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THE PSYCHOPHYSIOLOGICAL RESPONSES TO SOCIAL EXCLUSION AND AFFECTIVE FILMS

A Senior Honors Thesis

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by

Erik L. Knight

The Ohio State University
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Project Advisor: Dr. Julian F. Thayer, Department of Psychology

Abstract

This research studies the effects of viewing a positive or a negative (violent) film clip on the psychophysiological responses to social exclusion. While previous research has found impressive behavioral overlap between social exclusion and violent media, these two stimuli have not been studied together. Subjects were exposed to either a positive or a negative film prior to being ostracized by a computer-based, social exclusion paradigm. Resulting psychophysiological variables, principally heart rate and heart rate variability, were compared in a between-subjects design. Surprisingly, a task effect ($F(3, 33)=12.86$, $p<.001$) and interaction for heart rate and film type ($F(3,33)=3.690$, $p<.05$) demonstrated that the positive film seemed to have a protective effect on the physiological response to social exclusion, decreasing heart rate compared to baseline measures in this film-viewing group. The underlying dynamics of this cardiovascular response show that the decreased heart rate resulted from an attenuation of autonomic nervous system activity during the social exclusion period.

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Psychophysiological Responses to Social Exclusion and Violent Films

Currently, the separate fields of research on media violence and social exclusion lie at very disparate levels of achievement. The effects of media violence, studied for over half a century and utilizing longitudinal, correlational, and experimental methods, are fairly well understood. Comparatively, psychologists have only in the past two decades begun the much-needed examination of social exclusion and its effects. Although a field of study "still in its infancy" (Williams, Forgas, von Hippel, & Zadro, 2005, p.6), the behavioral responses to social exclusion closely mirror the results of studies of media violence in three key areas: aggression, pro-social behavior, and self-regulation. Additionally, there is overlap in the resulting behavior due to either stimulus' hypothesized effects.

A large meta-analytic review of media research found that exposure to violent media causes an increase in aggression (Bushman & Anderson, 2001). In another review of over two hundred studies, violent media and resultant increases in aggression were associated by a (Cohen's) medium correlation of $r=.31$ (Paik & Comstock, 1994). This correlation is comparable to that of smoking and developing lung cancer and the effects of the consumption of lead paint on children's IQ scores (Bushman & Anderson, 2001). Comparatively, Twenge, Baumeister, Tice, and Stucke (2001) found that socially excluded individuals administered stronger blasts of aversive noise to targets who insulted them as well as to neutral targets. Warburton, Williams, and Cairn (2006) suggest that sense of control over a situation inversely affects the degree to which the excluded individual aggresses.

Social exclusion has also been shown to decrease levels of pro-social behavior. Subjects socially excluded by a prediction of future loneliness were significantly less likely to donate money to charity or to volunteer for future studies (Twenge, Baumeister, DeWall, Ciarocco, & Bartels, 2007a). A media violence experiment found similar results, showing that pro-social behavior decreased, as measured by acceptance of anti-social behavior, following the viewing of a violent film clip (Hansen & Hansen, 1990).

Impulsive acts of aggression, previously discouraged, painful punishments leveled at a “learner,” increased following violence-laden film clips, (Zillman & Weaver, 2007). While not as aggressive in nature, ostracized subjects demonstrated a similar impairment in self-regulation, both in an attention task and in self-regulation of eating behavior (Baumeister, DeWall, Ciarocco, & Twenge, 2005).

Perhaps most importantly, both social exclusion and exposure to violent media have been separately postulated as contributing factors in recent, deadly school violence (Leary, Kowalski, Smith, & Phillips, 2003; Anderson, 2004). Yet even with the overlap of these findings, the interaction between social exclusion and media violence exposure has not been studied behaviorally or physiologically in an experimental setting.

Social Exclusion

Social exclusion, or ostracism, is the ignoring, excluding, or rejecting of an individual or group by another individual or group (Williams, 1997/2007a). Truly a universal experience, people of all cultures, ages, and economic status experience social exclusion. Ostracism has even been documented in a number of species of social animals, including chimpanzees, lions, wolves and bees (Gruter & Masters, 1986). That virtually all human societies and many social animals share the experience of exclusion is indicative of its important evolutionary implications. Historically, for animals (and perhaps early humans) living in groups, ostracism was a mechanism to remove abnormally behaving and non-contributing members, thereby increasing cohesiveness within the group and the evolutionary fitness of the group as a whole (Barner-Barry, 1986; Williams, 1997). Ostracized individuals would often face death unless capable of detecting and combating the imminent social exclusion. As a matter of life-and-death, the detection and response to social exclusion is necessarily a relatively strong alarm response, erring on the side of false alarms (Williams, 2007a; Williams & Zadro, 2005).

Williams (1997, 2001) proposed a two-stage model of the typical response to ostracism which emphasizes the idea of a strong, indiscriminate response. Excluded individuals first recognize their removal from a group in the Reflexive Stage. The immediate reaction essentially involves the detection of pain, a response found in anecdotal and neurological evidence. When interviewed in a clinical setting, many victims of ostracism describe their experiences in terms of physical pain, often specifically citing chest and/or full body pain (MacDonald & Leary, 2005).

While these descriptions of pain may be considered only analogical in nature, ostracism as a form of social pain shares neural correlates with physical pain. Eisenberger, Lierberman, and Williams (2003) found that ostracism increased activation in the dorsal anterior cingulated cortex (dACC) which directly correlated to subjectively reported measures of distress. The dACC is thought to act as the neurological alarm-system and responds strongly to the affective component of physical pain (Kimbrell et al., 1999) and in response to fear-inducing stimuli (Milad, Quirk, Pittman, Orr, Fischl, & Rauch, 2007). The right ventral pre-frontal cortex (RVPFC) mediated this response, showing the most activation in those subjects who reported the lowest level of distress (Eisenberger et al, 2003).

Williams' Reflexive Stage, in particular the decrease in mood ratings and increase in anger and distress which usually accompany this stage (Williams & Zadro, 2005), is relatively inflexible (Williams, 2007a). Underlying personal attributes or preceding situational factors do not seem to alter affective or physiological responses during the initial reaction to social exclusion. Experimental evidence indicates that neither introverts and extroverts (Nadasi, 1992), nor males and females (Williams & Sommer, 1997), differ in their immediate, responses following ostracism. Additionally, trait levels of social anxiety (Zadro, Boland, & Richardson, 2006), loneliness (Williams, 2007b), and self-esteem (Leary, Haupt, Strausser, & Chokel, 1998) did not interact with the immediate responses to ostracism displayed in these studies.

Even in situations in which exclusion by a group would presumably be beneficial, individuals still exhibit negative responses similar to those who are socially excluded without this caveat. Exclusion by out-group members or by members of a despised out-group, in this case an opposing political party or the Ku Klux Klan respectively, did not reduce the reflexive response to ostracism in comparison to exclusion by an in-group (Gonsalkorale & Williams, 2007). Another study indicated that manipulating the economic benefits of social exclusion, by deducting points for every inclusionary action on the part of confederates during a video game-based ostracism paradigm or by redesigning the same game as an electronic version of Russian roulette, still led to the same painful response found in other ostracized subjects (van Beest & Williams, 2007). The results of the neurological ostracism study described above emulate this lack of situational influence. Activation of the neural networks of physical pain occurred in response to seemingly unintentional exclusion as well. In Eisenberger and colleagues' (2003) study, an ostracism paradigm disguised as a computer game "malfunctioned," preventing the subject from participating. Being excluded, even due to this supposed computer malfunction, still activated the same neural networks as being intentionally socially excluded.

Much of the evidence from affective and physiological research of the primary reaction to ostracism consequently points to a powerfully distressing Reflexive Stage which may quickly alert an individual to impending isolation, regardless of personal or situational factors. The second stage of response to social exclusion, the Reflective stage, is comparatively more varied and represents a process of coping with the experience of being rejected socially in the short-term. By the time an individual enters the Reflective Stage, ostracism has already been perceived and experienced. This stage represents the excluded individuals' attempts to regain their thwarted needs through cognitive and behavioral modifications (Williams, 2007a) or to avoid the negative physical and affective ramifications of being ostracized (Twenge, Cantanese, & Baumeister, 2003).

The context in which the social exclusion occurs, as well as preexisting personal differences, determine the resulting course of action for the ostracized person. In this manner, divergent behaviors are seen post-ostracism for different groups of subjects in different situations. The results discussed in the introduction above represent a small tome of experimental work examining negative behavioral responses during the Reflective Stage of ostracism response. To reiterate, Twenge and colleagues (2001) found a strong association between ostracism and increases in aggression. The excluded subjects did not aggress against a confederate who had previously praised the subject (Twenge et al., 2001). Furthermore, increased anti-social behavior due to social exclusion can be diminished by invoking memories of positive, socially-themed memories (Twenge, Zhang, Catanese, Dolan-Pascoe, Lyche, & Baumeister, 2007b).

In one study, females acted pro-socially in their short-term responses to face-to-face social exclusion, working harder on a collective project with the group that excluded them (Williams & Sommer, 1997). Another study found that excluded subjects were more likely to conform by agreeing with a group's incorrect response to a question, perhaps demonstrating a willingness to rejoin the group (Williams et al., 2000). These actions have been delineated as the "tend-and-befriend" response (Williams, 2007a). By behaving more pro-socially, ostracized individuals take steps to re-include themselves in the group that just excluded them.

