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Aggression in the Laboratory: Problems with the Validity of the Modified Taylor Competitive Reaction Time Test as a Measure of Aggression in Media Violence Studies

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ABSTRACT. Many laboratory studies of aggression use a measure known as the modified Taylor Competitive Reaction Time Test (TCRTT), for which validation studies are lacking. Using sound blasts administered by the participant against a fictional human opponent, the TCRTT also allows for multiple methods of measuring aggression. The validity of the TCRTT was tested in 53 college student participants. Participants took a self-report measure of aggressiveness as well as neuropsychological measures of frontal lobe functioning predictive of aggression. Results were not supportive of the TCRTT's validity and indicated concerns regarding the use of the TCRTT as a measure of aggression. Results suggest that labaratory studies of media violence using the TCRTT are of questionable validity.

KEYWORDS. Aggression, violence, media violence, neuropsychology, impulse control, mass media

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OVERVIEW

Social science researchers have been interested in the issue of whether violence in the media is a cause of aggressive behavior in humans. Given that violent behavior and violent crime are important for American and other societies, the possibility that media violence may be a culprit offers a tantalizing explanation. Were media violence to prove to be a significant cause of violent behavior, it would follow that control or elimination of media violence may reduce the incidence of violence in our society. Some researchers have expressed concerns regarding the significance of the link between media violence and violent crime (Olson, 2004; Savage, 2004) whereas other researchers (e.g., Bushman & Anderson, 2001) have all but declared the debate on media violence effects complete, with effects on aggression having been conclusively shown.

Concerns about media violence research included unstandardized, unreliable measures of aggression and media exposure, selective focus on positive results while ignoring negative results, broad definitions of aggression, failure to consider causal variables other than media violence, failure to acknowledge weak effect sizes, and lack of external validity for many of the studies involved (Freedman, 2002; Olson, 2004; Savage, 2004). Research on media violence tends to rely on a combination of correlational (e.g., Fling et al., 1992) and experimental (i.e., Anderson & Murphy, 2003) studies. Just as correlational studies are valid only to the degree they consider all possible predictor variables that may explain a

relationship, so too must experimental studies be concerned that their dependent measures are valid indicators of the construct of interest. Although Mook (1983) has argued that external validity is not important for all laboratory research, when scientists attempt to generalize laboratory findings to real life events (as is the case for media violent effects research), external validity of those results and the measures used to generate them is a valid concern. This paper is concerned with experimental studies of media violence and their use of a modified Taylor Competitive Reaction Time Test (TCRTT) as a dependable measure of aggression.

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The Taylor Competitive Reaction Time Test

The original competitive reaction time test (Epstein & Taylor, 1967) involved a participant playing against an "alleged" human opponent, who in reality did not exist. The TCRTT consisted of a number of trials during which the participant was instructed to be faster than his or her opponent in a reaction time test. Before each trial, the participant set an electric shock level for his or her opponent, with the understanding that the opponent would receive that shock as punishment if the opponent lost. Alternatively, the participant would be shocked by their opponent if they themselves lost the competition. There was, in fact, no opponent and the series of wins and losses were standardized as a means of provoking aggression in the participant. Thus the participant is deceived into believing that she or he is playing against a human opponent when in fact there is no opponent.

Studies such as that of Anderson and Dill (2000) and Anderson and Murphy (2003) use a modified version of the TCRTT in which sound blasts are substituted for electric shocks. The procedure is otherwise similar, with noise blasts serving as punishment for losing. These noise blasts can be varied in both intensity and duration, thus producing multiple means of ostensibly measuring "aggression." In media violence laboratory studies, participants are typically randomized to watch media with either violent or nonviolent content. After viewing the media, participants then engage in the TCRTT task. This task is designed to provoke aggression, as their "opponent" appears to be initially quite harsh, selecting the highest possible noise level. Despite claims by Anderson and Dill that this modified TCRTT is "externally valid," the studies used to cite this external validity (i.e., Anderson & Bushman, 1997; Anderson, Lindsey, & Bushman, 1999; Giancola & Chermack, 1998) actually provide no evidence that higher use of noise blasts is associated with any external

