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NAME: Gina Gilpin

SIGNATURE: 

STUDENT NUMBER: GLPGIN001

SUPERVISORS NAME: Gosia Lipinska

Eliciting and Measuring Physiological and Subjective Responses to Sadness:

A Comparison Between VR, Film, and Text

Gina Gilpin
ACSENT Laboratory
Department of Psychology
University of Cape Town

Supervisor: Gosia Lipinska

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Abstract

Emotion is a complex construct which plays a crucial role in our everyday lives. Sadness, alongside other emotions, has been found to play an adaptive role in our lives by facilitating social attachment and empathic responding. However, dysregulation of emotion can result in maladaptive behaviours that underpin conditions like Major Depressive Disorder. Therefore, insight into the physiological systems that govern sadness is an important step in understanding how and why these systems become dysregulated. However, research has consistently struggled to elicit naturalistic emotions in a laboratory context, and often report discrepant results regarding the physiological correlates of emotions. Virtual Reality (VR) has been identified as a potential solution to these problems. A main factor which has been found to influence VR is presence. Presence is the degree to which mediated environments successfully construct true-to-life stimuli. Prior research has shown that as presence increases so does the intensity of the target emotion. However, existing research which employs VR as an emotion elicitation method is limited. Therefore, this study attempted to fill the gap in the literature by investigating whether an emotive film, story or VR experience would elicit differential patterns of physiological reactivity and subjective responding. The study recruited undergraduate university students (N = 60; aged 18-25 years) and exposed them to either a story, film or VR condition depicting the same sad event. During the experiment, participants' subjective and physiological responses were collected. The results confirmed that the three conditions successfully elicited the discrete emotion of sadness. However, film was the most effective in evoking sadness, whilst VR elicited the highest level of arousal. Moreover, VR had the highest levels of self-reported presence, followed by the film and the story conditions. Therefore, whilst presence was not significantly associated with emotion intensity, it was positively correlated with arousal. These results suggest that the VR may elicit more *activating* patterns of sadness; whereas the film and story condition elicited more *deactivating* patterns of sadness.

Keywords: virtual reality; emotion elicitation; presence; heart rate; skin conductance level; respiratory rate; respiratory sinus arrhythmia; sadness.

Eliciting and Measuring Physiological and Subjective Responses to Sadness: A Comparison Between VR, Film, and Text

Emotions are transient, multifaceted experiences which are evoked as a result of an internal or external cue, the saliency of which is individually determined, and unfolds through an interconnected series of physiological responses, subjective sensations and expressive behaviours (Ekman, 1992; Barrett, Gendron, & Huang, 2009; Fernández et al., 2012). Despite decades of research into the psychophysiology of emotion, there has been no consensus as to the specific autonomic patterns of emotion (Kreibig, 2010; Mauss & Robinson, 2009). These discrepant findings could be explained by, (a) the use of different emotion induction techniques across studies (McGinley & Friedman, 2017), (b) the use of different measurements across studies (Kreibig, 2010), (c) varying autonomic activation based on subtypes of emotions (i.e. loss versus failure as subtypes of sadness) (Kreibig, 2010; Shirai & Suzuki, 2017) (d) or alternatively, the current laboratory-based emotion elicitation techniques may not adequately elicit naturalistic emotions (Quigley, Lindquist, & Barrett, 2014; Uhrig et al., 2016).

The advancement of VR may provide a method of emotion elicitation which closely imitates the complexity and variability of real world emotional reactions without compromising experimental control (Quigley, Lindquist, & Barrett, 2014). Previous studies have shown that VR elevates feelings of presence, the subjective perception of "being there" (Makowski, Sperduti, Nicolas, & Piolino, 2017); and higher levels of subjective presence have been associated with enhanced emotional experiences (Lessiter, Freeman, Keogh, & Davidoff, 2001). However, this research is still relatively new and there remains limited empirical evidence to support the theoretical benefits of using VR in psychological research.

Conceptualizing Sadness.

Sadness is typically experienced as feelings of loneliness, rejection and helplessness, which as Kreibig, Wilhelm, Roth, and Gross (2007) suggest, might reflect a neurobiological reaction that helps facilitate and maintains group attachment and may prompt empathic responses. This is consistent with Panksepp and Biven (2012) conceptualization of sadness as a characteristic of separation anxiety, loss and grief, which positions sadness as an important factor for social attachment. Furthermore, dysregulation in sadness has been associated with various conditions, like major depressive disorder and bereavement (Lokko & Stern, 2014). Therefore, sadness also plays a crucial role in adaption (Kreibig et al., 2007). Although the importance of understanding psychological and physiological constituents of sadness has been demonstrated, research has consistently struggled to develop reliable methods of emotion elicitation in laboratory settings (Kreibig, 2010; Mauss & Robinson, 2009; Lindquist & Barrett, 2008).

Different Emotion Elicitation Methods.

Numerous induction methods have been developed in an attempt to elicit naturalistic emotions within laboratory settings (Gross & Levenson, 1995; Quigley et al., 2014; Uhrig et al., 2016). Some of which include, research using static images from the International Affective Picture System (IAPS), research utilizing the continuous music technique (CMT), and research using short stories (Quigley et al., 2014). Short stories have been found to be particularly useful in prompting empathetic reactions in individuals, which as a result helps participants form personal, emotional connections with the text (Zupan & Babbage, 2016). Shirai and Suzuki (2017) study revealed that the more personally relevant emotional stories are, the more intense the emotional experience is. Moreover, their study also found that narratives around loss resulted in the highest sadness ratings. However, research has

remained critical of the story method, claiming that it has very little real-life generalizability (Quigley et al., 2014). As such, current research has favoured film as the most effective method of emotion elicitation (Uhrig et al., 2016).

Films offer a more intense and vivid representation of a story than text, and are able to recreate dynamic situations with visual and auditory components (Coplan, 2006; Gross & Levenson, 1995). Films have been heralded as the most ecologically valid emotion elicitation technique. However, this has been challenged through the introduction of VR, which could elicit higher levels of presence and the subsequent increase in intensity of the target emotion (Lessiter et al., 2001).

McGinley and Friedman (2017) posits that the main source of discrepancy between studies is the use of different emotion elicitation techniques. Factors like ecological validity (i.e. the extent to which research findings can be generalized to real-world settings), immersion, presence, and sensory engagement all vary across emotion elicitation methods and thus, might potentially generate different psychological and physiological responses (Felnhofer et al., 2015; Parsons, 2015). VR studies which have measured presence have found it to be closely associated with arousal, which begs to reason that VR paradigms would differ in physiological reactivity to paradigms with low levels of presence like short stories (Ravaja et al., 2006). Therefore, assessing the physiological and psychological differentiation between conditions may reveal important insight into whether these emotion elicitation techniques do in fact elicit predictable autonomic response patterns (McGinley & Friedman, 2017).

Different Measurements of Emotion.

Kreibig (2010) proposes that another point of contention in the literature are the different physiological and subjective measurements which are used. Most studies rely on some form of self-report measure, which are vulnerable to social desirability bias and

inaccurate recollection (Kassam & Mendes, 2013). As such, objective measures like autonomic nervous system (ANS) responses are often measured alongside self-report measures (Quigley et al., 2014). Studies which focused on eliciting sadness have utilized a broad array of physiological measures, like skin conductance level (SCL) (Christie & Friedman, 2004), heart rate (HR) (Frazier, Strauss, & Steinhauer, 2004), respiration rate (RR) (Etzel, Johnsen, Dickerson, Tranel, & Adolphs, 2006), preejection period (PEP) (Kreibig et al., 2007), respiratory sinus arrhythmia (RSA) (Frazier et al., 2004), and finger pulse transit time (Gross & Levenson, 1995) amongst others. Due to this variation comparison across studies is limited (Kreibig, 2010). However, SCL and HR appear to be the most consistently reported measurements (Mauss & Robinson, 2009).

Emotion Subtypes.

A meta-analysis conducted by Kreibig (2010) suggests that the variability in findings across studies could also be a result of emotion subtypes. Shirai and Suzuki (2017) differentiate between sadness experienced through failure versus loss. These findings are consistent with what Kreibig (2010) terms *deactivating* sadness (relating to parasympathetic activation) and *activating* sadness (relating to parasympathetic withdrawal). *Deactivating* sadness is more closely associated with loss that has already occured or is inevitable. Whereas, *activating* sadness was more closely associated with imminent but not inevitable loss. Kreibig (2010) additionally, shows that studies which used film clips depicting scenes related to loss had similar *deactivating* patterns of sadness.

The present study is therefore, an extension of a small line of research which explores psychophysiological and psychological differentiation between emotion elicitation conditions (Mcginley & Friedman, 2017). Specifically, focusing on how factors like presence can impact physiological and subjective responses.

Rationale and Aims

High levels of presence supposedly intensify target emotions and increase ecological validity (Meehan & Brooks, 2001). Previous research has found elevated levels of presence in VR experiences indicating that this may be an effective emotion elicitation method. However, there is limited evidence to support this relationship, as well as no current evidence to suggest this relationship holds true for sadness as well (Parsons, 2015). This study attempted to bridge the gap in the literature by comparing an emotive short story, short film, and VR conditions to assess the differences in physiological reactivity and subjective reports of sadness. The proposed study will investigate the following hypotheses:

1)

   a. The emotion elicitation conditions will successfully elicit sadness, as measured by self-reported emotion and physiological reactivity.
   b. The VR condition will elicit the highest levels of sadness, followed by the film condition and then the story condition.

2)

   a. The VR condition will have the highest levels of self-reported presence, followed by the film condition and then the story condition.
   b. Higher levels of presence will result in more intense emotional experiences and greater physiological reactivity
      i. Specifically, participants in the VR condition with high levels of presence will report greater levels of sadness.

Methods

Design and setting

This was an interdisciplinary study between the Psychology Department at the University of Cape Town (UCT) and the Computer Science Department at UCT. A between-groups design was used to investigate the hypotheses of the study. The study included (1) a screening phase to verify participant's eligibility, and (2) a laboratory phase where eligible participants the study will be conducted in the Whisper Room in the ACSENT Sleep Laboratory within the UCT Department of Psychology.

Participants

Power analysis. An a priori power analysis was used to determine a sufficient sample size to achieve statistical power of .8 when using a one-way MANOVA analysis (Cohen, 1992; Faul, Erdfelder, Lang, & Buchner, 2007). In accordance with previous literature, a moderate effect size of .25 with a conventional $\alpha = .05$ was used to calculate a sample size of approximately 26 participants per condition, N = 77 (Schaefer, Nils, Sanchez, & Philippot, 2010; Parsons, 2015; Uhrig et al., 2016).

Recruitment. Convenience sampling was used to recruit undergraduate UCT students using the Department of Psychology's Student Research Programme (SRPP). An announcement was circulated via the SRPP Vula site (See Appendix A) requesting undergraduate psychology students, between the ages of 18 and 25 to participate in the study. The first phase of the study was an online screening survey. Subsequently, eligible students were invited to participate in the laboratory phase of the study and were randomly assigned to one of the three conditions. Figure 1 shows participant attrition throughout the study.

