation and non-interactive situation was significantly different. There was no significant difference between competitive and cooperative groups.

TABLE 4.

EFFECT OF STIMULUS VALENCE X EXTRINSIC RESPONSE

stimulus	Extrinsic Response		T	D
	Positive	Negative		
A	2.866(0.089)	2.862(0.089)	0.375	-0.0038
NA	2.844(0.086)	2.879(0.099)	3.193**	0.0349
T	2.175*	-1.557		

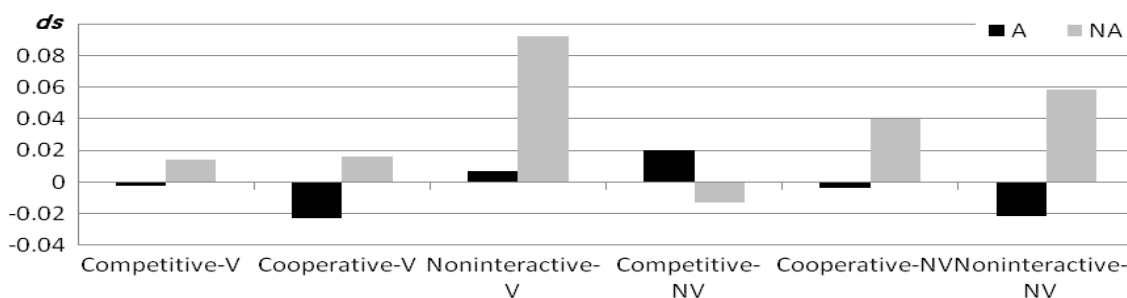


Figure 4. *ds* for aggressive and non-aggressive words of six groups

TABLE 5.
SIMPLE EFFECT OF EAST EFFECT×INTERACTION

	Interaction			F
	Competitive	Cooperative	Non-interactive	
A	.0087	-.0113	-.0090	0.371
NA	.0007	.0306	.0734	4.171*

TABLE 6.
POST HOC TEST FOR D OF INTERACTION STYLES IN NON-VIOLENT GAME

	Competitive	Cooperative
Competitive		
Cooperative	-.02996	
Non-interactive	-.07272**	-.04276

All analyses above focused on participants as a whole. The EAST effects of six administration groups were what we concerned most. The model of EAST effects reflected the implicit aggression of each group. We then analyzed the EAST effect of six groups separately. For the competitive violent group, the cooperative violent group, the non-interactive violent group, the competitive non-violent group, and the cooperative non-violent group, the stimulus valence X extrinsic response interaction was not significant. However, for the non-interactive non-violent group, the stimulus valence X extrinsic response interaction was significant, $F(2, 48) = 19.838$, $p = 0.002$, which indicated the model of positive or negative response for aggressive and non-aggressive words for these participants was different. Compare the non-interactive non-violent group to the other five groups, we can see that the implicit aggression of the other five groups were all changed. Results showed in Figure 4 indicated that, for non-interactive non-violent group, aggressive words were sensed negatively, and to the opposite, non-aggressive words were positively sensed. For the competitive violent group, the non-interactive violent group, the competitive non-violent group and the cooperative non-violent group, the attitude to aggressive words was more positive when compared to the non-interactive non-violent group (baseline). For the competitive violent group, the cooperative non-violent group, and the competitive non-violent group, the attitude to non-aggressive words was more negative compared to the baseline. Comparing non-interactive violent group to the baseline, we can see the effect of violent content in video game. The attitude of players to aggressive words was not so negative. When comparing competitive non-violent with the baseline, we found that the competitive situation changed the attitude to both the aggressive and non-aggressive words. The tendency was just opposite to the baseline. A further t-test showed that non-aggressive words in non-interactive violent group and baseline group was significant, $t(7) = -3.788$, $p < 0.01$ and $t(9) = -3.324$, $p < 0.01$.