A third response to social exclusion involves the psychological "freezing" of the individual. In order to avoid thinking about what could be wrong with themselves to incur the ostracism experienced, some socially excluded individuals enter a state of reduced self-awareness (Twenge et al., 2003) accompanied by flat affect and a reduction in cognitive capacity (i.e. reduced performance on tests of intelligence and increased response time in reaction test; Baumeister, Twenge, & Nuss, 2002). Additionally, the activation of the neural networks associated with physical pain (Eisenberger, et al., 2003) has been hypothesized to cause a subsequent decrease in pain sensitivity exhibited by socially excluded individuals (DeWall & Baumeister, 2006).

The differential responses found in these studies seems to be mediated by the perception of which needs are most affected by the ostracism. If self-esteem or belonging (relational needs) are most affected pro-social reactions will help to ingratiate the ostracized individual to the group (Williams, 2007a). Alternatively, anti-social behaviors and thoughts usually occur when a person's existence, recognition, or self-efficacy needs are hindered. If one of these needs is targeted by the social exclusion, the ostracized individual will usually work to re-exert control over the group or, in some cases, over innocent bystanders (Williams, 2007a; Catanese & Tice, 2005). Aside from comparisons of the affective state of suicidal individuals to that of socially excluded individual (Twenge et al., 2003), no research has examined what conditions predict the freezing response.

With the exception of the fMRI study described above (Eisenberger et al., 2003), there is a paucity of physiological research on the immediate and short-term effects of social exclusion. Presumably, psychophysiology could provide an objective analysis of an ostracism victim's experienced distress. Autonomic activation and recovery would be of particular importance, demonstrating the magnitude and duration of the negative effects of ostracism. Most psychophysiological measures of social exclusion study the longitudinal effects of long-term isolation (i.e. loneliness), rather than the immediate effects of ostracism. Socially isolated Swedish women exhibited decreased heart rate variability (HRV; a measure of cardiovascular health discussed below) over the course of a three year study compared to controls (Horsten, Ericson, Aleksander, Wamala, , Schenck-Gustafsson, & Orth-Gomer, 1999).

Other long-term studies of loneliness confirmed these results, with lonely individuals generally displaying poorer levels of cardiovascular health and reactivity (Cacioppo, et al., 2002; Cacioppo, et al., 2000). More recently, Blackhart, Eckel, and

Tice (2007) recorded salivary cortisol, one of three principle stress neurohormones, as an objective measure of stress experienced due to acute social exclusion. As predicted from behavioral data, ostracized individuals displayed a significantly increased stress response compared to non-ostracized individuals.

Media Violence

While social exclusion is a powerful and painful experience for those who are victims of it, violent media equally affects those who subject themselves to it. Violence in mass media is in no way a modern anomaly. Literature from ancient to early modern times is filled with bizarrely violent occurrences. However, the tremendous increase in the number of violent actions and in the overall realism of these events *is* a novel feature of modern mass media (Bushman & Anderson, 2001). As an example, one author estimated that the average American child will witness eight thousand murders and one hundred thousand other acts of violence via mass media before completing elementary school (Huston et al., 1992).

Accordingly, psychologists have devoted much attention to this particular issue. In addition to the experimental evidence described above, specifically that viewing violent media increases aggression and impulsive acts and decreases pro-social behavior, correlational and longitudinal studies have indicated that the increased aggression seen in the laboratory may translate into increased aggression in the real-world (Anderson & Bushman, 2001).

Much like the inflexible, immediate response found when socially excluding subjects (Williams, 2007a), the response to violent film seems to be relatively unaffected by individual variables. For example, the fact that violent media increases aggression has been shown across age, gender (Huesman & Taylor, 2006), and low and high trait levels of aggression (Bushman, 1995). As an exception to the rule, individuals with high trait levels of agreeableness seem to attenuate the aggressive state induced by violent media through the counter-production of pro-social thoughts (Meier, Robinson, & Wilkowski, 2006).

In their General Aggression Model (GAM), Anderson and Bushman (2001) argue that violent films increase aggression when viewers learn and later apply aggressive knowledge stored as memories. Additionally, violent media primes aggressive cognition and increases subjective and physiological arousal. Several studies have subsequently found increased blood pressure and heart rate in response to violent video games (for review see Anderson & Bushman, 2001).

In one of a few recent studies which investigated psychophysiological responses to film, Kreibig, Wilhelm, Roth and Gross (2007) compared cardiovascular measures for two modern, commercial films; one a horror film containing a threatening situation (to induce a fearful state) and the other a melodrama (to induce a sad state). The horror film included "themes of anticipation of immediate bodily injury or impending death by a pursuer and final confrontation with the source of the threat," which certainly can be interpreted as a violent film (Kreibig et al., 2007, p.789). As expected, the violent clip led to increased cardiovascular arousal as measured by a number of psychophysiological parameters. These results replicated a related work which showed that violent films specifically increased psychophysiological arousal via sympathetic nervous system activation (discussed below; Palomba, Sarlo, Angrilli, Mini & Stegagno, 2000).

Much less research has focused on the physiological effects of positive films. One study found that heart rate varied around baseline values during positive film viewing compared to an overall increase in heart rate during a negative film (Hubert & de Jong-Meyer, 1990). Palomba et al. (2000) found that a neutral film clip, which had elicited moderate joy in self-report measures, caused a decrease in HR during the viewing of the film. Other research has found that evoked positive affect correlates with modest increases in heart rate from baseline (reviewed in Ravaja, 2004).

Physiological Variables

Physiologically, this study utilizes modified three-lead electrocardiography (ECG) in order to determine inter-beat interval (IBI), the time in milliseconds between R-spikes of the heart beat. Ultimately, IBI is used to calculate heart rate (HR), the number of heart beats per minute, and heart rate variability (HRV), a measure of the beat-to-beat variation of the rhythm of the heart.

HR itself is the result of dual innervations of the heart by the two branches of the autonomic nervous system: the parasympathetic and the sympathetic nervous systems. In general, the parasympathetic nervous system (PNS or vagal) plays an inhibitory role over the sympathetic nervous system (SNS), essentially governing cardiovascular physiology in an interaction known as vagal dominance (Levy, 1971; Porges, 1992). Along the same lines, the SNS is usually construed as the activator of the cardiovascular system and is associated with the mobilization of energy throughout the body (Thayer & Lane, 2007). In the face of a stressor, the PNS and its inhibitory effects will usually release, allowing the SNS to increase heart rate. HRV then decreases as the adjustments of the PNS, on a millisecond time scale, no longer affect HR. HRV is therefore a measure of the relative contribution of the autonomic nervous system branches to HR.

A highly variable heart rate, or increased HRV, indicates that an individual's autonomic network works efficiently and effectively, responding to the changing environment on a beat-to-beat basis (Thayer & Siegle, 2002). Decreased HRV reflects a relative inflexibility and an inability to respond quickly and appropriately to the environment (Thayer & Lane, 2000), a condition which predicts dire health consequences (Thayer & Brosschot, 2006). In fact, decreased PNS function, and the resulting low HRV, predicts morbidity and mortality by cardiovascular disease (Thayer & Lane, 2007). Also noteworthy to the current study, HRV is associated with self-regulation of behavior and cognitive and attentional control (Thayer & Friedman, 1998; Hansen, Johnsen, & Thayer, 2003). In these cases, HRV is an index of the upper level inhibitory functions of the PFC on both behavior and autonomic activity (Thayer & Lane, 2000).

In view of the literature discussed above, I expected the viewing of a violent film to exacerbate the cardiovascular response to and lengthen the duration of the recovery from social exclusion. Following Williams' model of ostracism, cardiovascular measures were employed to investigate the interaction between affective films and the immediate, reflexive response to social exclusion as well as the short-term, Reflective Stage of ostracism.

Methods

Participants

Forty-nine, college aged (M=19, S.D.=3) undergraduates (F=20, M=17) participated in this research for credit in their introductory psychology class. Two subjects, one male and one female, were excluded from consideration due to pathological cardiovascular data (specifically a heart murmur and severe obesity). Participation was limited to those self-identifying as non-smokers. Additionally, subjects were asked to abstain from caffeine the day of the experiment and were also screened for any history of cardiovascular disease.

Film Stimuli

Films utilized in this study were shown in previous research to elicit specific emotions, namely anger and amusement (Hagemann et al., 1999; Hewig et al., 2005). The film clips chosen for the present research, *Gandhi* (Goldcrest Films International, 1982) for the violent stimulus and *When Harry Met Sally* (New Line Cinema, 1989) for the positive, were shown to be comparable on subjectively rated arousal (see Figs. 1 & 2). Each film segment was approximately two minutes in length. All sound was removed from the film clips (as in the original study) to reduce the potential for music-related responses rather than physiological reactions to violence or affect (Hewig et al., 2005). The clips were presented on the screen of a Hitachi Ultravision 42HDS69 television at a distance of approximately six feet from the participant.

Social Exclusion Paradigm

In order to ostracize participants, this study employed William, Cheung, and Choi's (2000) "CyberBall," a computer game consisting of simple ball tossing (Fig 3A). This social exclusion paradigm is disguised as an online game played with other participants over the internet. Researchers told subjects that CyberBall helped improve mental visualization which would in turn increase physiological responses. In fact, the subjects played against computer confederates programmed to exclude the subject for twenty-six tosses after an initial five or six inclusionary tosses. Subjects played CyberBall on the same television in the testing room through which they viewed the movie with a standard computer keyboard.