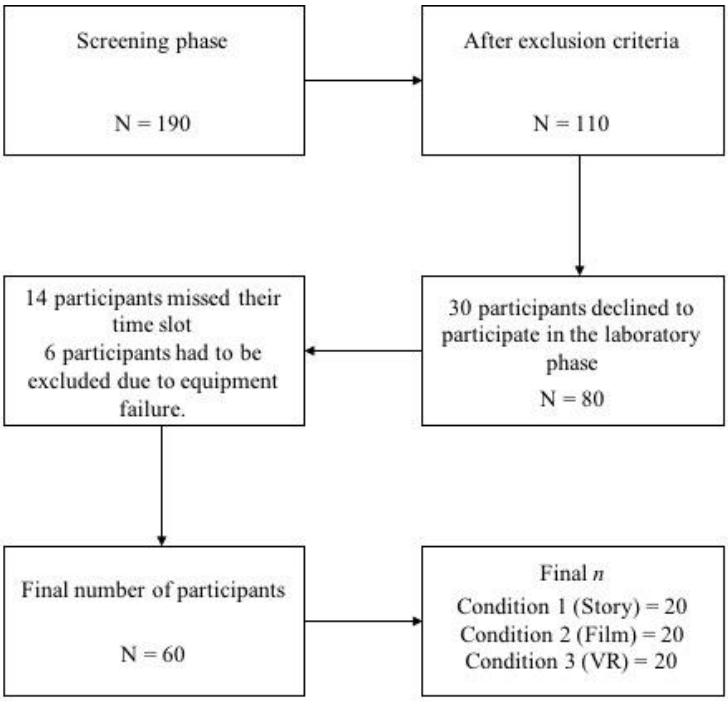

Figure 1. Participant attrition from the screening phase to the laboratory phase ($N = 190$ to $N = 60$).

Eligibility criteria. Participants were eligible to participate in the screening phase of the study if they were fluent in English; between the ages of 18-25; did not have a history of psychological, psychiatric or neurological conditions; and were not currently taking any psychiatric/chronic medication. Based on the survey in the screening phase if individuals reported moderate or severe depression or anxiety, or if they were found to have experienced recent traumas, they were excluded from the study. Research suggests that depression and anxiety are associated with autonomic nervous system dysfunction which may evoke greater variability in HR, SCL, RR, and RSA (Fedor, Chau, Bruno, Picard, Camprodon, & Hale, 2016; Lin, Lin, Lin, & Huang, 2011). Moreover, the narrative throughout the different conditions may be particularly distressing to individuals suffering with depression (Slavich, Monroe, & Gotlib, 2011). Thus, to avoid distortion of data, individuals with depression, anxiety or PTSD were screened out of the study. Individuals who demonstrated high levels of depression or anxiety scores in the screening survey, were sent an email notifying them of this and providing them with the contact details for student wellness services.

Measures

Screening phase. The following measures will be administered online via Google Forms (www.google.com/forms).

Beck Depression Inventory-II (BDI-II). The revised BDI-II is a widely used self-report instrument which consists of 21 questions used to assess and rate the severity of depression in individuals (see Appendix B; Beck, Steer, & Brown, 1996). Participants were excluded from participation if they scored ≥ 21, which indicates moderate to severe depression. Research suggests that in both psychiatric and non-psychiatric populations the BDI-II has generally good internal consistency (α = .93) (Beck, Steer, Ball, & Ranieri, 1996; Lasa, Ayuso-Mateos, Vázquez-Barquero, Díez-Manrique, & Dowrick, 2000; Stein et al., 2015; Storch, Roberti, & Roth, 2004); and more importantly studies have shown that this good internal consistency translates to South African populations as well (Kagee, Nel, & Saal, 2013; Somhlaba & Wait, 2009).

State-Trait Anxiety Inventory (STAI). This STAI questionnaire comprises of 20 questions which were used to evaluate an individual's general anxiety symptoms (see Appendix C; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983). Scores ≥ 50 indicated moderate anxiety and these individuals were excluded from participation. The STAI has good internal consistency (α = .92) and concurrent validity (Bados, Gómez-Benito, & Balaguer, 2010; Julian, 2011).

The 4-item Primary Care Post-Traumatic Stress Disorder Screen (PC-PTSD). In order to ensure that participants were not triggered by the content of the study, four yes or no questions were posed to determine whether participants had experienced any past traumas which might still be affecting them (See Appendix M). Individuals who answered yes to three or more questions were excluded from the study (Cameron & Gusman, 2003)

Laboratory phase.

ITC-Sense of Presence Inventory (ITC-SOPI). The ITC-SOPI is a cross-media presence questionnaire. It is a post-test subjective questionnaire which comprises of 44 items and is divided into Part A and Part B (See Appendix D). There are four main factors: Spatial (19 items), Engagement (13 items), Naturalness (5 items), and Negative Effects (6 items). The ITC—SOPI can assess presence for any medium and its focus on separate factors allows for a nuanced examination of media experiences (Riva et al., 2007). Previous research has reported high internal reliability (Baños et al., 2004; Riva et al., 2007).

Self-Assessment Manikin (SAM). The SAM consists of two 9 point scales, one for valence (a scale from negative to positive) and one for arousal (a scale from calm to aroused; see Appendix E). The SAM does not need written instructions because it consists of intuitive images of sad and happy manikins, and calm and excited manikins (Bradley & Lang, 1994).

Discrete Emotion Questionnaire (DEQ) A shortened version of the DEQ was used (Appendix F). It consisted of a short list of emotions and utilized a 7 point Likert scale to rate the strength of the emotion (Harmon-Jones, Bastian, & Harmon-Jones, 2016). Previous research has found that the DEQ has high internal consistency and content validity (Harmon-Jones et al., 2016).

Visual Analogue Scale for Emotion Intensity. After participants had completed the stimulus condition they were asked to report their primary emotion and rate it on a scale from 1 to 100 (Appendix G). Studies often use visual analogue scales (VAS) to more accurately ascertain how participants are feelings (Quigley et al., 2014).

Physiological Measures. The Biopac MP160 system will be used to measure the HR, SCL, RR and RSA of participants during the laboratory phase of the study. Etzel et al., 2006 shows how voluntary changes in respiration can effect emotion (i.e. reduce anxiety). Furthermore, respiration alongside HR was used to calculate RSA which is a noninvasive

measure of parasympathetic activity (Rottenberg, Wilhelm, Gross, & Gotlib, 2003). A measure of parasympathetic activity was chosen in accordance with literature which shows potential *deactivating* patterns of sadness.

Emotive Stimuli.

To maintain similarity of setting in the study all of the conditions were presented to participants on the same computer in the Whisper Room in the ACSENT sleep laboratories at UCT. Previous research has demonstrated how narratives surrounding loss have been most effective in eliciting sadness. Thus, the loss of a pet was chosen as the main narrative across conditions (for a specific outline of the story see Appendix H). The short story and short film were both designed and created by the researcher in order to keep the narrative as consistent as possible. The VR experience was developed by a computer science honours group, with additional help from a master's student, and was modelled on the same narrative as the story and film. The three conditions were all designed to be approximately 4 minutes in length. The film and story conditions were presented to participants via Eprime 2.0 (Psychology Software Tools, Pittsburgh, PA). A parallel port cable connected the parallel I/O port of the stimulus computer and the STP100C (Biopac's isolated digital interface device). This connection enabled event markers to be sent via Eprime to Biopac and recorded alongside the physiological data. This accurately integrated the physiological data with the stimulus presentation. Specifically, event markers were designed to denote when a participant moved on to the next chapter/scene in the story or film, respectively. The VR system which was used for this study was the Oculus Rift head mounted display (HMD). Manual event markers were used in the VR condition.

Procedure. The present study adhered to the ethical guidelines outlined by the UCT Code for Research Involving Human Subjects. The study was granted ethical approval from the Department of Psychology's Research Ethics Committee (Appendix I)

Screening phase. The first phase of the study required participants to complete an online survey circulated via the SRPP system, which determined if participants were eligible to proceed to second phase of the study.

Laboratory phase. The second phase of the study took place in the Whisper Room in the ACSENT sleep laboratories at UCT To avoid priming, participants were told that the focus of the study was on general emotions rather than sadness specifically (Lohse & Overgaard, 2017). Participants were invited into the laboratory where they were asked to complete an informed consent form (see Appendix J) and a brief background information form (Appendix K).

In order to measure participant's electrocardiogram (ECG), three disposable electrodes (EL-500 electrodes from Biopac) were then placed in a three-lead configuration: The two active electrodes were positioned under the right clavicle and under the lowest rib on the left side, and the ground electrode was placed under the left clavicle. The respiration belt transducer was positioned just under the sternum. SCL was measured by placing two disposable electrodes (EL-507 electrodes from Biopac) on the participants index and ring finger of their non-dominant hand. Participants were then asked to relax for five minutes while taking baseline. The participants were then required to complete baseline SAM and DEQ. Each participant was then shown one of the conditions as per their random assignment. After the condition had finished, participants were asked to complete the SAM, DEQ again, as well as the ITC-SOPI. Upon completion, a short debriefing was provided (See Appendix I). Moreover, participants were compensated for their time with 2 SRPP points.

Data Management and Statistical Analyses.

Data reduction of physiological measurements. All signals were sampled by a digital converter system MP150, Bopac Systems) set at 200Hz. SCL (resampled to 50hz and non-responders) Aqcknowledge was used to extract data from the electrocardiogram (ECG),

respiration and electrodermal activity (EDA) channels to calculate HR, RR, RSA, and SCL. The ECG, dfand EDA waveforms were visually inspected for any artefacts and data was discarded if it exceeded 3 standard deviations above the mean.

***Scoring of objective and subjective data*.** Baseline measures for physiological data were averaged over 3 minutes. Since, the different conditions were designed to be similar in length and reflect the same narrative, they all had six distinct sections/scene. Therefore, the story, film and VR conditions were divided into 6 epochs where epoch 3 to 6 represented the introduction of sad content (See Appendix) ST. Difference scores were calculated by subtracting the baseline measurements from the raw data across the 6 epochs. In order to establish variables which, represented the sad stimuli in each condition, physiological data for Epochs 3 to 6 were averaged, using the difference scores, to form new variables for SCL, HR, RR, and RSA. Unless otherwise specified, these new composite variables are simply referred to as SCL, HR, RR and RSA throughout the analyses. Similarly, the difference scores for subjective self-report measures were calculated by subtracting the posttest variables from the pretest variables, except for the VAS and ITC-SOPI which were only posttest measures. Difference scores were used throughout the analyses for both subjective and objective variables unless otherwise stated.

Generating descriptive statistics. Inferential statistical analyses were completed using SPSS version 25, with α set at .05 for all decisions regarding statistical significance. A full set of descriptive statistics were produced to provide an overview of the sample and the general trends in the data. Assumptions for the analyses were checked and if not otherwise specified, they were upheld.

Univariate analysis. A series of one-way ANOVAs were employed to analyse between-group differences in the continuous variables (BDI, STAI, and PC-PTSD-4 scores). Between-group differences stemming from categorical variables (gender, age, and home

language) were assessed using Chi-squared tests of contingency. Another series of one-way ANOVAs were conducted to ensure there were no significant differences between the baseline/pre-test data of the three conditions for both physiological and self-report data (Table 2). Three Chi squared tests of contingency were used to assess the within-group differences stemming from the 4 primary emotion categories evident in the VAS (i.e. sadness, neutral, anxious, and other).

Multivariate analysis of emotion effects. Two one-way MANOVAs were conducted to establish whether objective physiological measures and subjective self-report measures differed significantly between emotion stimulus conditions. A post hoc discriminant analysis was used to determine whether the variables could significantly predict the emotion stimulus condition. Bonferroni corrected post hoc one-way ANOVAs were then conducted to determine on which measures the groups differed significantly and if they successfully elicited sadness. Specifically, it was predicted that VR would elicit the highest levels of sadness compared to the film and story condition.