C. Aggressive Affect

The SHS grades of six groups were shown in Table 7 (V=violent, NV=non-violent). A 3(interaction style: competitive, cooperative, non-interactive situation) ×

2(game violence: violent, nonviolent) ANOVAS was conducted. The main effect of violence was not significant, $F(1, 52) = 3.281$, $p = 0.21$. The main effect of interaction was not significant, $F(2, 52) = 0.241$, $p = 0.806$. The interaction effect was not significant, $F(2, 52) = 2.012$, $p = 0.143$. A t-test was done for the violent and non-violent group, $t(60) = 0.011 < 0.05$, which indicated that the players in violent video games showed more hostile than those in non-violent video games. A one-way ANOVA was conducted for three interactive situations. $F(2, 59) = 0.358$, $p = 0.701 > 0.05$. The aggressive affect showed no difference among competitive, cooperative and non-interactive groups.

TABLE 7.
MEAN AND STANDARD DEVIATION OF HOSTILITY

	Competitive	Cooperative	Non-interactive
V	95.07(17.91)	78.98(21.23)	87.50(16.24)
NV	67.83(13.75)	75.17(25.44)	78.71(23.18)

IV. DISCUSSIONS

A. The effect of interactive and violent content on explicit aggressive behavior

Violent non-interactive group represents higher aggression level compared to non-violent and non-interactive group. The influence of violent contents is not obvious in competitive and cooperative situation because of the involvement of personal interaction. It can be seen that aggression levels are similar in cooperative situations of violent games and non-violent games, thus the involvement of cooperative factors can dim affection of violent contents, the possible explanation is that players focus more on interaction rather than violence in cooperation mode compared with those in the non-interactive group. Yet violent game group in competitive situation represents lower aggression level compared to non-violent game group of the same situation. The reason of such phenomenon may lie in the differences of the game themes and modes: two players have a third party enemy who is the common attack target in violent games, however, no such third party enemy exists in non-violent games, so the two players' aggression level is high though no direct attack to each other appears. Yet one subject's aggression aims at other subjects in Competitive Reaction Time (CRT) according to the experimental setting, and the target and level of aggression of violent game group both change, which may led to the result above. In one word, violence's influence decreases in cooperative situation, while its influence in competitive situation is still need to be studied.

Interaction has an effect on aggression, which can be demonstrated by the decreasing trend of aggression level from the competitive group, cooperative group to non-interactive group in non-violent games. Thus competitive situation can increase player's aggression which is consistent with Anderson's study employing non-violent games (Super Mary) that competitive

instruction can more easily induce aggression in games compared with cooperative instruction. Yet the effect on implicit aggressive behavior of cooperation is similar to that of non-interactive situation. In violent games, aggression of different interactive situations is not significantly different. We can infer that violent contents have a larger effect on aggression while interaction's influence is minor. So all violent games can increase aggression regardless of interaction modes. Thus influences of competition differ in violent and non-violent games. That is, competition will increase aggression in non-violent games while all violent games can increase aggression whatever modes they took.

B. Effect of interaction and violence on implicit aggression cognition and aggressive affect

Both violent contents and interaction affect aggression. All groups' attitudes towards aggressive and non-aggressive words are almost similar except non-violent-non-interactive game group who regards aggressive words to be negative and non-aggressive words to be positive; or rather, both interaction and violence enhance players' internal aggression, which is similar to Cui's results (2006) using IAT to investigate internal aggression cognition of internet addicts and non-internet addicts. Cui's study shows that compared with non-internet addicts, the internet addicts evaluate aggressive words less negative. Yet the mechanisms of violence and interaction are different: violent contents lead to a more positive evaluation of aggressive words, which may be caused by players' desensitization of aggression while competition affects attitudes towards aggressive and non-aggressive words simultaneously. Besides, the competition leads to a more positive attitude towards aggressive words and a more negative evaluation of non-aggressive words temporally because aggression can be strengthened by rewards and non-aggression such as cooperation and help will harm self-benefits in competitive situation. In a word, both violent contents and competitive situation can affect internal aggression but their mechanisms are different. Interaction between violent contents and competitive situation is more complex thus such interaction needs further discussion.