As a test of appropriate manipulation, a question, regarding whether the subject felt “included…right now,” was inserted into one of the questionnaires. Additionally, upon completion of the research protocol, but before revealing the deception involved, the experimenter performed a verbal manipulation check. Failure of both of these manipulation checks (i.e., reporting feeling extremely included and disbelief in the social exclusion paradigm) was required in order to discard a subject’s data.

Psychometric Variables

At the conclusion of the research, subjects were asked to fill out several questionnaires. Since anxiety is known to affect cardiovascular measurements, subjects completed the Spielberger State-Trait Anxiety Inventory (STAI; Spielberger & Vagg, 1984) as well as the Beck Anxiety Inventory (BAI; Beck & Steer, 1984). To test whether depressive symptoms, individual differences in loneliness and/or worry affected psychophysiological responses to social exclusion, both the first and second editions of the Beck Depression Inventories (BDI-I and BDI-II, respectively; Beck & Steer, 1984; Beck, Steer, & Brown, 1996), the UCLA-Loneliness Scale III (UCLA; Russell, 1996), and the Penn State Worry Questionnaire (PSWQ) were administered (Meyer, Miller, Metzger, & Borkovec, 1990). The State Self-Esteem Scale (SSES) was issued in order to examine between-subject differences in self-esteem following social exclusion (Heatherton & Polivy, 1991). Similarly, the Offense-Taking Scale (OTS; Sigmon & Snyder, 2006) and the Psychological Entitlement Scale (PES; Campbell, Bonacci, Shelton, Exline, & Bushman, 2004) were used to assess the effect of underlying behavioral tendencies on the subjects' physiological response. The Houston Non-Exercise Questionnaire (HNQ) was administered in order to control for individual differences in physical and cardiovascular health (Jackson et al., 1990).

All questions were presented in black lettering on a light-grey background on the television screen used throughout the experiment, through E-Studio, an experimentation software program. All answers were made by the participant using the standard computer keyboard in the subject room and collected by E-Studio.

Recent research has indicated that women show different cardiovascular reactivity at different stages of their menstrual cycles (Sato, Miyake, Akatsu, & Kumashiro, 1995). In order to control for this effect, female subjects were asked to respond to a simple, demographic questionnaire regarding their menstrual cycle. Subjects were asked when their last menstruation had begun, information which was then used to estimate the current stage of their menstrual cycle.

Psychophysiological Data

Data were collected using the MindWare 2000D (MW2000D) Impedance Cardiograph package. The MW2000D has a built-in 14 bit A/D with a maximum sample rate of 48k samples/second. The MW2000D injects a high precision frequency constant current of 400 micro amps which allows measurement of the impedance across the thorax. The precision electronics then derive and output three signals to be digitized by the USB A/D card. They are the impedance signal (Zo), its derivative (dZ/dt), and ECG. For the purposes of this study I concentrated on heart rate and heart rate variability.

Physiological data were analyzed using the suite of MindWare Technologies Signal Processing Applications. These programs automatically detect artifacts in the physiological signals, but the user can manually choose to delete artifactual data points missed by the correction algorithm. Kubios HRV Analysis software was used to calculate very low frequency (VLF) and low frequency (LF) bands, high frequency (HF) power, heart rate (HR), low frequency to high frequency heart rate variability ratio (LF/HF), and mean IBI.

A priori, HR, IBI, LF, HF, and LF/HF were considered of particular interest to this study. HF is a measure of the pattern of relatively quick changes in IBI which can only be caused by the fast-acting PNS. The LF/HF ratio determines sympathovagal balance by dividing LF, an amalgamated measure of SNS and PNS activity, by HF, a strict measure of PNS activity.

Experimental Design

The independent variable in this study consisted of the valence of the film, specifically either negative (violent) or positive. As a between-subjects design, participants saw only the film appropriate to the film-viewing group to which they were randomly assigned. The dependent variables were the assortment of psychophysiological measures, recorded throughout the experiment. Psychometric data retrieved from various questionnaires acted as covariates in this design. Overall, the experiment consisted of a 4 (baseline, film, social exclusion, recovery tasks) X 2 (positive, negative film) X 2 (median splits for several questionnaires) design.

Procedure

Subjects began by reading a consent form and consenting to research examining the “Psychophysiology of Film Violence.” The experimenter began the protocol by verbally describing the placement of seven (7) silver/silver chloride biosensors on the chest, abdomen and back. Following verbal confirmation of comfort with this process, the experimenter applied the electrodes to the predetermined locations on the subject. The researcher asked each subject for his or her age, height, and weight during this time.

Subjects listened as the researcher read a brief script describing the experiment as a study of the physiological effects of film violence. The researcher informed the subject of the relative level of violence to expect if the subject was placed in the negative film group. The researcher intentionally deceived each subject to believe that following the film presentation, he or she would play a simple computer game with two online players. Subjects were told specifically; “This game will help exercise your mental visualization in order to better visualize the film clip. This will allows us to collect more powerful physiological data.” This level of deception was necessary for effective manipulation of ostracism with the CyberBall paradigm. Finally, the subjects were informed that they were able to leave at any time without penalty. If there were no questions from the subject, the researcher dimmed the lights in the testing room and left the room in order to begin psychophysiological data acquisition.

Each subject then rested for five minutes in order to collect baseline cardiovascular measures. Upon completion of the baseline period, the researcher re-entered the testing room in order to turn on the television. After confirming that the television had in fact turned properly, the researcher began the presentation of the film via Window's Media Player® on the stimulus computer. The films were approximately two minutes in length (M=126, S.D.=2 seconds).

Following the film clip, the CyberBall ostracism game appeared on the screen. As stated above, an instructions screen led subjects to believe they were competing against actual people in an online ball-tossing game. Subjects began CyberBall by pressing "enter" on the keyboard and interacted with the game (i.e. tossed the ball) using keys "1" and "2" on the number pad. The game terminated after the preprogrammed, exclusionary tosses occurred, approximately 103 seconds (S.D.= 4 sec) in length.

A five minute recovery period immediately followed the completion of CyberBall. Subjects were asked to "sit as still and as quietly as possible" through the duration of the resting period. The sequence of questionnaires, preceded by the collection of demographic data, was then presented to the subjects in the following order: UCLA, OTS, SSES, PES, PSWQ, HNQ, BAI, STAI, BDI-I, BDI-II. The first manipulation check of the efficacy of CyberBall occurred during the presentation of the SSES.

The researcher then re-entered the room to disconnect the physiological recording equipment. During the process of disconnection, the experimenter performed the second manipulation check by simply asking, "What did you think about CyberBall?" The study was completed following a thorough debriefing of the actual purpose of the study. Subjects were then asked if they had any questions on the use of deception or on the experiment in general. Subjects were then thanked for their time and escorted out of the laboratory.

The researcher kept timing records for each period of the experiment by monitoring the elapsed time on the physiological data acquisition program. In this way, the start and stop time of each period of the research protocol could be related to specific points on the physiological output.

Data Analysis

The psychophysiological variables were calculated over the specific, but varied time periods in which they occurred. All statistical calculations and manipulations occurred via SPSS 16. Psychophysiological responses were checked for significant task and task by film (between-group) interactions via repeated measures, general linear models. To test for within-group effects of task on the psychophysiological measures, dependent (paired) t-tests were utilized. Outlier analysis consisted of visual inspection for physiological and psychometric data points which occurred at values greater than three times the standard deviation from the mean of the normal curve.

Results

Multivariate testing of within subject effects showed a significant task effect for HR ($F(3,33)=10.893$, $p<.001$; Fig. 4C). In pair-wise comparisons, the mean HR for the film and social exclusion periods, while not significantly different from each other, were significantly decreased compared to baseline ($t(36)=5.043$, $p<.001$; $t(36)=4.194$, $p<.001$, respectively) and recovery periods ($t(36)=2.331$, $p<.05$; $t(36)=2.932$, $p<.01$, respectively; see Table 1B).

The general linear model also revealed a significant interaction between task and film ($F(3,33)=3.030$, $p<.05$). In this case, splitting the mean HR of tasks by film type showed that the positive film-viewing group's HR decreased while watching the film clip in comparison to the baseline measure ($t(17)=8.371$, $p<.001$). Mean HR for the social exclusion task after watching a positive film remained attenuated compared to baseline

($t(17)=3.651$, $p<.01$). A t-test of the recovery period demonstrated further that HR recovered fully when evaluated with the baseline measure (N.S.). As such, the mean HR of the recovery period represented a significant increase compared to the positive film ($t(17)=3.276$, $p<.01$) and the ostracism period ($t(17)=3.266$, $p<.01$). The positive film-viewing group mean HRs for the film and for the social exclusion periods were statistically equivalent (N.S.). Additionally, the HRs for the violent film-viewing group did not differ across periods (N.S.).

IBI, in a GLM multivariate analysis, demonstrated a significant task effect ($F(3)=12.86$, $p<.001$; Fig. 6C) as well as a task by film interaction ($F(3,33)=3.698$, $p<.05$; see Fig. 7C). Pair-wise comparisons revealed that mean IBI for the film and social exclusion periods were significantly increased compared to both the baseline ($p<.01$) and recovery values ($p<.05$). Once again, an ANOVA comparing the two film-viewing groups found only marginal significance in the increased mean IBI associated with watching the positive versus the violent film ($F(1,35)=2.966$, $p=.094$; Table 2B).