Effects of presence. A one-way ANOVA was run to determine whether presence levels differed significantly between conditions. To further assess the effects of presence on emotion intensity, a Pearson's bivariate correlation matrix was produced. The final part of the analysis involved a series of General Linear Models, which were used to assess whether the interaction between emotion elicitation conditions and presence explained a significant proportion of the variance in subjective and physiological responses. The outcome variables included those subjective and physiological variables that were significantly correlated with presence. The reason for this choice of outcome variables is to avoid running multiple models, which inflates type 1 error

Results

Sample characteristics.

Table 1 shows that that the analyses found no significant between-group differences in terms of age, sex, home language, BDI, STAI and PC-PTSD-4 score (all *p*s > .517).

Table 1
Sample Characteristics and Between-group Differences: (N = 60)

	Group					
	Story	Film	VR			
Variable	(*n* = 20)	(*n* = 20)	(*n* = 20)	F / χ^2	*p*	ESE
Age (years)				.42	.659	.02
M (*SD*)	20.60 (1.27)	20.90 (1.62)	20.50 (1.40)			
Range	19-23	18-24	18-24			
Sex				.17	.918	.05
Female	14 (70%)	15 (75%)	12 (60%)			
Male	6 (30%)	5 (25%)	8 (40%)			
First language				1.38	.503	.15
English	14 (70%)	17 (85%)	15 (75%)			
Other	6 (30%)	3 (15%)	5 (25%)			
BDI				.02	.979	.00
M (*SD*)	8.15 (5.32)	8.10 (4.99)	7.85 (4.45)			
STAI				.19	.830	.01
M (*SD*)	33.30 (6.26)	33.00 (7.42)	32.05 (6.66)			
PC-PTSD-4				.67	.517	.02
M (*SD*)	.75 (.85)	.80 (.83)	.55 (.76)			

Note. For the variables *Sex* and *Home Language*, counts are presented with percentages in parentheses. *BDI* = Beck's Depression Inventory; *STAI* = State Trait Anxiety Inventory; *PC-PTSD-4* = Primary Care Post Traumatic Stress Disorder Screen; ESE = effect size estimate (in this case, η^2 for one-way ANOVA and Cramer's *V* for chi-squared tests of contingency).

Assessment of baseline and pre-test differences. Table 2, shows the results of a series of one-way ANOVAs which indicates that there were no significant differences between baseline and pre-test measures (all *p*s > .272).

Table 2
Univariate analysis of variance between baseline and pretest measures across the three conditions (N = 60)

	Condition					
Variable	Story (*n* = 20)	Film (*n* = 20)	VR (*n* = 20)	F	p	ESE
Physiological Measures						
SCL Baseline	3.10 (.65)	3.07 (.99)	3.14 (.95)	.029	.971	.00
HR Baseline	83.80 (11.18)	82.92 (8.03)	82.34 (8.17)	.13	.881	.00
RR Baseline	15.67 (1.30)	15 (.99)	15.22 (1.77)	1.33	.272	.00
RSA Baseline	5.31 (1.22)	5.33 (1.11)	5.04 (1.46)	.32	.729	.01
Subjective Measures						
Arousal Pre-test	6.05 (1.99)	6.40 (1.73)	6.15 (1.69)	.20	.820	.01
Valence Pre-test	4.95 (1.67)	5.05 (1.67)	5.35 (1.53)	.33	.721	.01
Sadness Pre-test	1.90 (1.02)	1.50 (.76)	1.71 (.90)	1.00	.374	.03

Note. Means are presented, with standard deviations in parentheses. ESE = effect size estimate (in this case, η^2 for one-way ANOVA). SCL = skin conductance level; HR = heart rate; RR = respiration rate; RSA = respiratory sinus arrhythmia.

Primary emotion analysis. Figure 2 shows that the majority of people across conditions reported their primary emotion on the VAS as sadness. Three chi square tests of contingency showed that there was no significant within group differences in the story condition (χ^2 = 41.80, p = .350), in the film condition (χ^2 = 27.67, p = .686), or in the VR condition (χ^2 = 60.00, p = .368) for the primary reported emotion. The following analyses will include all the VAS scores rather than differentiating between those who reported sadness and those who did not, because removing individuals based on a single subjective measure would remove relevant statistical power.

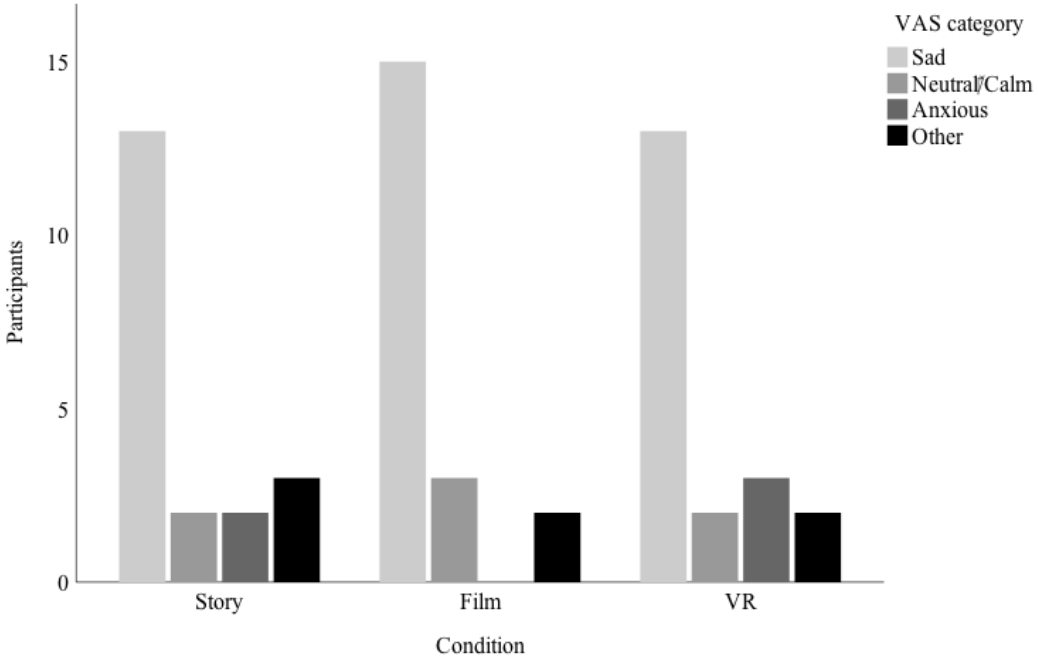

Figure 2. The primary emotion reported on the VAS. (N = 60)

Multivariate Analysis of Emotion Effects.

The first MANOVA was conducted to determine if the three emotion stimulus conditions (Story, VR, and Film) differed across the four dependent variables of SCL, HR, RR and RSA. Box's M test of equality of covariance matrices was significant; therefore, Pillai's trace criterion was used, (Box's M = 51.29, F (20, 9171.13) = 2.270, p < .001). The multivariate results indicated that there were significant between-group differences across the four dependent variables (F (8, 98) = 8.83, p < .001, partial η^2 = 0.42). The MANOVA was followed up by a post hoc discriminant function analysis in order to determine the linear combination of the continuous variables which best differentiates the three conditions: Story, Film, and VR. The discriminant analysis revealed two discriminant functions. The first function explained 79.5% of the variance, canonical R^2 = .58., whereas the second function only explained 20.5%, canonical R^2 = .26. Together these functions significantly discriminate condition membership. The correlations between the physiological measures and the discriminant functions revealed that SCL loaded fairly more highly onto function 1, whereas HR, RR and RSA all loaded more highly on the second function than the first (Table 3). The

canonical variate correlations (Table 3) shows the relative contribution of each variable to group separation. As such, it appears that SCL contributed the most to group separation in function 1 and RSA contributed the most in function 2. Furthermore, the discriminant function plot showed that the first function discriminated the film from the VR and story condition and the second function differentiated the VR from the Film and Story condition (Figure 3). Overall, the MANOVA revealed that there is a significant difference between the conditions and the discriminant analysis showed that these differences can be predicted with approximately 80% accuracy in order to differentiate group membership.

Table 3
A structure matrix showing the relative contribution of both subjective and physiological variables to the group separation (N = 60)

	Structure Matrix	
Variable	Function 1	Function 2
Physiological Measures		
SCL	.67	-.41
HR	-.62	.49
RR	-.35	.53
RSA	-.25	.60
Subjective Measures		
VAS	.83	-0.1
Sadness	.44	-0.5
Valence	-.21	-.32
Arousal	-.30	.70

Note. SCL = skin conductance level; HR = heart rate; RR = respiration rate; RSA = respiratory sinus arrhythmia; VAS = visual analogue scale.

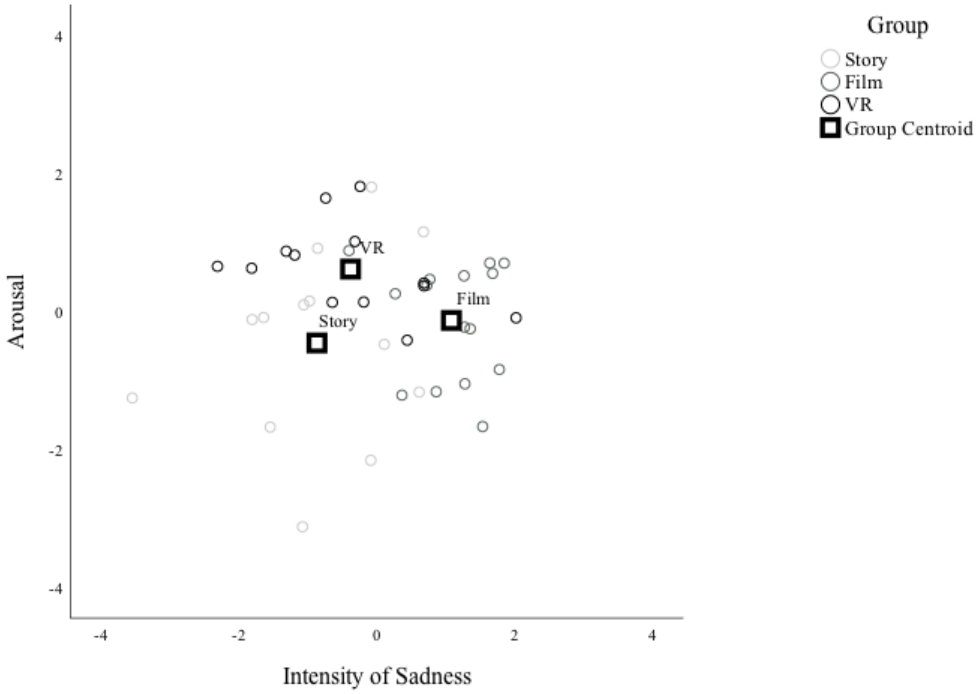

Figure 3. Group centroids plots using the physiological variables. Discriminant function 1 (vertical axis) is interpreted as arousal and discriminant function 2 (horizontal axis) intensity of sadness. (N = 60)