Violent games arouse higher hostility than non-violent games in terms of aggressive affect, and this result consists with Anderson's studies. However, only the violent game-play competitive group and non-violent game-play competitive group's enmity levels are significant, and reason is that the sample of this study is too small which limits effectiveness and sensitivity of psychological scales. However, out of our expectation, there is no difference among enmities in different interaction modes. Even though some competitions will arouse hostility, it's not always like this. So the effect of competition is not working through hostility

C. Comprehensive discussions

This study separates violent contents and interaction to discuss mechanisms and effects of the two on aggression respectively through employing one violent game and

another non-violent game and setting competitive, cooperative and non-interactive situations. This study also aims at investigating how violent contents and interaction change explicit aggression by Competitive Reaction Time and discusses mechanisms of the two on aggression by analysis of the effects on implicit aggression cognition and explicit aggressive mood.

The conclusion that violent games can more easily arouse aggressive behavior, change aggressive cognition (evaluate aggressive words less negatively) and increase hostility compared with non-violent games can be made by comparing violent non-interaction group and non-violent non-interaction group which can separate the factor of violence, which is consistent with many other researches through attesting effect of violence on external aggressive behavior, internal aggressive cognition and external aggressive mood. The GAM, proving violence can affect aggressive cognition thus leading to desensitization of aggression of players, an increase of hostility and a change of internal state, which all can result in explicit aggressive behavior, is consistent with this study. Yet the deficiency of this study is we didn't take implicit aggression cognition and aggressive affect as moderation thus the GAM can't be demonstrated.

Through comparison between competitive group and non-interactive group in non-violent games by which the factor of competition can be separated, we can come to a conclusion that competition can work alone to affect aggression, and this is the most valuable finding of present study. The competition can increase aggressive behavior by analyzing the results of the two groups. The two groups' attitudes towards aggressive and non-aggressive words are opposite in implicit associate test, and this demonstrates competition can temporally change aggressive cognition which should be paid to more attention than violence. We can see the competition work mainly through aggressive cognition since there are no significant differences between the two groups. Because the measure of frustration in this study is too simple to demonstrate the Frustration-aggression hypothesis, whether competition works through frustration can't be proved. So the further study is needed to find out the mechanisms of it.

The aggressive cognitions of non-violent cooperation group and non-violent non-interaction groups both change when separating the factor of cooperation though the changes are not significant. So cooperation has minor effect on aggression. Thus we can conclude that team cooperation of on-line games can't suppress aggression effectively. This conclusion is valuable in real life.

D. Suggestions for the future studies

Through the previous and present studies, we could find that it is not absolute of violent games arousing higher aggression level than non-violent games in all conditions. Because of involving social and personal interaction, the aggression level will be changed in some extent. The mechanism of violent and nonviolent game on aggression seems more complicated. In the future studies, in the broad view, the social background (e.g.

other violent or related media, violent experience, personality) of video game player, in the narrow view or the lab studies, researchers should focus more on the violent components (separated situations) and different interactive mode among players (e.g. online multiple player interactive condition, or complicated situation interaction with players which are more like the real world in virtual game world) which affect the player aggression and related behaviors. Finally, further studies also need to focus on the cognitive and physiological mechanism of violent and other video games playing. Some studies has been ongoing in our lab, and we will look forward to more related studies will be done by researchers. Video game designers, engineers and producers also should have some social morality and responsibility to avoid negative effect of video game.

V. CONCLUSIONS

According to present study, we can draw the following conclusions: (1). Competitive situation can increase explicit aggressive behavior and implicit aggressive cognition in non-violent video games, but did not cause an increase of hostility. (2). Violent content in video games can cause an increase of aggressive behavior, aggressive cognition and aggressive affect.(3). The effect of competition and violent content was different on implicit aggressive cognition: violent content made the attitude of players to aggressive words not so negative; competition made the players to sense aggressive words more positively and non-aggressive words more negatively. (4). When competition and violent content was both contained in a video game, the violent content contributed more to the increase of aggression. (5). Cooperation had little effect on aggression behavior, especially in non-violent video game. To some extent, it has an effect on implicit aggressive cognition. (6). Not only the violent content, but also the competitive situation should be avoided in video game. Even though there were cooperation situations in violent video game, players' aggression still increased.

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