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indicator of aggression (such as criminal violence) within individuals. Establishing the external validity of an instrument such as the TRCTT would typically involve demonstrating a statistical relationship between the instrument and target behaviors in the real world, in this case violent behavior within a given sample of participants or other measures that have demonstrated predictive validity for violent behavior. None of the studies mentioned above undertake such statistical approaches. Instead, given that correlational and experimental studies of media violence effects, although undertaken with different samples, produce similar (if weak) results, they suggest this is sufficient to argue in support of external validity. Few clinical measures would be considered sufficient with such limited evidence of external validity. (For a discussion of the conceptual and methodological concerns with laboratory measures of aggression, see Tedeschi & Quigley, 2000).

Related specifically to the modified TCRTT, there is no uniformity in the literature regarding the way that the modified TCRTT is used to measure aggression. Sound blasts are measured in both intensity and duration. However, the varieties of total scores that can be derived are numerous. One could report on either average intensity across all trials, average duration across all trials, average intensity only after wins, average duration only after wins, average intensity only after losses, average duration only after losses, or use some arbitrary cutoff (such as total of all intensity scores of 8 or greater on a 10-point intensity scale). These examples alone provide seven ways to presumably measure aggression using the modified TCRTT. Given that different studies use different means of measurement (for example, see the different methodology employed by Anderson & Dill, 2000 and Anderson & Murphy, 2003), the opportunities for capitalization on chance are numerous. Not unexpectedly, a variety of effects are found for studies using the TCRTT. As noted below, Anderson and Dill found few positive results using averaged intensity and duration after both win and loss trials only (with win and loss trials independent of each other). For the four independent measures of aggression, the overall effect size was $r = 0.06$, with an effect size confidence interval that crossed zero (suggesting that no true relationship exists between the independent and dependent variables in the population from which the sample was drawn). Anderson and Murphy (2003) found a small but statistically significant effect using counted intensity trials of 8 or more out of 10 (regardless of win or loss), whereas Bartholow, Bushman, and Sestir (2006) found a stronger effect using averaged intensity for both win and loss trials.

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No research has been conducted to determine which (if any) of these means of measuring aggression are valid. For example, in their study of video game violence effects Anderson and Dill (2000) employed the average intensity and duration after losses as measures of aggression. They failed to find significant effects for noise intensity or duration after win trials, but they did find significant effects for duration of noise after loss trials (with a mean difference of 0.16 second), although intensity of noise remained insignificant. This study is held up as "proof" of the effects of video game violence on aggression, but as the study failed to find any effects for noise intensity (or duration after win trials), it could just as easily be interpreted as proof that there are not any effects for video game violence, particularly as three out of four measures failed to find significance. It is difficult to conceive of a person attempting to be aggressive by setting a low, calm noise lasting for a very long time. Unfortunately, this subtlety is lost in the way that media violence laboratory studies are discussed in the general population.

Executive Functioning, Frontal Lobe Deficits, and Violent Behavior

A wide body of literature has indicated that deficits in frontal lobe functioning are associated with violent and antisocial behavior (Hare, 1993). This has been found to be true both for mentally ill (Kumari et al., 2006) as well as for non-mentally-ill individuals (Soderstrom et al., 2002). It has been theorized that low cortical arousal in the frontal lobes results in deficits in executive functioning, which in turn limit control of aggressive and violent impulses (Elliot & Mirsky, 2002; Hare 1993). Thus it would be expected that measures of executive functioning would prove capable of distinguishing violent individuals from nonviolent individuals.