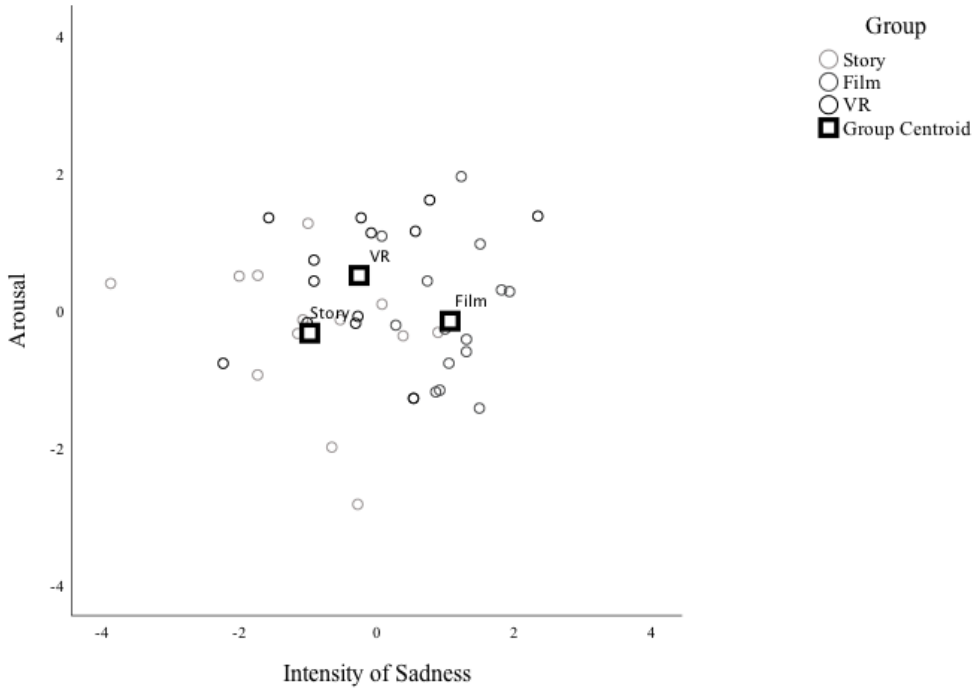

Figure 4. Group centroids plots using the subjective variables. Discriminant function 1 (vertical axis) is interpreted as arousal and discriminant function 2 (horizontal axis) intensity of sadness. (N = 60)

Post hoc one-way ANOVAs were conducted in order to assess how each dependent variable contributed to the between-group differences. However, Levene's test was violated for HR (F (2, 57) = 28.27, p = .012) and RSA (F (2, 57) = 24.53, p = .007). Log transformations were attempted on the data but did not change the results of Levene's test, hence, the original data was kept, because ANOVA is robust to minor violations (Harwell, Rubinstein, Hayes, & Olds, 1992; Schmider, Ziegler, Danay, Beyer, & Bühner, 2010). The one-way ANOVAs revealed that there were significant between group differences for all the measures (Table 4). Bonferroni corrected post-hoc tests showed that for the physiological measures the film group was significantly different from both the story (p < .001) and VR (p < .001) group on SCL. Meaning that individuals in the film group had higher SCL in comparison to the VR and story group. Whereas, the VR group was significantly different from the story (p = .024; p = .049; p < .001, respectively) and film group (p = .001; p = .023; p < .001, respectively) on RR, HR, and RSA. Meaning that individuals in the VR group had higher baseline-adjusted HR and RR but lower RSA as compared to the story and film groups. The differences in physiological activation patterns between conditions is represented graphically in figure 5.

Table 4
Between group comparison of physiological and subjective measures (N = 60)

	Condition					
Variable	Story (*n* = 20)	Film (*n* = 20)	VR (*n* = 20)	F	p	ESE
Physiological Measures						
SCL	1.36 (.72)	3.27 (1.20)	1.91 (.82)	19.52	< .001***	.43
HR	-1.74 (1.25)	-1.97 (2.85)	.20 (82.95)	4.62	< .014*	.14
RR	-1.05 (1.20)	-1.60 (1.91)	.40 (1.82)	7.61	< .001***	.21
RSA	1.30 (.63)	2.00 (1.03)	-.19 (1.57)	18.76	< .001***	.40
Subjective Measures						
Arousal	-1.80 (1.54)	-2.15 (2.56)	-.05 (2.16)	5.58	< .006**	.17
Valence	-.85 (1.53)	-1.75 (2.10)	-1.50 (1.91)	1.25	.295	.14
Sadness	2.05 (1.28)	3.55 (1.85)	2.5 (1.36)	5.26	< .008**	.16
VAS	59.19 (11.83)	76.60 (5.57)	64.54 (12.70)	10.56	< .001***	.26

Note. Means are presented, with standard deviations in parentheses. The analyses were conducted using the change scores except for the VAS. ESE = effect size estimate (in this case, η^2 for one-way ANOVA). SCL = skin conductance level; HR = heart rate; RR = respiration rate; RSA = respiratory sinus arrhythmia. VAS = visual analogue scale.
*p < .05. **p < .01. *** p < .001 (Bonferroni-corrected p-value).
.

The second MANOVA was conducted to determine if the three conditions differed across the main four self-report measurements: valence, arousal, sadness, and the VAS (only where individuals reported sad as their primary emotion). The multivariate results indicated that there were significant between-group differences across the five dependent variables (F (10, 68) = 2.92, p < .004, partial η^2 = 0.30).

The MANOVA was followed up by a post hoc discriminant function analysis which revealed two functions. The first function explained 85.5% of the variance, canonical R^2 = .44, whereas the second function only explained 20.5%, canonical R^2 = .12. Together these functions significantly discriminate group membership. The correlations between the subjective measures and the discriminant functions revealed that the VAS, sadness and valence all loaded more highly on Function 1, whereas arousal loaded more highly on

function 2 (Table 3). It appears that the VAS (limited to the individuals who reported sad as their primary emotion) contributed the most to group separation in function 1 and arousal contributed the most in function 2. Furthermore, discriminant function plot showed a similar trend that the physiological variables, in that the first function discriminated the film from the VR and story condition and the second function differentiated the VR from the film and story condition (Figure 4). Overall, the MANOVA revealed that there is a significant difference between the conditions and the discriminant analysis showed that these differences can be predicted with approximately 73% accuracy in order to differentiate group membership

Post hoc one-way ANOVAs were conducted to ascertain where the differences lay. The one-way ANOVAs revealed that there were significant between group differences for all the measures except valence (Table 4). A Bonferroni corrected post hoc test showed that VR group was significantly different from the story ($p = .036$) and film ($p = .009$) group on measures of arousal. The film group was significantly different from the story group ($p = .008$) and trended towards significance for the VR group ($p = .076$) on the discrete sadness measure. Similarly, the film group was significantly different from the story ($p < .001$) and VR group ($p = .011$) on the VAS measure of sadness. The descriptive statistics further verifies these differences by showing that the film condition was the best emotion induction technique across both VAS and the discrete sadness scale, followed by the VR condition, and finally the story condition (See Table 4). Overall, these results are inconsistent with the prediction that VR would elicit the most sadness.

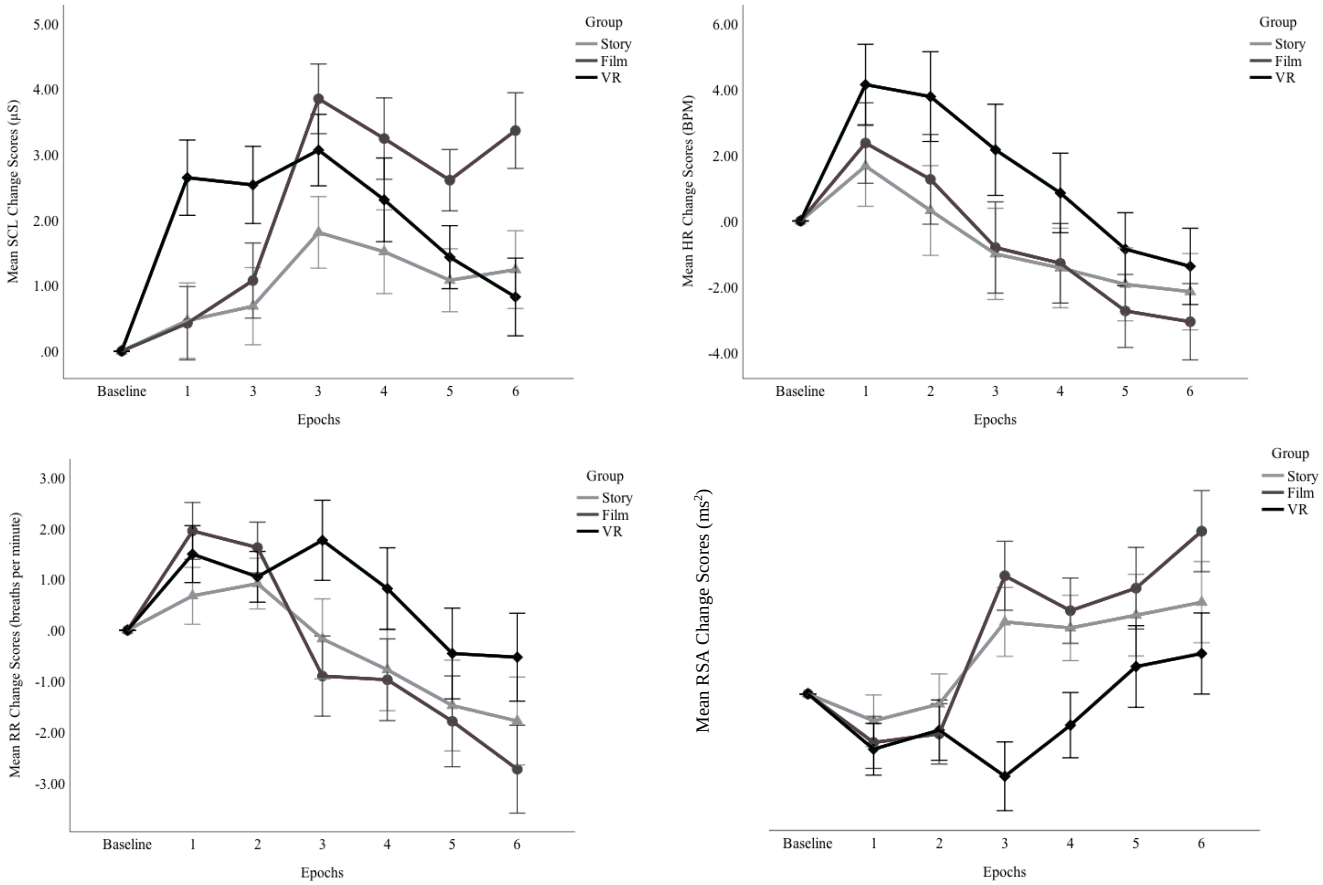

Figure 5. Mean change scores in physiological variables across the different conditions. Error bars represent the 95% confidence interval.