Measurements of LF resulted in a significant task effect in the GLM multivariate analysis ($F(3,33)=82.022$, $p<.001$; Table 4B & Fig. 8C). No interaction of task and film occurred, as illustrated by the parallel results for each film type (N.S.; Figure 9C). Similarly, a task effect was found for HF in multivariate testing ($F(3,33)=3.535$, $p<.05$; Table 5B & Fig. 10C). Dependent t-tests showed that HF during the film was significantly increased compared to the ostracism ($t(36)=3.128$, $p<.01$) and marginally larger than recovery ($t(36)=1.865$, $p=.070$). No interactions of task by film were found for HF (N.S.). But splitting the HF by films illustrated interesting trends (Fig. 11C). The differences seen in the task effects of HF were reflected in the positive film ($t(17)=2.782$,

$p<.05$ for film and social exclusion and $t(17)=2.906$, $p=.01$ for film and recovery) but not in the violent film (N.S.). Finally, while both LF and HF demonstrated a significant drop during social exclusion, graphing the two measures together demonstrates the magnitude of the decrease in LF in comparison to the decrease in HF (Fig. 12C)

The GLM for LH/HF ratio showed a significant task effect ($F(3,31)=9.023$, $p<.001$; see Table 3B & Fig. 13C). No interaction between task and film was found for LF/HF (N.S.; Fig. 14C). Dependent t-tests of the LF/HF ratio values collapsed across film types showed that viewing a film and then participating in the ostracism paradigm produced significant decreases in the LF/HF ratio values compared to baseline ($t(36)=3.224$, $p<.01$; $t(36)=2.378$, $p<.05$, respectively) and recovery ($t(36)=2.981$, $p<.01$; $t(36)=5.132$, $p<.001$, respectively).

Analyzing gender, ethinicity, and BMI as between-subjects factors produced no significant interactions (N.S.). Of the psychometric data collected, only the PSWQ was found to significantly interact with task when analyzed with LF/HF ($F(3,30)=4.269$, $p<.05$; Table 15C). It seems that during the film viewing period, individuals who exhibited low levels of worry symptoms demonstrated a decrease in LF/HF, a response that high worriers did not experience (ANOVA: $F(1,35)=5.889$, $p<.021$).

Discussion

Surprisingly, the task effect on HR, collapsed across film types, illustrated a decreased response during the social exclusion period in comparison to baseline and recovery. This result is the exact opposite of the result predicted by the initial hypothesis. By splitting the psychophysiological results by film type, it is clear that the positive film-viewing group drove this decline in HR. Once HR decreased during the positive film, HR remained attenuated during the ostracism paradigm. The violent film group, although not significantly different from the positive film group in independent sample t-tests, did not show this reactivity in mean HR. Instead, the violent film group demonstrated no significant changes in HR between any of the four periods of the experiment.

The attenuation of HR after viewing a positive film can be conceptualized as a protective measure on a person's psychophysiology against what would normally be a stressful social encounter. The positive film's amusing quality, essentially the defining characteristic which makes it "positively" valenced, relaxed the individual physiologically, decelerating the heart. Since the two films were matched for subjective arousal, it must be the valence of the film that leads to this result and not just a comparative lack of stimulation. In sum, this effect on HR implies that the individual who experiences a positively valenced stimulus prior to encountering social exclusion responds psychophysiologically better (i.e., more relaxed) than an individual who experiences a negatively valenced stimulus.

The underlying cardiovascular dynamics present a much less clear picture of the effects of social exclusion. A decrease in heart rate can result from a number of physiological occurrences. Considering the notion of vagal tone though, a slowing of HR usually results from an increase in PNS activity, which inhibits the energy-mobilizing nature of the SNS and causes increased, vagally moderated HRV (which is what HF measures). The subjects' psychophysiology collectively followed this pattern during the film viewing but not during social exclusion. A trend of increased HF occurs from baseline to film. Although not significantly different in HF between groups, the positive film-viewing group exhibited this trend, as determined by dependent sample t-tests. No substantial differences were found in the violent film-viewing group for HF. Coupling this result with the SNS deactivation (decreased LF/HF) seen during the film viewing period again shows the expected response of a dually innervated, vagally mediated heart rate: Applying the physiological “brakes” while releasing the “accelerator” slows the HR.

During the social exclusion period however, the task effects on HF show a significantly decreased activation, indicating a release of PNS inhibition. Facing ostracism, the subjects’ autonomic nervous system reacts through an inhibition of PNS activity. Lacking the inhibitory effects of PNS, HR should have increased for the period of ostracism. But a simultaneous decrease in SNS activity occurred, based on the LF and the LF/HF ratio measurement, which counterbalanced this loss of parasympathetic inhibitory effects on HR during social exclusion (see Fig. 12C). To continue the automobile analogy, social exclusion disengaged both the physiological “brakes” and “accelerator.” It seems that the social exclusion task took the autonomic nervous system offline, with both branches showing attenuated activation. Thus, the decreased HR inherent in watching a positive film carried through to the experience of ostracism for this group, as HR in the violent film-viewing group remained unchanged.

In principle, a psychophysiological response characterized by dual attenuation of the autonomic nervous system branches corresponds to results found in some behavioral and affective studies of social exclusion. As described above, the concussive state felt by some subjects in response to social exclusion included flat affect (Twenge et al., 2003), increased tolerance and thresholds of pain, and emotional insensitivity (Dewall & Baumeister, 2006). The results of this study may be the psychophysiological attendant to this defensive state. Further studies would be necessary to examine individuals for signs of the flat affect in order to complete this connection.

Two problems arise however with the correlation of this physiology to the previous research on non-responding, ostracized individuals. Temporally, this affectively flat state occurs in the Williams' Reflective Stage (Williams, 2007a). As the measures analyzed in the present study occurred during the social exclusion paradigm, the psychophysiology discussed thus far is more appropriately labeled by Williams' Reflexive Stage, the immediate response to ostracism. This does not mean these two results are not related. Just as Zadro, Williams & Richardson (2006) studied how long the effects of social exclusion persisted, future research needs to examine how early the different responses to ostracism are enacted.

In addition, LF is not a very physiologically clean signal, as described previously. When analyzed as in this research, the values that constitute a "low frequency" can often be affected by the normally higher frequency vagal activity. This study cannot definitively state that the decrease found in LF is due specifically to a decrease in SNS. But the lack of an increase in HR and the magnitude of the decrease in LF point to this SNS reaction and, therefore, deserve further study.

The lack of an effect of social exclusion and/or film type on psychophysiological recovery is a bit surprising as well. Research indicates that negatively valenced incidents inhibit cardiovascular recovery (Brosschot & Thayer, 2003). As outlined in the hypothesis, I expected to see such an effect on the psychophysiology of the subjects following social exclusion. No self-report measures existed in this study to test whether subjects felt that the ostracism in the experiment was relatively negative. But, based on the research of social exclusion and specifically of CyberBall (reviewed in Williams & Jarvis, 2006), we can assume that most subjects will perceive the ostracism negatively. Thus, psychophysiological recovery should have been affected.

Yet, when considered in the light of Williams' model of ostracism (1997, 2001), the lack of an effect on recovery, averaged across subjects, may result from the dichotomous nature of the short-term responses to social exclusion. The individual that responds pro-socially will almost certainly have a different psychological experience, and therefore a different psychophysiological recovery, than the individual that responds anti-socially. Unfortunately, this research did not attempt to definitively elicit each subject's psychological response along a pro- versus anti-social continuum. As discussed above, the PES, OTS, and SSES may give a general indication of a subject's tendency to take offense or demand satisfaction in a social situation. This should have allowed a comparison of the individual physiological responses associated with those subjects high in offense-taking, perception of entitlement, and/or low in self-esteem. Alas, no interactions between task and any of these psychometric responses were found.

Future Studies

Based on post-experimental commentary from the participants, the violent films were rated as relatively non-violent compared to what the subjects were used to viewing. A general desensitization to filmed violence may have affected the results of the violent film-viewing group. Presumably, physiological desensitization and subjective desensitization occur concurrently, causing decreased cardiovascular responses to violent content. This may explain the lack of psychophysiological response on the part of the violent-film viewing group on almost every physiological measure studied. Providing an ecologically valid, violent film stimulus may enhance the subjects' psychophysiological responses.

Apart from modification of the film stimulus, an additional change in the duration and magnitude of social exclusion (e.g., a larger ratio of exclusionary to inclusionary tosses in CyberBall) may help augment the physiological response found in this study. Additionally, the development of a social exclusion paradigm which can be used in a within-subjects design would greatly benefit the psychophysiological study of ostracism. As great individual differences exist in physiology, a between-subjects, psychophysiological experiment, such as the current study, suffers from the lack of a comparison of the effect of an independent variable (i.e., film type or film by ostracism interaction) on the same subject's psychophysiology. A within-subjects ostracism paradigm would especially improve the study of comparative measures, such as the effect of different films, on the psychophysiological response.

Finally, it is necessary to develop a more complete psychophysiological model of social exclusion. Since individual responses to ostracism vary, research that looks explicitly at the concomitant physiological states of anti-social versus pro-social reactions will be of extreme interest. A model with this comparison inherent in its design would allow psychologists to predict behavioral responses to social exclusion based on an objectively determined physiological state. Additionally, physiological comparisons of the effect of various situational factors and parameters of social exclusion would be more feasible with such a model.

Fig. 1A Violent film: ***Gandhi*** **(1982)**

Fig. 2A Positive film: ***When Harry Met Sally*** **(1989)**

Fig. 3A Screen shot of CyberBall, an ostracism paradigm (Williams, Chueng, & Choi, 2000). Subjects believed the two players on the left and right of the screen were online players. In actuality, the players were computer confederates which excluded the subject after five to six tosses.