Empirical research has supported this conclusion. Mercer and Selby (2005) noted that neuropsychological measures of executive functioning distinguished violent psychopathic male inmates from nonviolent nonpsychopathic male inmates. Similarly, Donovan and Ferraro (1999) found that measures of executive functioning such as the Stroop and the Trails B test distinguished domestic violence perpetrators from a matched sample of nonviolent controls. In each of the above cases, violent individuals performed less well on measures of executive functioning than did nonviolent individuals. As such, given that measures of executive functioning are predictive of violent behavior, it would be expected that valid

laboratory measures of aggressive behavior should demonstrate some correlational relationship with measures of executive functioning. Particularly on an intended measure of provoked aggression such as the TCRTT, poor executive functioning should predict increased aggressive response.

The Current Study

The purpose of the current study is to examine the validity of the modified TCRTT used in media violence research. This will be done by examining the degree to which results on this instrument are associated with other indicators of aggressiveness that already have some form of empirical support for their validity. For example, individuals with high trait aggression should demonstrate greater aggressive response on a valid laboratory measure of aggressive behavior. Furthermore, results on the TCRTT will be examined for their association with neuropsychological indicators of frontal lobe executive functioning and planning. A body of literature has indicated that low cortical arousal in the frontal lobe regions of the brain in particular may be associated with violent behavior (see Hare, 1993 or Brower & Price, 2001 for a discussion). If the TCRTT is a valid indicator of aggression, it should correlate with either trait aggression or with neuropsychological markers of poor executive functioning associated with impulsive aggression.

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METHODS

Participants

Participants included 53 undergraduate students from a public mid-sized university in the Midwest. This sample represents a preliminary sample from a larger study of video game effects. Of these students, 24 (45.4%) were male and 29 (54.7%) were female. Regarding ethnicity, 42 (79.2%) were Caucasian, 8 (15.1%) were African American, and 1 student (1.9%) identified as Hispanic, Asian, and "Other." Students' average age was 20.9 (SD = 3.76) and they had an average education level of 15.2 years of formal education (equivalent to a college junior).

Measures

Trait Aggressiveness

To measure trait aggressiveness, participants completed the Aggression Questionnaire-Short Form (AQ-sf; Buss & Warren, 2000). The shortened

version consists of the first 15 items of the original 34-item version and was designed to measure the degree to which respondents endorse statements about their levels of aggression. Items are responded to using a 5-point Likert scale, ranging from *Not At All Like Me* to *Completely Like Me*, with higher scores indicating more aggressiveness. An example item is "At times I get very angry for no good reason." Based on the normative sample reported in the manual, the AQ-sf obtained an alpha coefficient of 0.90 for the total score. Based on the current sample, this measure demonstrated a coefficient alpha reliability of 0.85. The AQ has been demonstrated to have good predictive validity (Felsten & Hill, 1999) and convergent validity with other measures of trait aggression (Garcia-Leon et al., 2002). It would be expected that a valid laboratory measure of aggression should correlate significantly with this measure of trait aggression.

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Executive Functioning

Executive functioning and planning associated with low cortical arousal in the frontal lobe and aggression was measured using the Stroop Color and Word Test (Golden & Freshwater, 1998). The Stroop presents information to participants in three formats: black and white printed words (red, green, blue), color-hued Xs, and color-hued printed words. Participants are asked either to read the words aloud or state the color of the ink that the words are printed in as quickly as they can. This test measures a participant's ability to select appropriate stimuli and eliminate distraction. Test-retest reliability studies for the Stroop range between 0.70 and 0.89. Low interference scores on the Stroop have been associated with brain injuries including in the prefrontal cortex (Golden & Freshwater, 1998).

The second measure used in this study for executive function is the Trail Making Test Versions A and B (Reitan & Wolfson, 1985). The trails require connecting numbered (Trails A) or interchanging numbered and lettered (Trails B) dots on a page of paper as quickly as possible. These tests are designed to measure attention, mental flexibility, and visual search functions. Numerous studies have reported satisfactory interrater and alternate forms reliability for the Trail Making Test (see Spreen & Strauss, 1998, p. 535 for a full discussion). The Trails tests have been found to be valid indicators of brain damage (Leininger, Gramling, & Farrell, 1990) and frontal lobe deficits (D'Esposito, Alexander, Fischer, McGlinchey-Berroth, & O'Connor, 1996; Lezak, 1983). Measures of

mental flexibility and executive functioning include time score on Trails B as well as the difference between the time score on Trails B and Trails A (referred to below as the executive score).