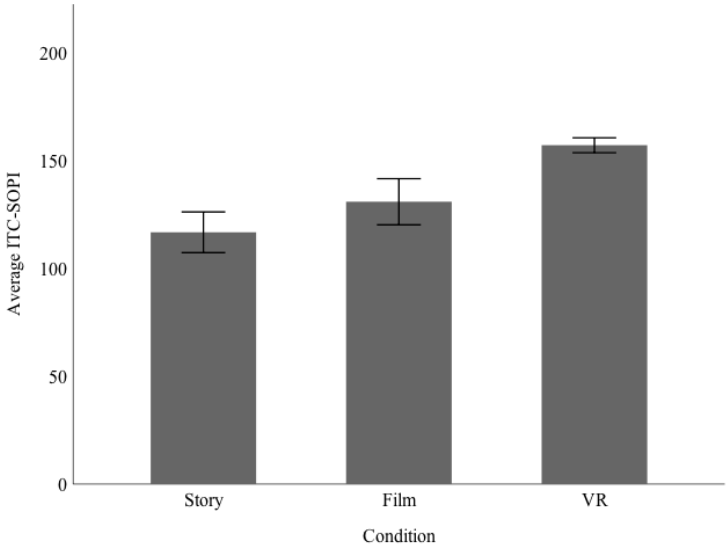

Figure 6. The mean scores for subjective presence levels between conditions. Error bars represent the 95% confidence interval.

Effects of presence. It was found that presence levels were significantly different between Film (M =130.75, SD = 22.84), VR (M = 156.90, SD = 7.40), and the Story condition (M = 116.6, SD = 20.13), F (2, 57) = 25.56, $p < .001$. Figure 6 illustrates the gradual increase from the story condition to the VR condition. Moreover, it also shows that the variance in the VR condition is very small relative to the film and the story condition which reflects a lot more spread in the data. This indicates that participants more consistently reported high levels of presence in the VR condition. Pearson's bivariate correlation matrix was produced to further assess the effects of presence on the intensity of subjective emotion and psychophysiology. The analysis detected a strong negative correlation between presence and RSA; a moderate positive correlation between presence and HR; and a moderate positive correlation between presence and arousal. Overall, presence seems most closely associated with subjective arousal and physiological indices of arousal (i.e. HR and RSA). As such, general linear models were conducted to explore whether presence interacted with the emotion conditions to predict RSA, HR and arousal. I was specifically interested in determining how high levels of presence effected the emotional experience of the participants in the VR group.

The GLMs showed that although, the model was significantly associated with RSA (adjusted $R^2 = .397$, $p < .001$), HR (adjusted $R^2 = .122$, $p = .033$), and arousal (adjusted $R^2 = .176$, $p = .008$); neither presence nor group (individually or in interaction) significantly predicted RSA, RR, or arousal (all ps > .107).

Table 5.
Bivariate correlations: subjective and physiological variables (N = 60)

Variable	ITC-SOPI	VAS	Sadness	Valence	Arousal	RSA	SCL	HR	RR
ITC-SOPI	1								
VAS	.08	1							
Sadness	.08	.22	1						
Valence	-.20	-.16	-.27*	1					
Arousal	.22*	-.12	-.08	.15	1				
RSA	-.38**	.44**	.10	.08	-.41**	1			
SCL	-.02	.48**	.22	.01	-.03	.14	1		
HR	.24*	-.27*	-.09	.02	.42**	-.36**	-.04	1	
RR	.21	-.45**	-.10	.04	.59**	-.53**	-.17	.58**	1

Note. Data presented are Pearson's *r* correlation coefficients. The correlation was two tailed. ITC-SOPI = Presence scale; VAS = visual analogue scale; RSA = respiratory sinus arrhythmia; SCL = skin conductance level; HR = heart rate RR = respiration rate.
*$p < .05$. **$p < .01$.

Discussion

The present study analyzed psychophysiological and subjective differences in sadness between three emotion elicitation conditions: A short story, a short film, and a VR experience. The study aimed to address 2 main questions. The first question was twofold: (a) Did the three conditions successfully elicit sadness based on subjective responses and physiological reactivity, and (b) did the VR condition elicit higher levels of sadness relative to the film and story conditions. The measure of emotion intensity showed that participants consistently reported sadness as their primary emotion. Moreover, there were significant between-group differences for all of the physiological and subjective measures except for self-reported valence. Thus, the results confirm that the three conditions did successfully elicit the discrete emotion of sadness. However, the film condition appears to have elicited the most sadness and not the VR condition, as predicted. This is evident in the that SCL, HR and respiration all decreased and parasympathetic activity increased the most in the film condition. These physiological changes are corroborated the subjective ratings of sadness and emotion intensity, which were the highest in the film condition as well. Overall, these results appear to confirm the hypothesis that the conditions successfully elicited sadness based on

subjective emotion experience and physiological reactivity. But they also serve to disconfirm the hypothesis that VR would elicit the highest levels of sadness.

The second question was also twofold: (a) Did the VR condition have the highest levels of self-reported presence, followed by the film condition and then the story, and (b) did higher levels of presence in the VR group result in more intense emotional experiences and greater physiological reactivity. The results demonstrated that VR did have the highest self-reported presence scores, followed by the film condition and then the story condition. Additionally, the analyses showed that participants more consistently reported high levels of presence in the VR group compared to the film and story group. However, the findings demonstrated that presence was not directly correlated with any of the main subjective emotion constructs, but rather, it was correlated with the physiological and subjective measures of arousal. In spite of the high correlation between presence and subjective arousal, results found that presence did not significantly predict RSA, respiration or subjective arousal for the specific conditions. Therefore, higher degrees of presence were associated with withdrawal of the parasympathetic nervous system and higher subjective arousal. Despite this, it was not a predictive relationship, suggesting the possibility of a third unknown factor explaining this association. It is important to note that this discussion differentiates between arousal as a construct, and arousal as a subjective measure. Overall, these results confirm the hypothesis that VR would have the highest levels of self-reported presence, followed by the film and the story conditions. Albeit, disconfirms the hypothesis that higher levels of presence in the VR group would predict more intense emotional experiences.

Between-group differences in subjective measures.

A more nuanced review of the results revealed that, only sadness as a discrete construct was significantly different between groups. The dimensional measure of valence was not significant despite numerous studies confirming its reliability (Christie & Friedman,

2004; McGinley & Friedman, 2017). Although, the SAM specified that valence was a negative-to-positive emotion scale, there may have still been confusion as to what the term meant. Similar studies have found this to be the case as well (Kreibig et al., 2007). Despite this, arousal (the second dimensional component) had significant between group differences and generally decreased across conditions. Film had the lowest subjective arousal ratings, followed by the story and then the VR condition.

Between-group differences in physiological measures.

Theoretical accounts of emotional arousal have described it as a general increase in physiological activation (Mauss & Robinson, 2009). However, recent research has argued that this view is overly simplified and does not account for the variation in emotional experiences (Ekkekakis & Russel, 2013). Therefore, Kreibig (2010) differentiates between two distinct physiological activation patterns of sadness: *Activating* and *deactivating* sadness. *Deactivating* sadness is associated with decreased HR, respiration and elevated parasympathetic activity. It is commonly observed in films clips which employ narratives of loss (Shirai & Suzuki, 2017). Conversely, *activating* sadness is associated with increased HR, respiration and parasympathetic withdrawal (Kreibig, 2010). The current study found that participants in the story and film conditions experienced elevated levels of parasympathetic activation, and reduced levels of HR and respiration, which is consistent with a *deactivating* pattern of sadness. Conversely, participants in the VR condition experienced parasympathetic withdrawal, and elevated HR and respiration, which is consistent with an *activating* pattern of sadness. These physiological measures were corroborated by the subjective measures which showed that participants in the story and film conditions reported being less aroused, relative to participants in the VR condition. Because, films and stories are passive experiences, loss may appear inevitable and thus, elicit *deactivating* patterns of sadness. Whereas, participants

in the VR condition were able to interact with the environment in a way which may have made the loss seem avoidable, thus, producing an *activating* response.

Previous research has found positive correlations between presence and arousal, which might also explain why participants in the VR condition experienced the most subjective arousal (Felnhofer et al., 2015; Ravaja et al., 2006). Moreover, research suggests that novel stimuli, like VR, might cause an orienting effect (Meehan & Brooks, 2001). The orienting effect posits that individuals who experiences or see something novel will experience elevated physiological arousal (Meehan & Brooks, 2001). However, from figure 5 it is clear that the most physiological reactivity occurred from epoch three onwards (i.e. when the sad content was presented). This suggests that although, novelty may have influenced physiological arousal, the effect of the emotive content was still evident.

Intersection of physiological and subjective measures.

Previous studies have associated SCL with subjective arousal, however, this study found that it was not correlated with subjective or objective measures of arousal (Kreibig, 2010; Quigley & Barrett, 2014). Interestingly, SCL was highly correlated with the emotional intensity (i.e. VAS value). SCL and emotional intensity together explained the most variance between conditions (69%). Similarly, the discriminant analyses showed that SCL and emotion intensity both contributed the most to group separation in function 1. Given the strong relationship between SCL and emotion intensity it seems speculatively appropriate to interpret that SCL reflects a discrete *sadness intensity* factor, rather than valence or arousal as previously argued (Christie & Friedman, 2004; McGinley & Friedman, 2017; Sinha, 1996). As such, it appears that function 1 in both the discriminant analyses is consistent with a *sadness intensity* factor. Whereas, in function 2 RSA and arousal contributed the most to group separation in their respective analyses. Elevated RSA reflects parasympathetic activation which effectively reduces the peripheral indices of arousal (i.e. HR) (Frazier,

Strauss, & Steinhauer, 2004). Therefore, parasympathetic activation has a numbing effect on arousal (Kreibig et al., 2007). RSA along with HR and respiration (which also loaded more highly on function 2) were all moderately correlated with the subjective level of arousal. Frazier et al. (2004), similarly found RSA to be associated with arousal.Thus, it appears that function 2 is consistent with an *arousal* factor. Reinterpreting the factor axes on the group centroid plots (figure x), reveals a pattern consistent with the overall findings from the study: VR reflected the most arousal but film was the most effective emotion discrete elicitation technique based on self-report measures and elevated SCL levels. These interpretations were in line with Christie and Friedman (2004) study which used film-clips to induce sadness; their results similarly showed factor 2 to be consistent with arousal, but factor 1 in their study was consistent with valence rather than emotion intensity. However, these interpretations are merely speculative and are thus, interpreted with caution.

Convergent and divergent findings with past literature.

Overall, the physiological activation patterns in the present study are generally consistent across studies using film and story paradigms to induce sadness (Kreibig et al., 2007). Increased SCL levels and decreased HR is in accord with the majority of studies (Etzel et al., 2006; Kunzmann & Grühn, 2005; Tsai, Levenson, & Carstensen, 2000). Moreover, decreased respiration was consistent across studies, except for Ekman, Levenson, and Friesen (1983) who reported an increase in respiration and Boiten (1998) who reported no change in respiration. However, Boiten (1998) study differed in that participants were given paced breathing instructions. The present study reframed from this as there is evidence that it can add additional cognitive demand and distort results (Mauss & Robinson, 2009). Fewer studies have measured and reported RSA and from the small existing literature there is no consensus as to the direction of activation (Rottenberg et al., 2003). This may be due to the *deactivating* and *activating* patterns of sadness (Kreibig, 2010).

VR is more commonly used to induce fear, with very few studies inducing sadness (Quigley et al., 2014). However, the limited literature is generally still consistent with the findings presented in this study (Felnhofer et al., 2015; Parsons, 2015; Riva et al., 2007). Felnhofer et al. (2015) showed similar increases in SCL and presence. The scant literature on VR and sadness seem to rarily report both subjective and physiological measures. Baños et al., (2004) and Riva et al., (2007) both report only subjective measures.

Condition-specific patterns in physiological reactivity and subjective responses.