Task * Film: HR in BPM

Film	Task	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Neg	Baseline	75.310	2.383	70.472	80.148
	Film	73.809	2.289	69.162	78.456
	Soc.Ex	73.239	2.148	68.878	77.600
	Ostracism	74.924	2.231	70.394	79.453
Pos	Baseline	72.203	2.449	67.232	77.174
	Film	68.445	2.352	63.670	73.219
	Soc.Ex	69.545	2.207	65.064	74.026
	Ostracism	71.203	2.292	66.549	75.857

Table 1B Task: F(3,33)=10.893, p<.001; Task*Film: F(3,33)=3.030, p<.05

Task * Film: IBI in msec.

Film	Task	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Neg	Baseline	816.368	29.264	756.958	875.778
	Film	831.145	29.128	772.013	890.277
	Soc.Ex	834.762	26.975	780.000	889.524
	Ostracism	821.440	27.739	765.128	877.753
Pos	Baseline	857.425	30.066	796.387	918.463
	Film	903.070	29.926	842.318	963.822
	Soc.Ex	884.843	27.714	828.580	941.105
	Ostracism	866.160	28.499	808.304	924.015

Table 2B Task: F(3,33)=12.286, p<.001; Task*Film: F(3,33)=3.698, p<.05

Task * Film: LF/HF in unitless values

Film	Task	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Neg	Baseline	2.106	.320	1.457	2.755
	Film	1.411	.212	.980	1.842
	Soc.Ex	1.317	.253	.803	1.831
	Ostracism	1.963	.247	1.462	2.464
Pos	Baseline	1.622	.320	.973	2.271
	Film	1.064	.212	.633	1.495
	Soc.Ex	1.526	.253	1.013	2.040
	Ostracism	1.874	.247	1.373	2.376

Table 3B Task: $F(3, 32)=9.023$, $p<.001$; Task*Film: N.S., $p=.197$

Task * Film: LF in log units

Film	Task	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Neg	Baseline	7.172	.163	6.841	7.504
	Film	6.654	.220	6.208	7.101
	Soc.Ex	4.659	.260	4.131	5.188
	Ostracism	7.302	.183	6.930	7.674
Pos	Baseline	7.202	.168	6.862	7.543
	Film	6.861	.226	6.403	7.320
	Soc.Ex	4.715	.268	4.171	5.258
	Ostracism	7.142	.188	6.760	7.524

Table 4B Task: $F(3,33)=82.022$, $p<.001$; Task*Film: N.S., $p=.416$

Task * Film: HF in log units

Film	Task	Mean	Std. Error	95% Confidence Interval Lower Bound	Upper Bound
Neg	Baseline	6.645	.231	6.176	7.115
	Film	6.716	.209	6.292	7.140
	Soc.Ex	6.584	.216	6.146	7.021
	Ostracism	6.735	.223	6.283	7.188
Pos	Baseline	6.956	.237	6.474	7.438
	Film	7.044	.215	6.609	7.480
	Soc.Ex	6.744	.222	6.294	7.194
	Ostracism	6.741	.229	6.277	7.206

Table 5B Task: F(3,33)=3.535, p<.05; Task*Film: N.S., p=.130

Task * PSWQ: LF/HF unitless ratio

PSWQ	Task	Mean	Std. Error	95% Confidence Interval Lower Bound	Upper Bound
Lo	Baseline	1.812	.319	1.163	2.461
	Film	.870	.182	.499	1.240
	Soc.Ex	1.399	.247	.896	1.901
	Ostracism	1.881	.246	1.380	2.381
Hi	Baseline	1.935	.360	1.201	2.670
	Film	1.767	.206	1.348	2.186
	Soc.Ex	1.560	.279	.992	2.128
	Ostracism	1.978	.278	1.412	2.545

Table 6B Hi and Lo PSWQ scores determined by median split. Task*PSWQ: F(3,30)=4.269, p<.05

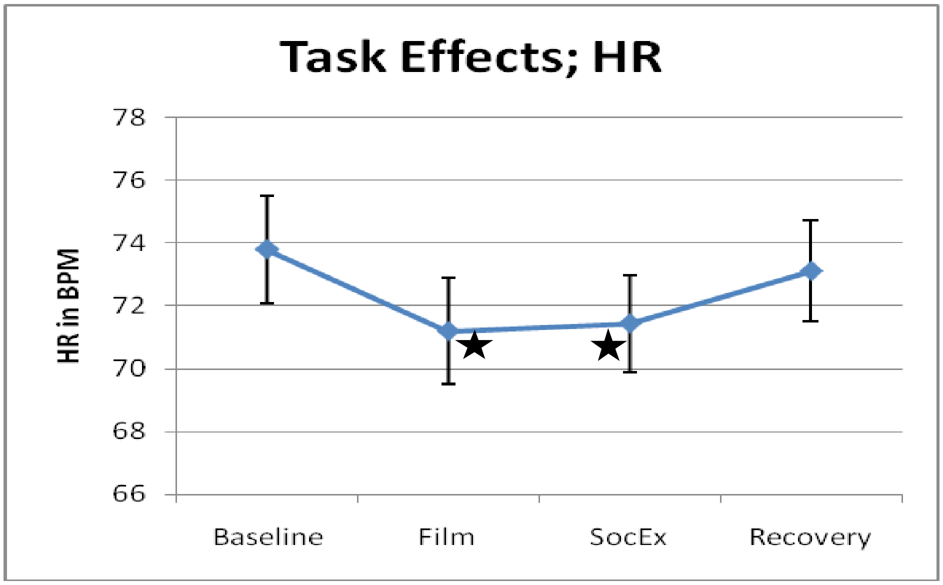

Fig. 4C Task Effects on HR: Film and SocEx were significantly different from Baseline (t(36)=5.043, p<.001; t(36)=4.194, p<.001, respectively) and Recovery (t(36)=2.331, p<.05; t(36)=2.932, p<.01, respectively) but not from each other.

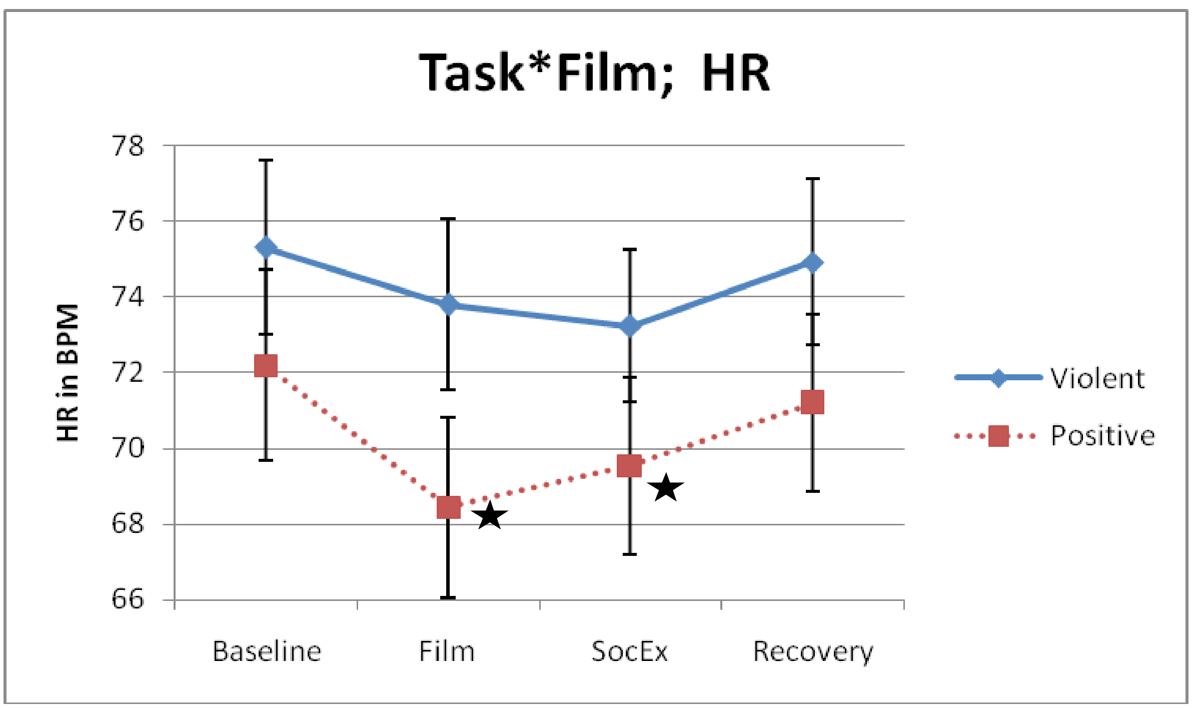

Fig. 5C Task*Film interactions on HR (F(3,33)=3.030, p<.05): Mean HRs for the film (t(17)=8.371, p<.001) and social exclusion periods (t(17)=3.651, p<.01) were decreased significantly for the positive film-viewers