Intelligence

All participants were assessed for general cognitive ability using the verbal intelligence scale portion of the Wechsler Adult Intelligence Schedule (WAIS; Wechsler, 1997). The testing manual for this cognitive test reports good test-retest and coefficient alpha reliability as well as a number of supportive validity studies for the verbal portion of this test. Elliot and Mirsky (2002) noted that low verbal intelligence is associated with violent criminal behavior, although intelligence tests are likely less sophisticated in predicting violence than tests of executive functioning. This measure is used here as an overall indication of cognitive functioning and it is expected that valid measures of aggression should show some degree of negative correlation with verbal intelligence.

Taylor Competitive Reaction Time Test

This experiment used a modified version of the TCRTT identical to those used in other studies of media violence (e.g., Anderson & Dill, 2000). The TCRTT provides an opportunity for the participant to play a "reaction time game" against a fictional opponent. Participants are asked to set the level of a noise "blast" that will serve as "punishment" for their competitor in a reaction time game. This noise blast can vary both in terms of intensity (loudness) and duration. If they win each trial, their opponent (actually a computer) will hear the noise blast they have set. If they lose, they will hear a noise blast that their opponent (the computer) has set for them. This pattern of wins and losses is preset in the computer, as there is no actual human opponent. As such, participants are initially deceived as to the nature of this task. White noise levels range between 0 and 95 decibels, with the upper limit just over the United States Safety and Health Standards recommendations for *sustained 8-hour* exposure of 90 decibels for full-time workers and well under the pain threshold of 125 decibels. Although the TCRTT is reported to be externally valid (Anderson & Murphy, 2003) the external validity of the TCRTT has never actually been tested adequately within a given sample, for example, correlating outcome on the TCRTT with self-reported violent crime or police reports of violent crime.

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The use of sound intensity and duration after all trials as dependent variables are evaluated in this study, as was the option to use all intensity settings over 8 (out of 10) across all trials, whether for wins or losses. Noise intensity on the TCRTT was measured both by average noise level on all trials and by the sum of all trials (win or loss) in which the intensity setting was 8 or higher. Each of these variations of the TCRTT outcome was correlated with the measures of trait aggression as well as neuropsychological measures of executive functioning and planning. The coefficient alpha for the averaged noise intensity measure was 0.90. For the total intensity over setting 8, coefficient alpha was 0.88. For the average noise duration measure, coefficient alpha was 0.97. Thus all three measure examined in this study demonstrate good reliability.

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Procedure

Students were approached in undergraduate classrooms and asked to volunteer to participate in a research project regarding reaction time and video games. With the consent of the instructor, students were offered extra credit in exchange for their participation. The procedure for this experiment was adapted from those used in Anderson and Dill (2000). Participants who volunteered for this study signed up for a 2-hour appointment time. Student volunteers were given an informed consent form that included a notice that they would be exposed to noise blasts that were below the threshold for pain. The intelligence test, questionnaires, and neuropsychology tests were then administered to them. Prior to testing, participants were informed that they would conclude the session by playing a reaction time game against a human opponent but that they would have no direct contact with this opponent either during or after the session. After testing, participants were provided instructions on completion of the TCRTT and informed (truthfully) that they would be unobserved during the experimental session. After participating in the research study, students were given a thorough debriefing regarding the nature and purpose of the study and invited to ask any questions that they had. All procedures met professional ethical standards for conducting research with human subjects and were approved by the university Institutional Review Board (IRB).