It is thus, clear from the results that the three emotion induction methods showed different patterns of physiological activation and subjective responses. Numerous studies have looked at the differential physiological activation patterns between discrete emotions (Kreibig, 2010; Christie & Friedman, 2004). But, very few studies have applied this same logic to emotion induction methods (Kreibig et al., 2007). McGinley and Friedman (2017) argued that the researchers often overlook the potential variability in emotion elicitation methods, which could account for the discrepancies in the literature. This study found that the physiological and subjective measures could discriminate between the three conditions approximately 80% and 73% of time respectively, thus indicating condition-specific response patterns. This, confirms McGinley and Friedman's (2017) conjecture that emotion induction methods are inherently different and to some extent, explains the disparate physiological and subjective findings in the literature.

Limitations and recommendations for future research.

Due to the results from prior research on VR and presence we would have expected to see elevated emotional experiences in the VR condition (Parsons, 2015; Riva et al., 2007). There are two main explanations of the divergent findings in this study. Firstly, participants remained seated across all the conditions to maintain consistency. This may have blunted the immersive and interactive elements of the VR experience (Parsons, 2015). Secondly, the

design of the VR condition was limited due to time restrictions and knowledgeability of the software. As such, the virtual environment was not as immersive as it could have been. Therefore, this study does not provide conclusive evidence that VR is inferior to traditional emotion elicitation techniques, like film. On the contrary, even with the limitations, the VR condition was still able to elicit the sadness more than the story did. Thus, demonstrating that VR still holds potential to be an effective and naturalistic method of emotion elicitation. However, before implementing VR as a method of emotion elicitation, it is imperative to consider the cost-benefit ratio associated with this technique specifically, the benefit of implementing this tool needs to outweigh the costs, namely the time and money taken to construct the stimuli.

Another limitation of the present study was its relatively small sample size. Moreover, participants who cried during the conditions (albeit not many) were not controlled for. Studies show that crying has been associated with specifc physiological changes relative to normal sadness (Rottenberg et al., 2003).

Future research should further assess the relationship between presence and emotion, and the potential existence of a third factor. Moreover, research should strive to record both physiological and subjective measures so results can be comprehensively compared within the study as well as between studies. Moreover, to properly invesetigate the effects of presence on arousal, future studies should employ cardiovascular measures of parasympathetic activation (i.e. RSA) as well as, sympthetic activation (i.e. PEP).

Conclusion

In a world subsumed by emotion, it is essential to consider how various affective states underpin the way humans interact with an in their specific contexts. In particular, it is necessary to understand how emotion functions in both adaptive and maladaptive ways. Whilst emotions facilitate human connection, emotional dysregulation could result in

consequences such as depression. The salience of emotion in everyday function necessitates research into the most effective methods of emotional elicitation. Specifically, by combining physiological and subjective methods, the current study investigated the potential of VR as a technique for eliciting sadness in an interactive environment. The findings indicated that, although the VR condition had the highest levels of presence it did not predict emotion intensity. Furthermore, the results suggested that, whilst VR elicited the most arousal, film was able to evoke the highest level of reported sadness. These results indicate that the film and story conditions reflected a *deactivating* pattern of sadness, in contrast, to the more immersive VR condition which reflected an *activating* pattern of sadness. These findings have practical implications as they could inform future studies using VR to evoke arousal and emotion. In addition, this study adds to the emotion induction literature by demonstrating that there are differential physiological and subjective responses to specific emotional elicitation methods. These differences can potentially explain the discrepancies in the literature regarding the physiological correlates of discrete emotions.

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Appendix A

SRPP Announcement

Subject: Get all your semester's SRPP points in one study!

Organiser: Gina Gilpin

Hi Everyone,

I am an honours student currently conducting a research study through the Department of Psychology. The project aims to assess whether different conditions with the same emotive narrative (Text, Film and Virtual Reality) will elicit different levels of emotion intensity.

In order to be eligible to participate in this study, you need to:

1. Be a student at UCT
2. Be a fluent English-speaker
3. Be between the ages of 18-25
4. Not have a history of psychological, psychiatric or neurological disorders
5. Not currently be taking any psychiatric/chronic medication

If you meet the aforementioned criteria then you can sign up. Please can you fill out the **online survey** (linked below) to determine if you are eligible for the study. The survey should take approximately 30 minutes to complete and you will receive **1 SRPP point.**

Online Survey (please click here to do the survey)

If you ARE eligible for the study you will be notified via email and required to choose a time slot which suits you best. The study will be held in the Whisper Room in the Sleep Laboratories within the Psychology Department at UCT. The study will require participants to fill out several self-report measures and then either read, watch or interact with emotional stimuli (depending on what condition you are assigned to). I will also be using adhesive electrodes to record physiological measures. This should take approximately one hour and you will receive an additional **2 SRPP points.**

Best,
Gina Gilpin
(Please contact me on ginamaygilpin@gmail.com if you have any questions about the study)

Appendix B

Beck Depression Inventory-II

Name: _____ Student number: _____

Age: _____ Sex: ____

Instructions: This questionnaire consists of 21 groups of statements. Please read each group of statements carefully, and then pick out the one statement in each group that best describes the way you have been feeling during the past two weeks, including today. Circle the number beside the statement that you have picked. If several statements in the group seem to apply equally well, circle the highest number for that group. Be sure that you do not choose more than one statement for any group, including Item 16 (Changes in Sleep Pattern) and Item 18 (Changes in Appetite).

1. Sadness 0 I do not feel sad. 1 I feel sad much of the time. 2 I am sad all of the time. 3 I am so sad or unhappy that I can't stand it. **2. Pessimism** 0 I am not discouraged about my future. 1 I feel more discouraged about my future than I used to be. 2 I do not expect things to work out for me.	**6. Punishment Feelings** 0 I don't feel I am being punished. 1 I feel I may be punished. 2 I expect to be punished. 3 I feel I am being punished. **7. Self-Dislike** 0 I feel the same about myself as ever. 1 I have lost confidence in myself. 2 I am disappointed in myself. 3 I dislike myself. **8. Self-Criticalness** 0 I don't criticise or blame myself more than usual.

3 I feel my future is hopeless and will only get worse. **3. Past Failure** 0 I do not feel like a failure 1 I have failed more than I should have. 2 As I look back, I see a lot of failures. 3 I feel I am a total failure as a person. **4. Loss of Pleasure** 0 I get as much pleasure as I ever did from the things I enjoy. 1 I don't enjoy things as much as I used to. 2 I get very little pleasure from the things I used to enjoy. 3 I can't get any pleasure from the things I used to enjoy. **5. Guilty Feelings** 0 I don't feel particularly guilty. 1 I feel guilty over many things I have done or should have done 2 I feel quite most of the time. 3 I feel guilty all of the time.	1 I am more critical of myself than I used to be. 2 I criticise myself for all my faults. 3 I blame myself for everything bad that happens. **9. Suicidal Thoughts or Wishes** 0 I don't have any thoughts of killing myself. 1 I have thoughts of killing myself, but I would not carry them out. 2 I would like to kill myself. 3 I would kill myself if I had the chance **10. Crying** 0 I don't cry anymore than I used to. 1 I cry more than I used to. 2 I cry over every little thing. 3 I feel like crying, but I can't.

11. Agitation

0 I am no more restless or wound up than usual.

1 I feel more restless or wound up than usual.

2 I am so restless or agitated that it's hard to stay still.

3 I am so restless or agitated that I have to keep moving or doing something.

12. Loss of Interest

0 I have not lost interest in other people or activities.

1 I am less interested in other people or things than before.

2 I have lost most of my interest in other people or things.

3 It's hard to get interested in anything.

13. Indecisiveness

0 I make decisions as well as ever.

1 I find it more difficult to make decisions than usual.

2 I have much greater difficulty in making decisions than I used to.

3 I have trouble making any decisions.

14. Worthlessness

0 I do not feel I am worthless.

17. Irritability

0 I am no more irritable than usual.

1 I am more irritable than usual.

2 I am much more irritable than usual.

3 I am irritable all the time.

18. Changes in Appetite

0 I have not experienced any changes in my appetite

1a My appetite is somewhat less than usual.

1b My appetite is somewhat more than usual.

2a My appetite is much less than usual.

2b My appetite is much more than usual.

3a I have no appetite at all.

3b I crave food all the time.

19. Concentration Difficulty

0 I can concentrate as well as ever.

1 I can't concentrate as well as usual.

2 It's hard to keep my mind on anything for very long.

3 I find I can't concentrate on anything.

20. Tiredness or Fatigue

1 I don't consider myself as worthwhile and useful as I used to be. 2 I feel more worthless as compared to other people. 3 I feel utterly worthless. **15. Loss of Energy** 0 I have as much energy as ever. 1 I have less energy than I used to have. 2 I don't have enough energy to do very much. 3 I don't have enough energy to do anything. **16. Changes in Sleep Pattern** 0 I have not experienced any change in my sleeping pattern. 1a I sleep somewhat more than usual. 1b I sleep somewhat less than usual. 2a I sleep a lot more than usual. 2b I sleep a lot less than usual. 3a I sleep most of the day. 3b I wake up 1-2 hours early and can't get back to sleep.	0 I am no more tired or fatigued than usual. 1 I get more tired or fatigued more easily than usual. 2 I am too tired or fatigued to do a lot of the things I used to do. 3 I am too tired or fatigued to do most things I used to do. **21. Loss of Interest in Sex** 0 I have not noticed any recent change in my interest in sex. 1 I am less interested in sex than I used to be. 2 I am much less interested in sex now. 3 I have lost interest in sex completely.

Appendix C

State Trait Anxiety Inventory

SELF-EVALUATION QUESTIONNAIRE

STAI Form Y-2

Name_____Date_____

DIRECTIONS

A number of statements which people have used to describe themselves are given below. Read each statement and then circle the appropriate number to the right of the statement to indicate how you *generally* feel. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe how you generally feel.

	ALMOST NEVER	SOMETIMES	OFTEN	ALMOST ALWAYS
21. I feel pleasant	1	2	3	4
22. I feel nervous and restless	1	2	3	4
23. I feel satisfied with myself	1	2	3	4
24. I wish I could be as happy as others seem to be	1	2	3	4
25. I feel like a failure	1	2	3	4
26. I feel rested	1	2	3	4
27. I am "calm, cool, and collected"	1	2	3	4
28. I feel that difficulties are piling up so that I cannot overcome them	1	2	3	4
29. I worry too much over something that really doesn't matter	1	2	3	4
30. I am happy	1	2	3	4
31. I have disturbing thoughts	1	2	3	4
32. I lack self-confidence	1	2	3	4
33. I feel secure	1	2	3	4
34. I make decisions easily	1	2	3	4
35. I feel inadequate	1	2	3	4
36. I am content	1	2	3	4
37. Some unimportant thought runs through my mind and bothers me	1	2	3	4
38. I take disappointments so keenly that I can't put them out of my mind	1	2	3	4
39. I am a steady person	1	2	3	4
40. I get in a state of tension or turmoil as I think over my recent concerns and interests	1	2	3	4

STAIP-AD Test Form Y
www.mindgarden.com

Appendix D

ITC-Sense of Presence Inventory (ITC-SOPI)

Please read the instructions below before continuing

Instructions:

We are interested in finding out what you feel about the experience you have just had in the 'DISPLAYED ENVIRONMENT'. We use the term 'displayed environment' here, and throughout this questionnaire, to refer to the text, film, or virtual world that you have just encountered. Some of the questions refer to the 'CONTENT' of the displayed environment. By this we mean the story, scenes or events, or whatever you could see, hear, or sense happening within the displayed environment. The displayed environment and its content (including representations of people, animals, or cartoons, which we call 'CHARACTERS') are different from the 'REAL WORLD': the world you live in from day-to-day. Please refer back to this page if you are unsure about the meaning of any question.