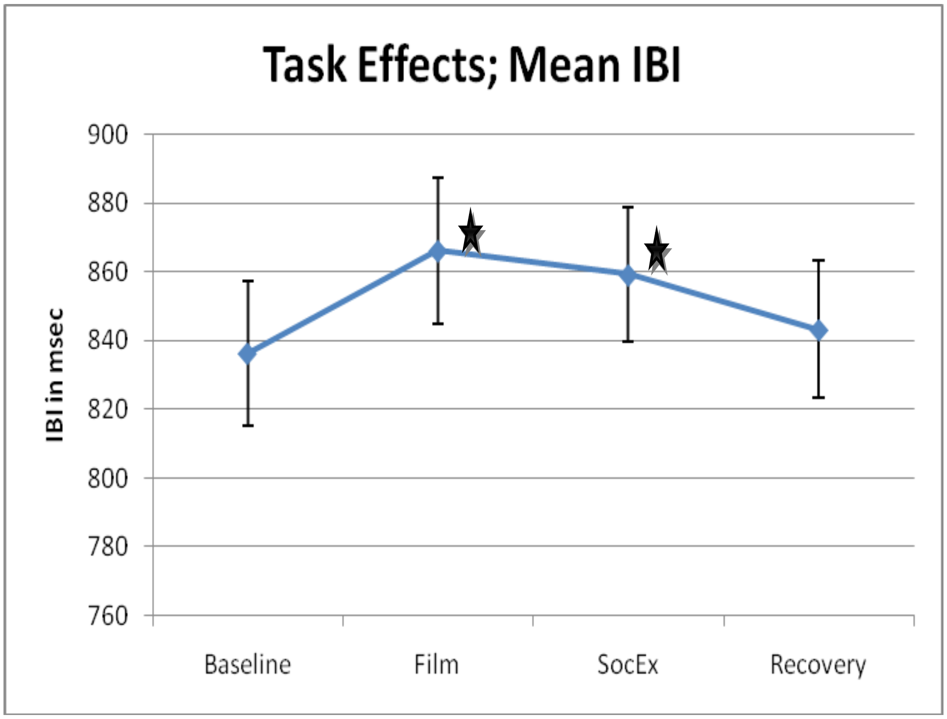

Fig. 6C Task Effects on IBI (F(3)=12.86, p<.001): Film and social exclusion IBI were higher than baseline (p<.01) and recovery (p<.05).

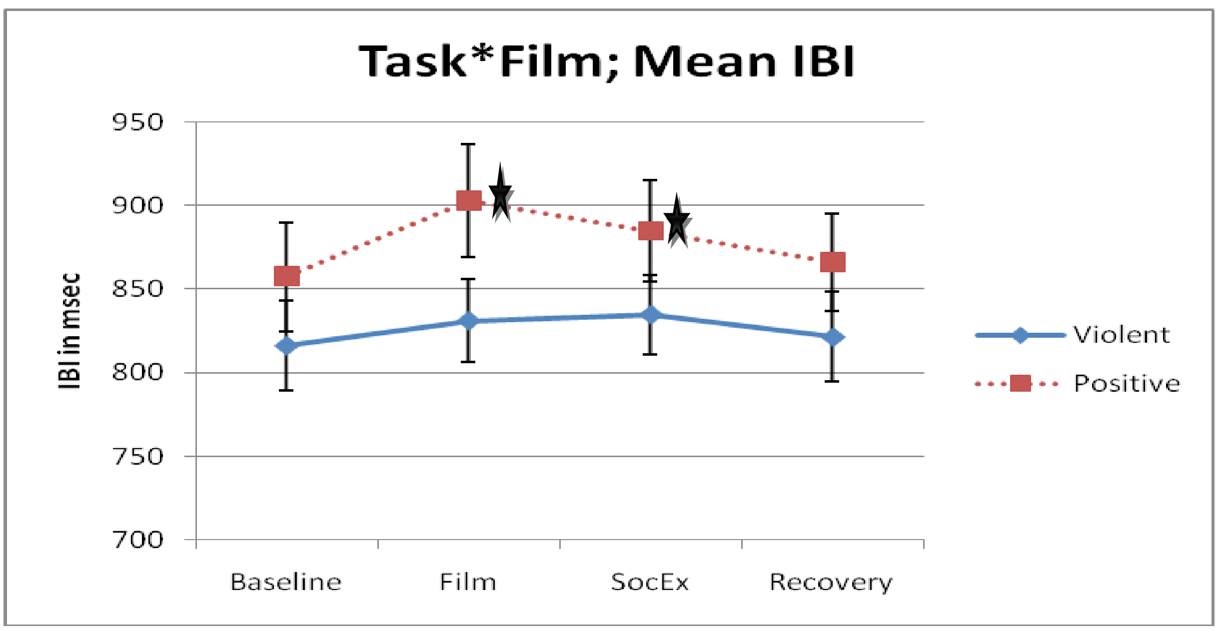

Fig. 7C Task*Film interactions on IBI (F(3,33)=3.698, p<.05): Only the positive film was marginally different between the two film groups (F(1,35)=2.966, p=.094).

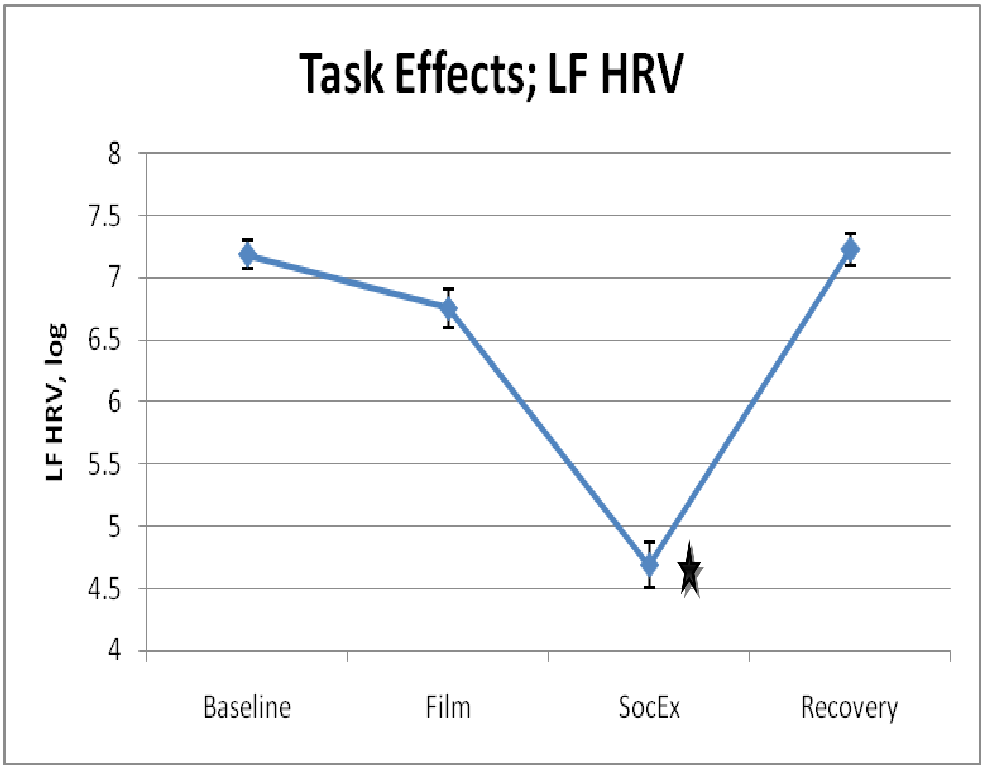

Fig. 8C Task Effects on LF HRV **F(3,33)=82.022, p<.001): Social exclusion was significantly different from the other three periods (p<.05).**

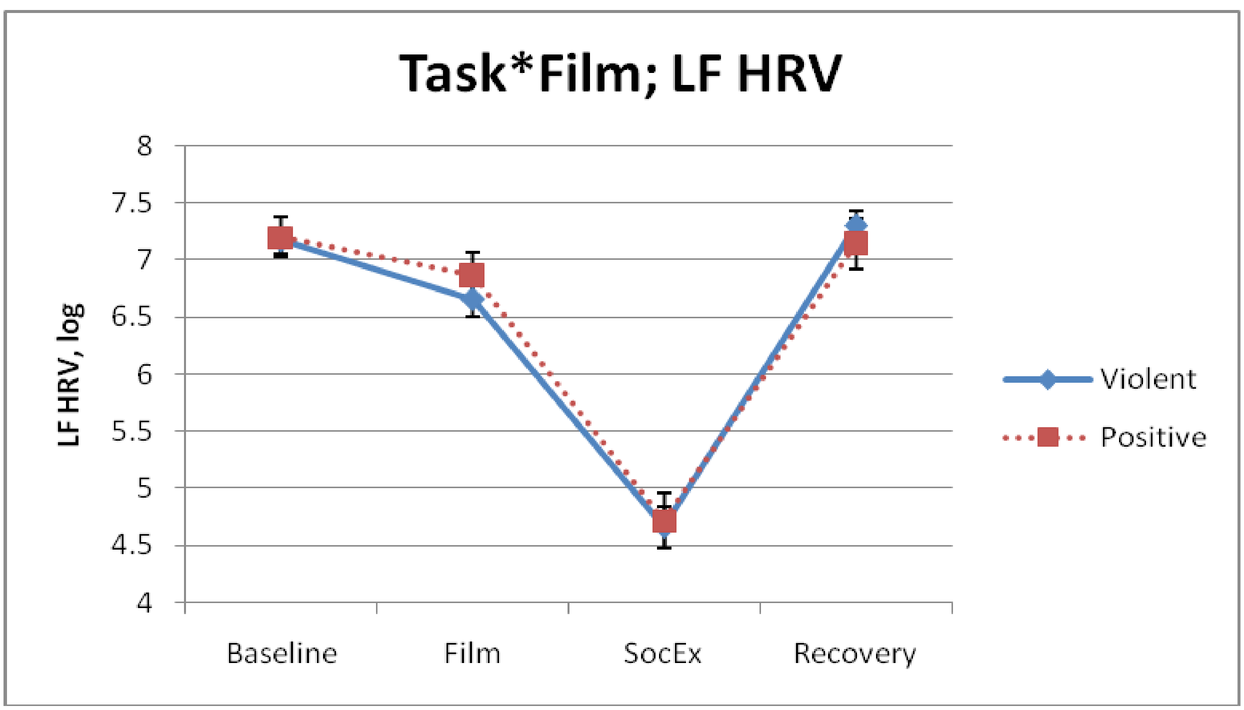

Fig. 9C Task*Film interactions on LF HRV: N.S.