RESULTS

Table 1 presents all correlations between noise and intensity on the modified TCRTT and trait aggression (AQ) and neuropsychological

TABLE 1. Correlation between the modified TCRTT and trait aggression and executive function

	Inttot	Dura	AQ	StroCW	Inter	TrailsB	ExT	WAIS
IntAve	0.92**	0.13	0.39**	–0.03	0.00	0.17	0.16	–0.09
Inttot		0.15	0.32*	0.06	0.08	0.26	0.27	–0.11
Dura			0.05	0.37**	0.32*	–0.32	–0.33*	0.31*

*$p < 0.05$ **$p < 0.01$.

IntAve = Average intensity setting; Intto = Total intensity trials above 8, both following wins and losses; Dura = Average duration; StroopCW = Stroop Color-Word score; Inter = Stroop Interference score; ExT = Trails B – Trails A; WAIS = verbal score on the Wechsler Adult Intelligence Schedule.

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measures of executive functioning. All analyses included 95% confidence intervals for effect size. Effect size confidence intervals that cross zero suggest that an effect, though statistically significant, is not "true" (i.e., a Type I error) in the population from which the sample was drawn. By contrast, an effect size confidence interval that does not cross zero is indicative of a true effect in the population (see Cohen, 1994).

Results indicated that both TCRTT intensity measures were associated with trait aggression scores. Average intensity immediately following all trials was associated with trait aggression, $r = 0.39$, $p \leq 0.01$; $r^2 = .15$, 95% CI: $0.13 \leq r \leq 0.60$. Intensity as measured by total number of trials (win or loss) with an intensity above 8 was also associated with trait aggression, $r = 0.32$, $p \leq 0.05$; $r^2 = .10$, 95% CI: $0.05 \leq r \leq 0.54$. Using a Bonferroni correction for multiple analyses for intensity (with a minimal $p = 0.025$) would render this result for intensity above 8 across all trials as nonsignificant. Neither measure of noise intensity was associated with neuropsychological measures of executive functioning.

Noise duration immediately following all trials was also analyzed. This measure did not correlate significantly with trait aggression. However, it did correlate significantly with neuropsychological indicators of executive functioning. Specifically, duration was associated with the Stroop Word-Color scores ($r = 0.37$, $p \leq 0.05$; $r^2 = .14$, 95% CI: $0.08 \leq r \leq 0.56$) and with Stroop Interference scores ($r = 0.32$, $p \leq 0.05$; $r^2 = .10$, 95% CI: $0.05 \leq r \leq 0.54$), indicating that longer durations were associated with *better* planning and executive functioning. Similarly, the duration score correlated with the Trails B measure ($r = –0.32$, $p \leq 0.05$; $r^2 = .10$, 95% CI: $0.05 \leq r \leq 0.54$), as well as with the Trails executive score (Trails B-Trails A;

$r = -0.33$, $p \leq 0.05$; $r^2 = .10$, 95% CI: $0.07 \leq r \leq 0.55$), indicating that longer noise duration scores were associated with better (faster) performance on Trails B and the trails executive score. Thus, although noise duration scores do correlate with performance on measures of executive functioning, they correlate in the opposite direction than would be expected if noise duration were an indicator of impulsive aggression. Finally, the duration measure was positively correlated with verbal intelligence, $r = 0.31$, $p \leq 0.05$; $r^2 = .10$, 95% CI: $0.04 \leq r \leq 0.54$. As such, participants with higher verbal intelligence used higher duration levels on the TCRTT. Note that none of the effect size confidence intervals cross zero, thus suggesting these effects would appear to be true in the population from which the sample was drawn.

We also analyzed the degree to which these three measures from the TCRTT (average noise intensity, total noise intensity over 8, average noise duration) were associated with each other. If all of these measures were valid measures of aggression, they at minimum should correlate highly with each other. However, only the two measures of noise intensity were correlated with each other, $r = 0.92$, $p \leq 0.01$; $r^2 = 0.84$, 95% CI: $0.87 \leq r \leq 0.95$. Noise duration failed to correlate with either measure of noise intensity. This is a clear indication that noise intensity and noise duration do *not* both measure the same construct.