There are two parts to this questionnaire, PART A and PART B. PART A asks about your thoughts and feelings once the displayed environment was over. PART B refers to your thoughts and feelings while you were experiencing the displayed environment. Please do not spend too much time on any one question. Your first response is usually the best. For each question, choose the answer CLOSEST to your own.

Please remember that there are no right or wrong answers – we are simply interested in YOUR thoughts and feelings about the displayed environment. Please do not discuss the questionnaire with anyone who may also complete it as this may affect your answers or theirs. We should be grateful if you would also complete the 'Background Information' overleaf.

All of your responses will be treated confidentially.

PART A

Please indicate HOW MUCH YOU AGREE OR DISAGREE with each of the following statements by circling just ONE of the numbers using the 5-point scale below.

(Strongly disagree)	(Disagree)	(Neither agree nor disagree)	(Agree)	(Strongly agree)
1	2	3	4	5

AFTER MY EXPERIENCE OF THE DISPLAYED ENVIRONMENT…

1. I felt sad that my experience was over 1 2 3 4 5
2. I felt disorientated 1 2 3 4 5
3. I had a sense that I had returned from a journey 1 2 3 4 5
4. I would have liked the experience to continue 1 2 3 4 5
5. I vividly remember some parts of the experience 1 2 3 4 5
6. I'd recommend the experience to my friends. 1 2 3 4 5

PART B

Please indicate HOW MUCH YOU AGREE OR DISAGREE with each of the following statements by circling just ONE of the numbers using the 5-point scale below.

(Strongly disagree)	(Disagree)	(Neither agree nor disagree)	(Agree)	(Strongly agree)
1	2	3	4	5

DURING MY EXPERIENCE OF THE DISPLAYED ENVIRONMENT…

1. I felt myself being 'drawn in'. 1 2 3 4 5
2. I felt involved (in the displayed environment). 1 2 3 4 5
3. I lost track of time. 1 2 3 4 5
4. I felt I could interact with the displayed environment 1 2 3 4 5
5. The displayed environment seemed natural. 1 2 3 4 5
6. It felt like the content was 'live'. 1 2 3 4 5
7. I felt that the characters and/or objects could almost touch me. 1 2 3 4 5
8. I enjoyed myself. 1 2 3 4 5
9. I felt I was visiting the places in the displayed environment. 1 2 3 4 5
10. I felt tired. 1 2 3 4 5

(Strongly disagree)	(Disagree)	(Neither agree nor disagree)	(Agree)	(Strongly agree)
1	2	3	4	5

DURING MY EXPERIENCE OF THE DISPLAYED ENVIRONMENT…

11. The content seemed believable to me. 1 2 3 4 5

12. I felt I wasn't *just* watching something. 1 2 3 4 5

13. I had the sensation that I moved in response to parts of the displayed environment 1 2 3 4 5

14. I felt dizzy. 1 2 3 4 5

15. I felt that the displayed environment was part of the real world. 1 2 3 4 5

16. My experience was intense. 1 2 3 4 5

17. I paid more attention to the displayed environment than I did to my own thoughts (e.g., personal preoccupations, daydreams etc.). 1 2 3 4 5

18. I had a sense of being in the scenes displayed 1 2 3 4 5

19. I felt that I could move objects (in the displayed environment). 1 2 3 4 5

20. The scenes depicted could really occur in the real world 1 2 3 4 5

21. I felt I had eyestrain. 1 2 3 4 5

22. I could almost smell different features of the displayed environment. 1 2 3 4 5

(Strongly disagree)	(Disagree)	(Neither agree nor disagree)	(Agree)	(Strongly agree)
1	2	3	4	5

DURING MY EXPERIENCE OF THE DISPLAYED ENVIRONMENT…

23. I had the sensation that the characters were aware of me.....1 2 3 4 5

24. I had a strong sense of sounds coming from different directions within the displayed environment.....1 2 3 4 5

25. I felt surrounded by the displayed environment 1 2 3 4 5

26. I felt nauseous.....1 2 3 4 5

27. I had a strong sense that the characters and objects were solid.....1 2 3 4 5

28. I felt I could have reached out and touched things (in the displayed environment).....1 2 3 4 5

29. I sensed that the temperature changed to match the scenes in the displayed environment.....1 2 3 4 5

30. I responded emotionally 1 2 3 4 5

31. I felt that *all* my senses were stimulated at the same time.....1 2 3 4 5

32. The content appealed to me.....1 2 3 4 5

33. I felt able to change the course of events in the displayed environment.....1 2 3 4 5

(Strongly disagree)	(Disagree)	(Neither agree nor disagree)	(Agree)	(Strongly agree)
1	2	3	4	5

DURING MY EXPERIENCE OF THE DISPLAYED ENVIRONMENT…

34. I felt as though I was in the same space as the characters and/or objects... 1 2 3 4 5

35. I had the sensation that parts of the displayed environment
(e.g. characters or objects)were responding to me. 1 2 3 4 5

36. It felt realistic to move things in the displayed environment..... 1 2 3 4 5

37. I felt I had a headache..... 1 2 3 4 5

38. I felt as though I was participating in the displayed environment..... 1 2 3 4 5

If there is anything else you would like to add, please use the space below:

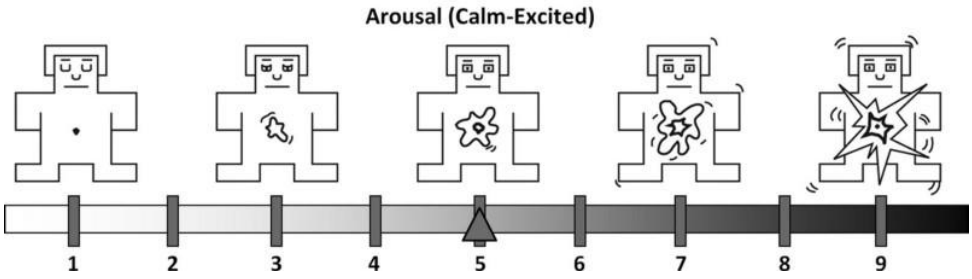
PLEASE CHECK THAT YOU HAVE ANSWERED ALL THE QUESTIONS

THANK YOU VERY MUCH FOR YOUR TIME AND PARTICIPATION

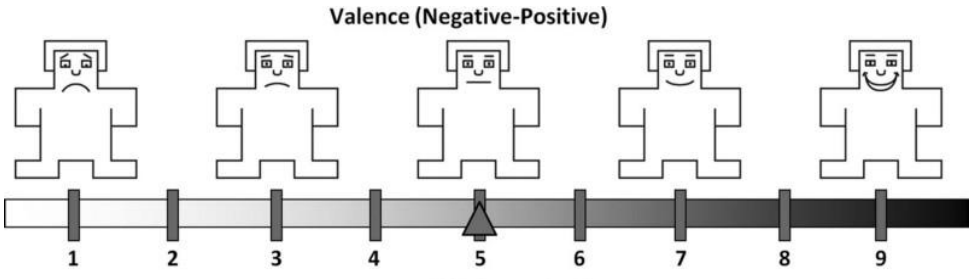
Appendix E

Self-Assessment Manikin (SAM)

Please circle the number that most accurately describes how you feel right now:



Please circle the number that most accurately describes how you feel right now:



Appendix F

Discrete Emotion Questionnaire (DEQ)

To what extent are you experiencing these emotions right now. If you felt a specific emotion circle the most appropriate intensity of feeling. It is also ok to indicate that you did not feel a specific emotion at all.

Please circle your response using the scale provided:

Anger

1	2	3	4	5	6	7
Not at all	Slightly	Somewhat	Moderately	Quite a bit	Very much	Extremely

Sadness

1	2	3	4	5	6	7
Not at all	Slightly	Somewhat	Moderately	Quite a bit	Very much	Extremely

Happiness

1	2	3	4	5	6	7
Not at all	Slightly	Somewhat	Moderately	Quite a bit	Very much	Extremely

Fear

1	2	3	4	5	6	7
Not at all	Slightly	Somewhat	Moderately	Quite a bit	Very much	Extremely

Disgust

1	2	3	4	5	6	7
Not at all	Slightly	Somewhat	Moderately	Quite a bit	Very much	Extremely

Surprise

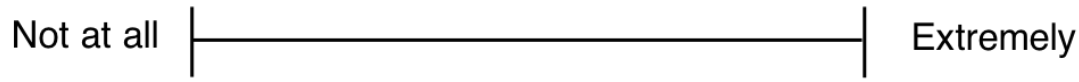
1	2	3	4	5	6	7
Not at all	Slightly	Somewhat	Moderately	Quite a bit	Very much	Extremely

Appendix G
Visual Analogue Scale

What is the primary emotion you are feeling right now?

Please write the emotion below and then place a line on the scale that best characterizes the intensity of the emotion.

Primary Emotion: _____



Appendix H

Emotive Stimuli: Story, film, VR

Story:

Paragraph 1

He sat there amongst the other puppies, staring up at her with big brown eyes. As she leaned in to pick him up, the shy, quiet puppy crawled into her arms, put his head on her shoulder, and never left. They would be together forever. She adopted him then and there and took him to his new home. After endless treats, belly rubs and a bath, she put on his new collar with a shiny name tag - Bear. Although, he was more of a cub now he was sure to grow into his name. And so, he did.

Paragraph 2

Days of playing catch in the long grass turned into weeks of long rainy days inside by the fire and months of adventures together at the park. They were inseparable. As a puppy, he would race ahead of her, clumsily falling over his big paws. But as the years went by, he lagged further and further behind her on their daily trips to his favourite park.

Paragraph 3

One day along their usual route, Bear falters and falls, he tries to get up but he falls down again. She runs to his side and he whimpers silently as she bends down to see what is wrong. Tears well up in her eyes as she fears the worst. He isn't the young pup he once was.

Paragraph 4

Weeks pass and his condition does not improve. She hopes he will be fine- she needs him to be fine. She could not lose her best friend. But she finally takes him to the vet. It was the hardest decision she has ever had to make.

Paragraph 5

And for the last time she scratches him behind the ears and kisses him on the head. For the last time, she stares into those big brown eyes that she had fallen in love with that day at the adoption shelter. The vet gently touches her on the shoulder, takes Bear's leash and leads him away. She puts her head in her hands and cries. She knows he will not come out from behind that wooden door.

Paragraph 6

After what felt like the longest, loneliest time the vet returns to the waiting room and slowly hands her Bear's leash. The collar that he wore with such pride, dull and scratched from years of adventures together shall never be worn again. She looks down and holds it close as her tears fall down her cheeks. Goodbye Bear.