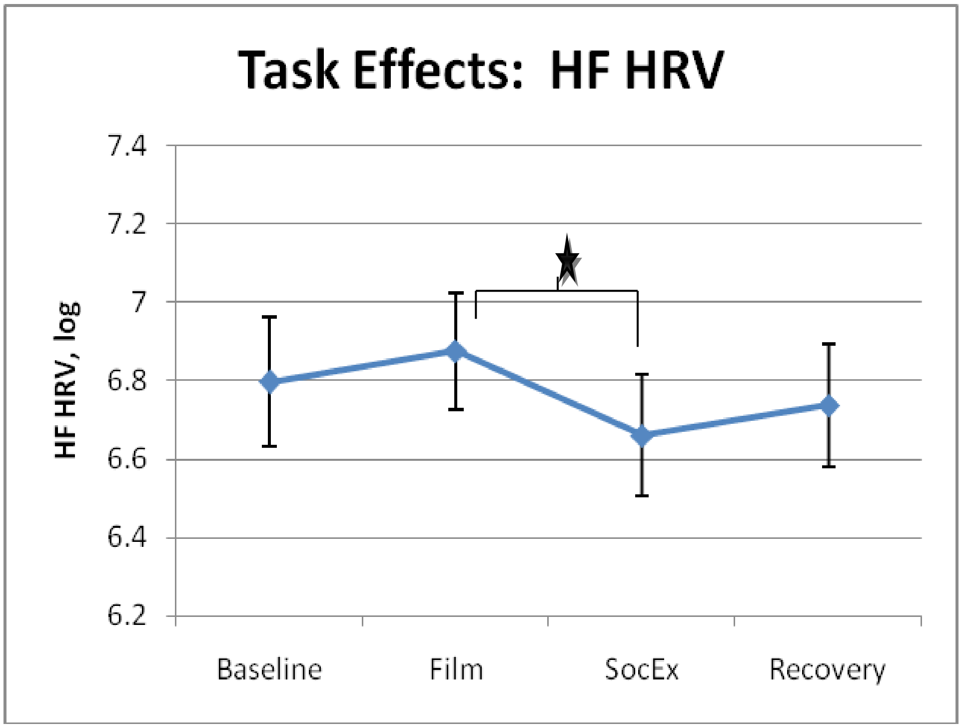

Fig. 10C Task Effects on HF HRV F(3,33)=3.535, p<.05): Film was significantly increased compared to social exclusion (p<.01)

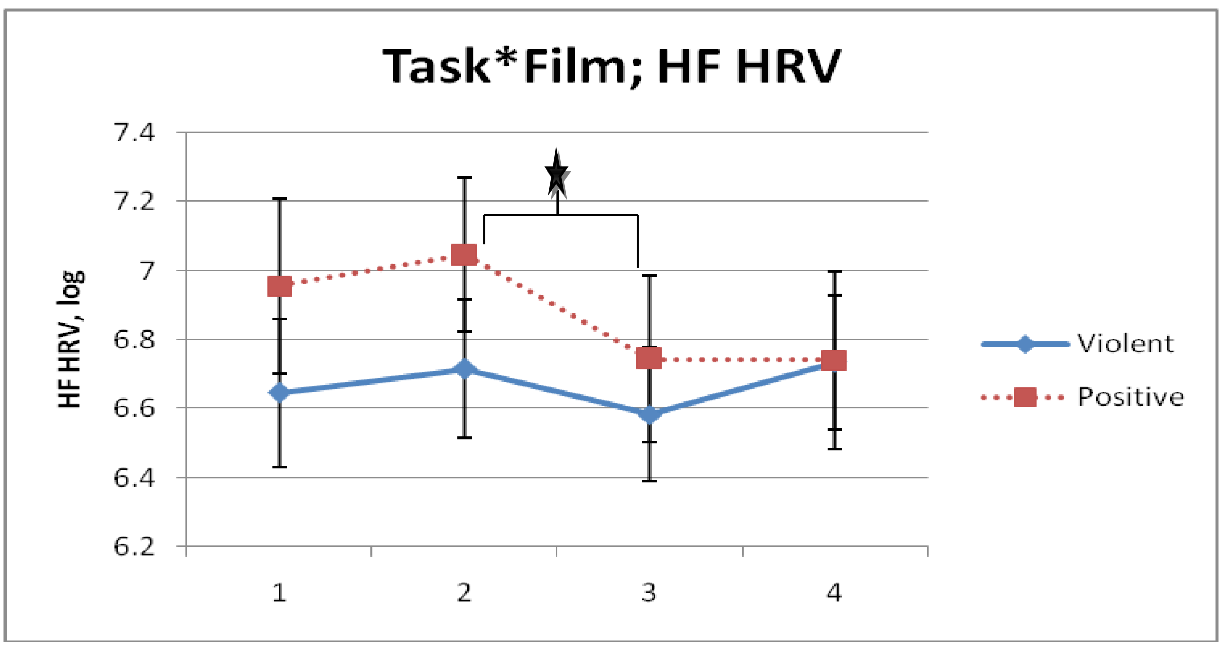

Fig. 11C Task*Film interactions on HF HRV (N.S.): Violent showed no significant differences. Positive film period HF was larger than social exclusion (p<.01) and marginally greater than recovery (p=.070)

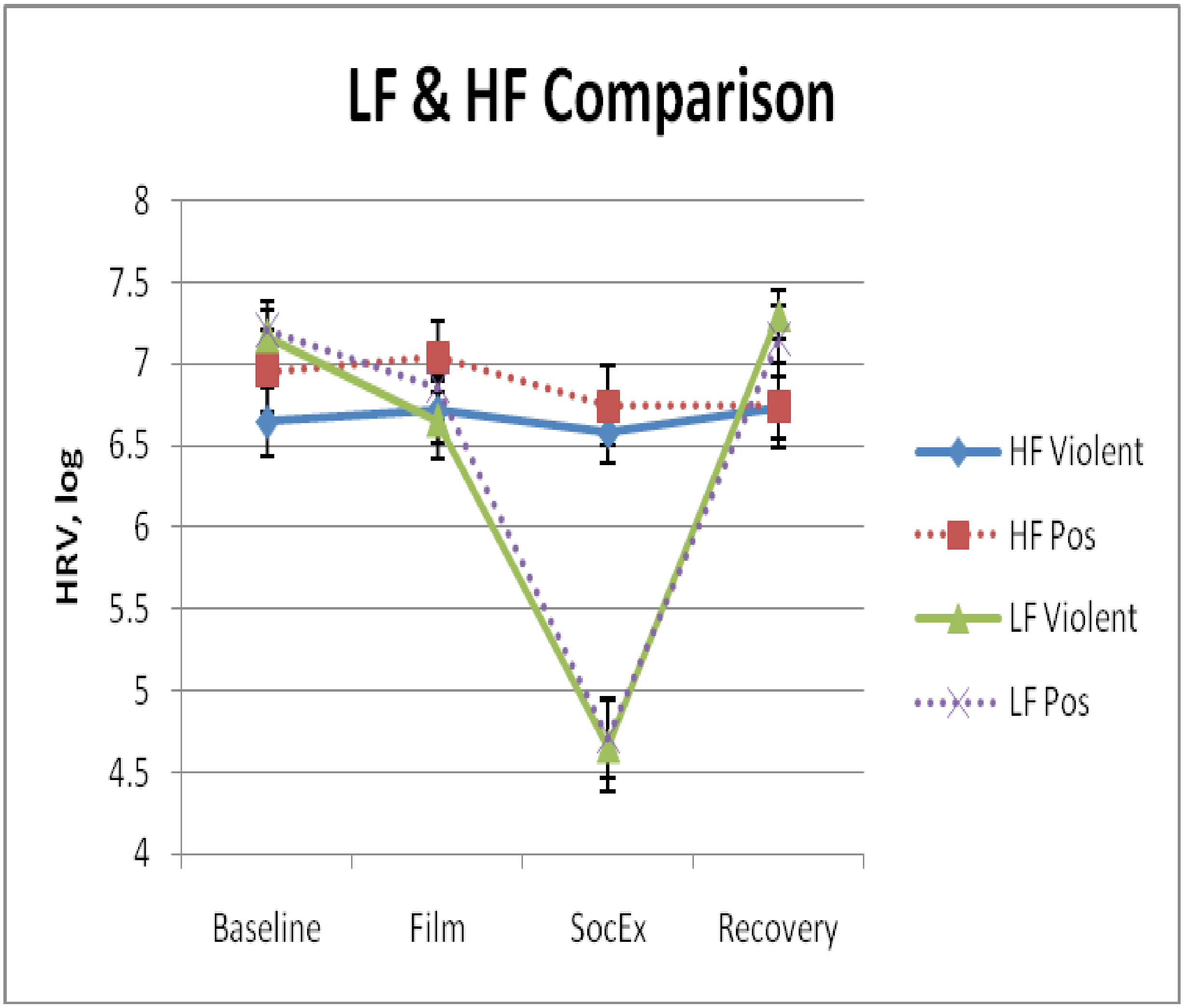

Fig. 12C Comparison Task*Film interaction on LF and HF HRV.