DISCUSSION

The results from this study have important implications for the use of the modified TCRTT as a measure of aggression. As noise intensity and noise duration do not significantly correlate with each other, it must be acknowledged that noise intensity and noise duration cannot be used interchangeably as equally valid measures of aggression. Thus, it begs the question of which measure is a valid measure of aggression and what sort of aggression.

Measures of intensity garner the best support in this study, as indicated by positive findings for both averaged intensity and total number of high intensity trials. However, when a Bonferroni correction was applied to these analyses, only average intensity attained significance. It should be noted that there is some debate regarding the use of such corrections and whether it is better to be conservative or liberal in their use. In the case of this study, all significant results are reported without Bonferroni corrections, but their potential application is pointed out here as a potential

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decision making tool. As such, average intensity across all trials may be the most valid indicator of trait aggression. No intensity measure may be of particular use in examining impulsive aggression, as these did not correlate significantly with measures of executive functioning. As noted in the introductory section, deficits in frontal lobe functioning, as measured by tests of executive functioning, are associated with violent behavior. One could speculate that the poor correlation between intensity and duration measures may have been due to each of them measuring a different type of aggression (i.e., trait aggression versus impulsive aggression); however, as neither intensity nor duration correlated with executive functioning in the expected manner, there appears to be little reason to believe that this is the case.

In this study, there clearly was no support for use of noise duration as a valid indicator of any form of aggression. Noise duration did not correlate with trait aggression and actually correlated in the wrong direction with measures of executive functioning. Thus, individuals who are better planners and have better executive functioning used longer noise blasts than individuals with poor executive functioning. This is the opposite of what would be expected if noise duration were a valid indicator of aggression. Similarly, longer durations were correlated with higher verbal intelligence. It may thus be that the duration measure is a better measure of thoughtfulness or better impulse control than it is a measure of aggression. This finding has serious consequences for laboratory studies of media violence that find significance only for noise duration and not intensity.

Results from this study are a preliminary indication that the way the modified TCRTT has been used in past studies may be flawed and misleading. Particularly studies that purport a positive relationship between media violence and laboratory aggression using the noise duration exclusively may need to be reconsidered in light of the potentially poor external validity of this element of the TCRTT. Studies that find significance for noise duration only may not be sufficient evidence of a causal link between viewed aggression and aggressive behavior. Clearly, more research needs to be done in order to surmise exactly what it is that noise duration on the modified TCRTT is measuring, as it does not appear to be associated with a propensity for greater aggression.

Even noise intensity needs to be researched with greater scrutiny. It appears from this study that average noise intensity after all trials is the best indicator of trait aggression and that total number intensity settings

above 8 is a weaker measure. As such, the latter measure may need to be discontinued from use in favor of standardized use of the average intensity measure. Studies that have used this weaker measure of aggression should provide a rationale for doing so, as otherwise the concern is raised that results on such studies may be selectively choosing variants of the TCRTT that are most supportive of the research hypotheses and ignoring variants of the TCRTT that are less supportive. Given that media violence studies have relatively small effect sizes (Ferguson, 2002), developing a standardized, reliable laboratory measure of aggression used consistently across all studies may help elucidate whether these reported effects are real or illusory.

The current study should be regarded as a preliminary examination of the modified TCRTT and its validity as a measure (or measures) of aggression. Clearly, more and larger studies need to be done. The current study has a relatively small sample size, but findings from this study argue for the continued need for validity research in regards to the TCRTT and other laboratory measures of aggression. Broader studies and studies examining the validity of the modified TCRTT with the aim of developing a standardized, reliable, and valid version of this instrument would be helpful in moving the field of aggression studies along. It would also be valuable to correlate the modified TCRTT with self-reports of actual violent crime committed as well as police reports of violent crime. Self-report and police report measures each have weaknesses in regards to potential underreporting of actual violent crimes committed, although both should be considered as potential criterion measures for external validity for laboratory measures of aggression. Until such as time as the modified TCRTT has established proper external validity, attempts to generalize findings based on the TCRTT to the external social environment (as is the ultimate goal of media violence studies) may need to be limited.

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