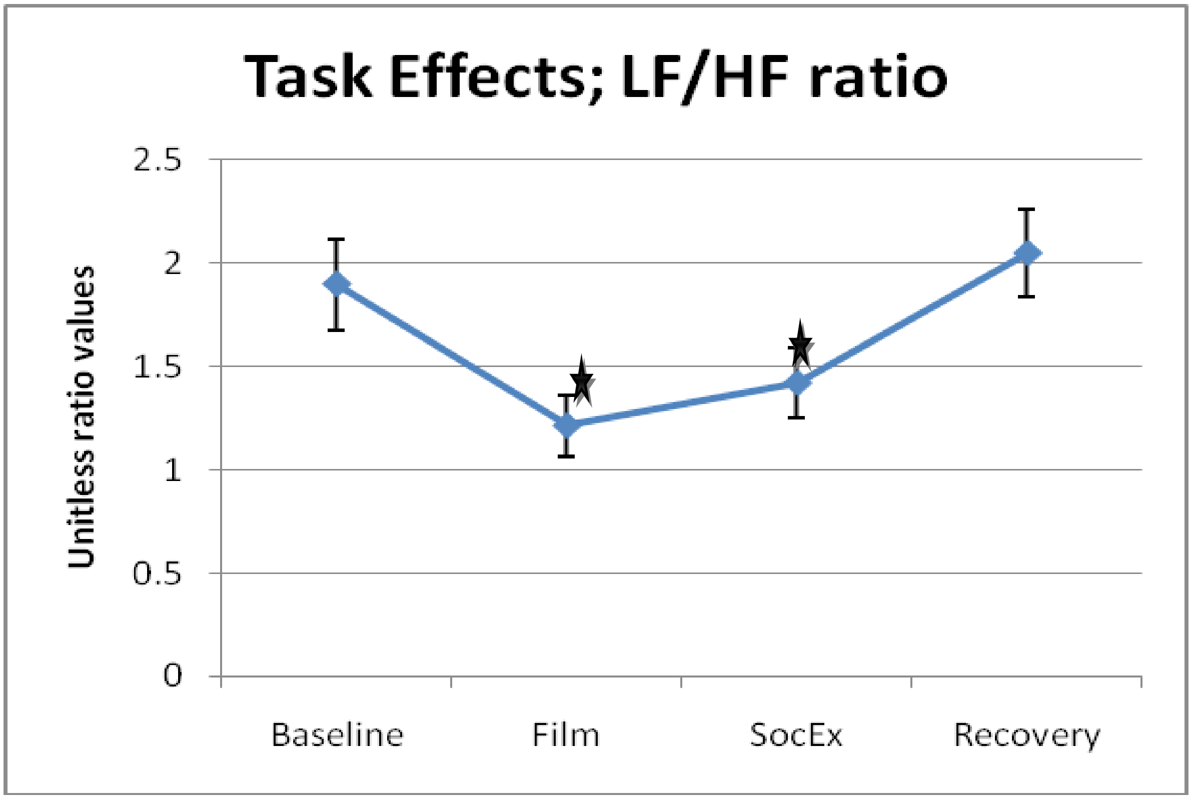

Fig. 13C Task Effects on LF/HF ratio (F(3,31)=9.023, p<.001): Film and social exclusion were significantly reduced compared to baseline (t(36)=3.224, p<.01; t(36)=2.378, p<.05, respectively) and recovery (t(36)=2.981, p<.01; t(36)=5.132, p<.001, respectively).

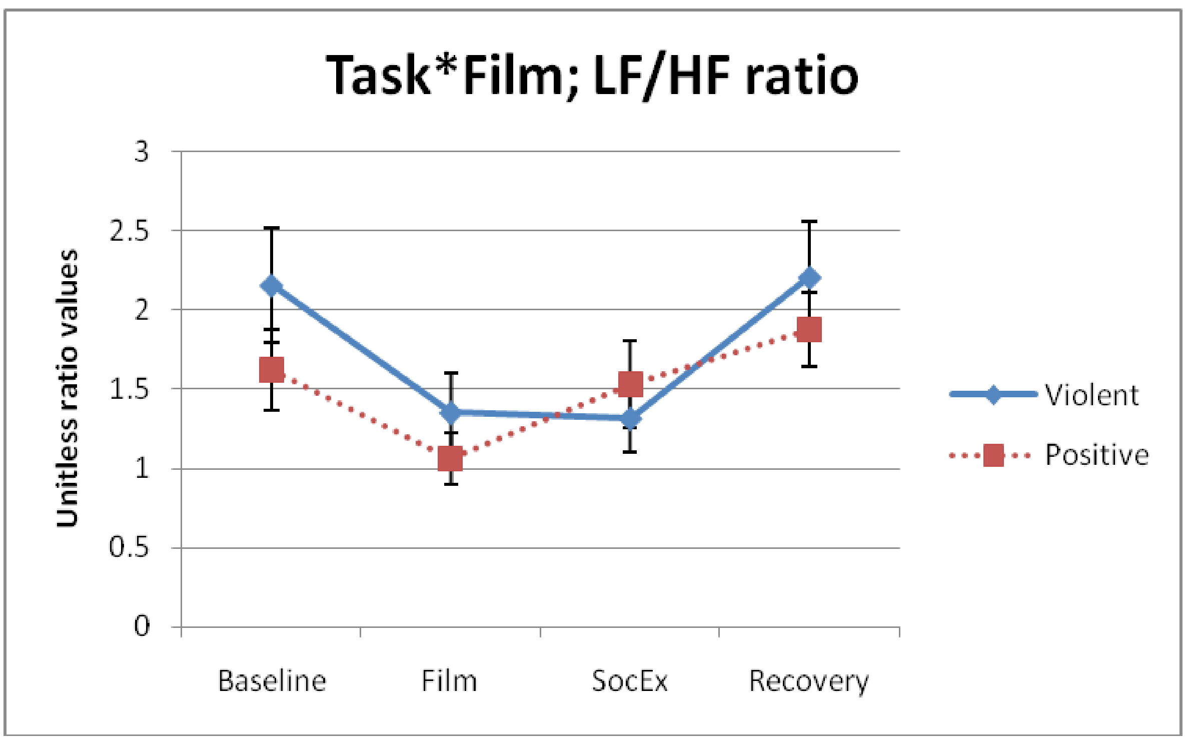

Fig. 14C Task*Film interactions on LF/HF ratio (N.S.)

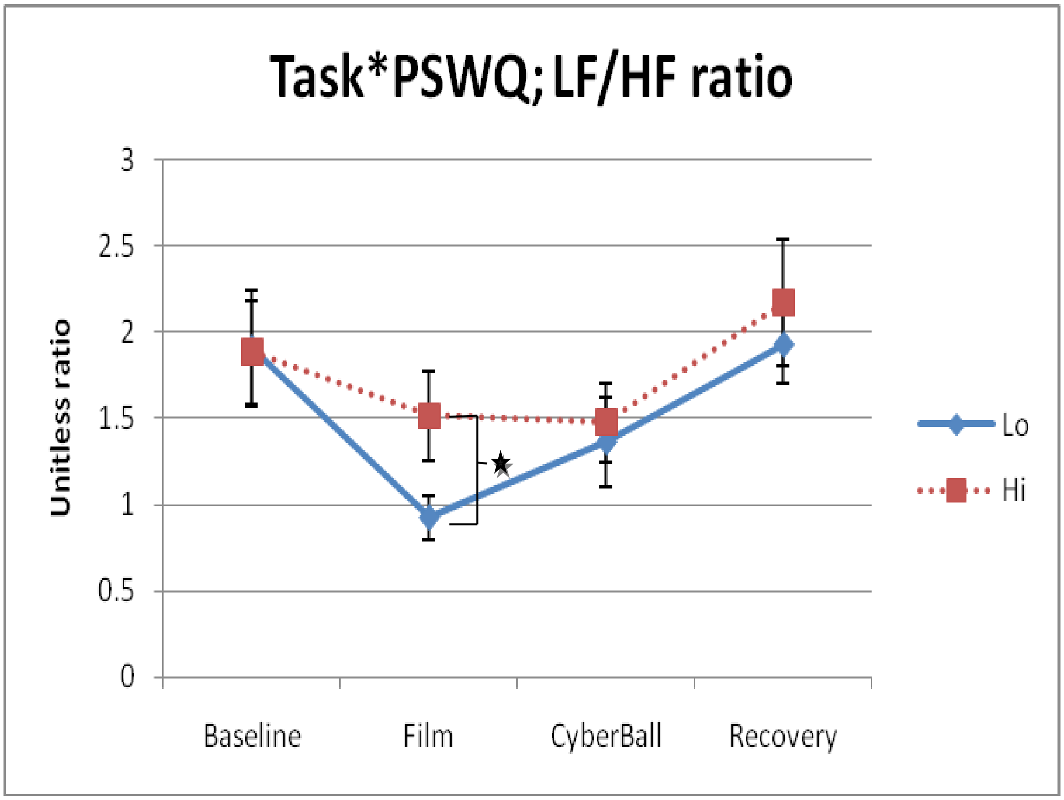

Fig. 15 Task*PSWQ for LF/HF ratio (F(3,30)=4.269, p<.05): ANOVA showed that low worriers exhibited a decreased LF/HF ratio (F(1,35)=5.889, p<.021).

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