Film:

Scene 1

Scene 2

Scene 3

Scene 4

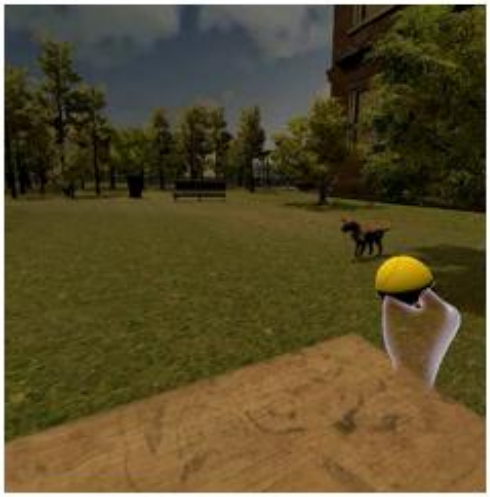
Scene 5

Scene 6

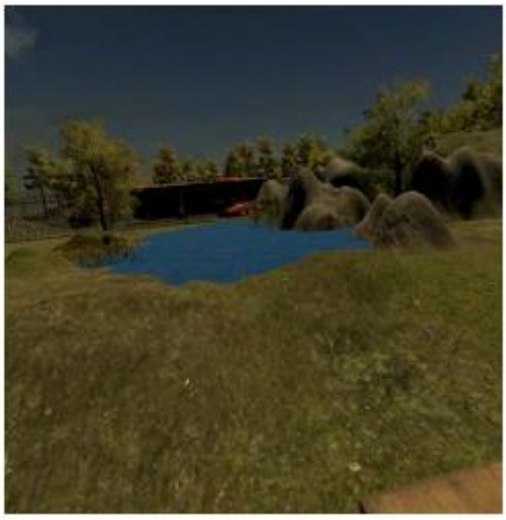
VR:

Scene 1

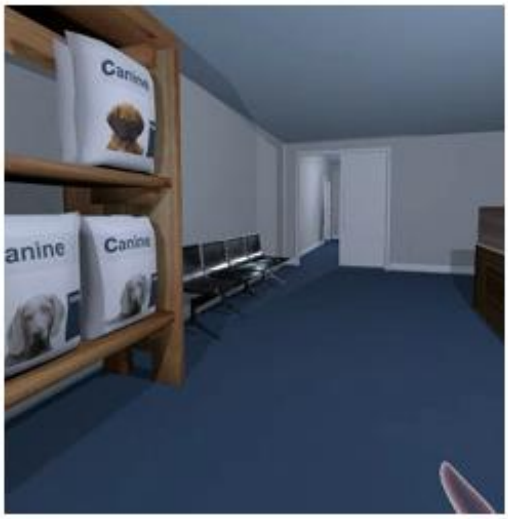
Scene 2



Scene 3



Scene 4

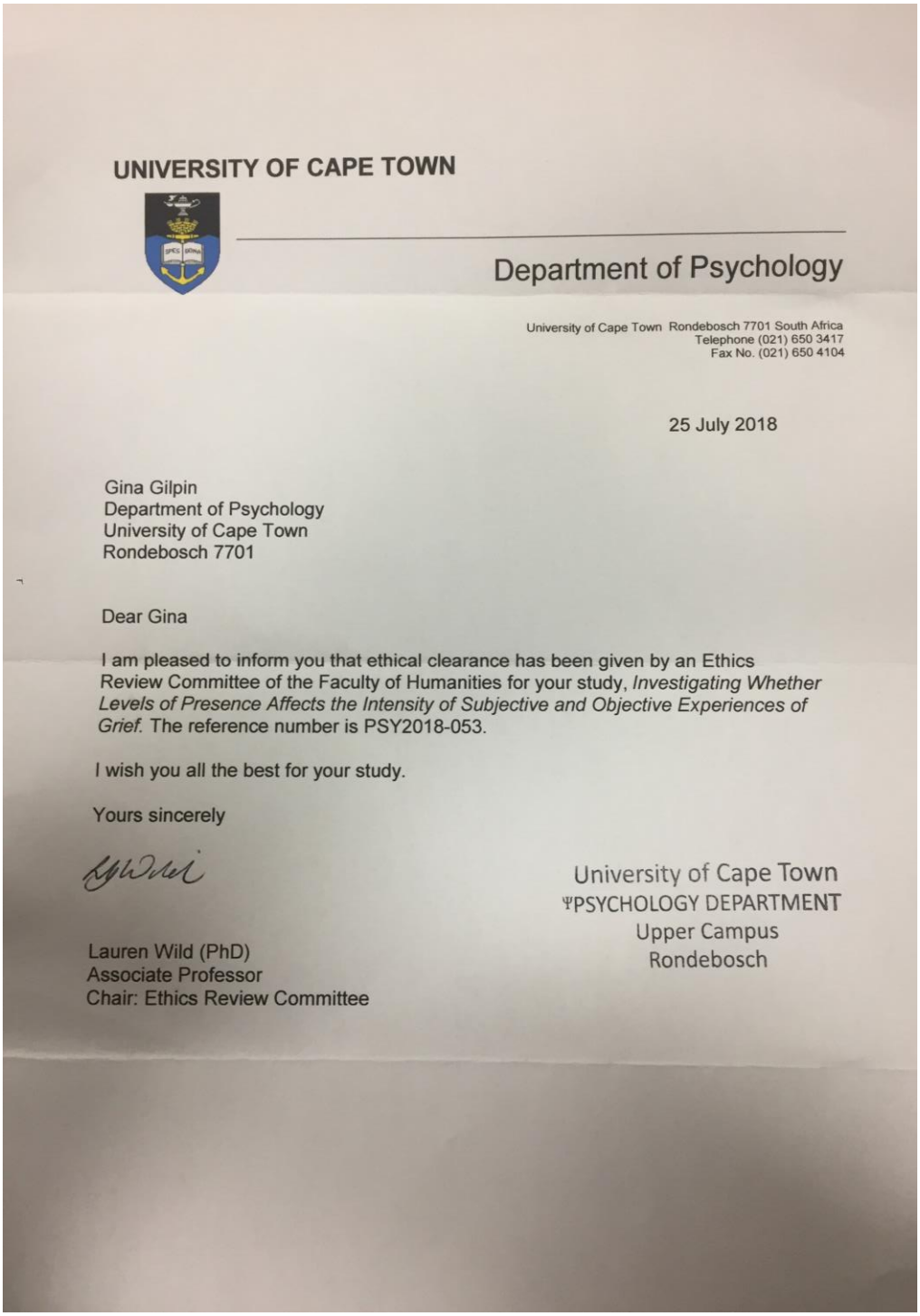


Scene 5

Scene 6

Appendix I

Ethics Approval



UNIVERSITY OF CAPE TOWN

Department of Psychology

University of Cape Town Rondebosch 7701 South Africa
Telephone (021) 650 3417
Fax No. (021) 650 4104

25 July 2018

Gina Gilpin
Department of Psychology
University of Cape Town
Rondebosch 7701

Dear Gina

I am pleased to inform you that ethical clearance has been given by an Ethics Review Committee of the Faculty of Humanities for your study, *Investigating Whether Levels of Presence Affects the Intensity of Subjective and Objective Experiences of Grief.* The reference number is PSY2018-053.

I wish you all the best for your study.

Yours sincerely

Lauren Wild (PhD)
Associate Professor
Chair: Ethics Review Committee

University of Cape Town
ΨPSYCHOLOGY DEPARTMENT
Upper Campus
Rondebosch

Appendix J

Informed Consent Document

University of Cape Town

The Effects of Presence on the Intensity of an Experienced Emotion

Purpose

I am investigating whether levels of presence have an effect on the intensity of the subjective and objective experience of emotion. Presence is the feeling of immersion, the feeling of being there and experiencing something as you would in reality. Subjective emotion refers to your own perception of what you are feeling, whereas, objective measurements look at your heart rate and skin conductance levels. I will be looking at three different conditions, text, film and virtual reality and whether they differ on the level of presence and the intensity of emotion experienced.

Procedure

If you decide to take part in this study you will be required to complete an online survey. This survey will determine whether you are eligible to continue to phase 2, the laboratory phase of the study. The survey should take approximately 30 minutes and you will be compensated with 1 SRPP point on completion.

If you are eligible to take part in the study, we will contact you via email and request that you choose a time slot that suits you best. The study will take place in the Whisper Room in the Sleep Laboratories within the UCT Psychology Department. The study will require you to fill out several self-report questionnaires and then either read, watch or interact with an emotion evoking narrative. I will also be recording physiological data which will be attached to you via adhesive electrodes. This should take approximately one hour and you will receive 2 SRPP points.

Possible Risks and Benefits

There are no risks of any psychological, physical, or psychosocial harm. If you complete the online survey you will receive 1 SRPP point and if you attend the laboratory phase of the study you will receive an additional 2 SRRP points.

Voluntary Participation

Participation is completely voluntary and participants have the right to withdraw from the study at any time without consequence.

Confidentiality

Information collected from you for the study will be kept confidential. Any identifying information will be kept in a locked file cabinet or in a password protected file on my laptop. The results of the study will not identify you or any other participant.

Questions

If you have any questions or issues related to the study please contact me on:

Gina Gilpin
Department of Psychology
University of Cape Town
ginamaygilpin@gmail.com

Or if you have any queries, comments or complaints about participation in this study, please contact:

Rosalind Adams
Department of Psychology
University of Cape Town
021 650 3417
rosalind.adams@uct.ac.za

By signing this form you are confirming that: (1) you are satisfied with the information provided to you about this study and its potential risks and benefits, (2) your questions about participation have been answered satisfactorily, (3) your participation is completely voluntary.

_____

Name of Participant

_____ _____

Signature of Participant Date

Appendix K

Background Information

Name: _____ Surname: _____

Student Number: _____

Gender (please circle): Female Male Other

Course Code (for SRPP points): _____

Is English you home language? Yes No

Appendix L
Debriefing Form

The Effects of Presence on the Intensity of an Experienced Emotion

Debriefing Form

Thank you for participating in this research study.

You were told that the purpose of this study was to measure feelings of presence and its effect on emotional experience. However, I am particularly concerned with the emotion of grief. To protect the integrity of this research, I was not able to give full details of the study at the start. This experiment is designed to investigating whether levels of presence effects the intensity of subjective and objective experiences of grief.

The experiment utilizes a between subjects design with three conditions (text, film and VR). My hypotheses were:

1. There is a significant difference in levels of presence between the conditions – with a linear increase in presence between the conditions, ranging from text with the lowest levels of presence to VR with the highest levels of presence.
2. There is a significant difference in the intensity of emotion between the conditions – with a linear increase in emotion intensity between the conditions, ranging from text with the least intense emotional experience to VR with the most intense emotional experience.
3. Presence will mediate the relationship between physiological measures and subjective emotion intensity – where higher levels of presence will indicate stronger physiological responses and more intense emotional experiences.

There is a clear need to develop more effective treatments and therapies for grief related psychopathologies like depression. However, to do so more needs to be known about the biological basis of emotion and how/why it effects cognition and behaviour. This research has historically been accomplished using methods of emotion elicitation, like static images, that aren't representative of the real world. With the emergence of VR, psychologists finally have a potential method of emotion elicitation which closely imitates the complexity and variability of real world emotional reactions. This study therefore, considers whether VR

really does elicit stronger emotional reactions than other less naturalistic techniques (like text and film).

I hope that this has given you a little bit of insight into the complex and exciting world of experimental research! If you want to learn more about emotion theory and the potential applications of virtual reality in a psychological setting then please see the additional readings below:

Barrett, L. F. (2006). Are Emotions Natural Kinds? Perspectives on Psychological Science, 1(1), 28–58. doi:10.1111/j.1745-6916.2006.00003.x

Parsons, T. D. (2015). Virtual Reality for Enhanced Ecological Validity and Experimental Control in the Clinical, Affective and Social Neurosciences. Frontiers in Human Neuroscience, 9. doi:10.3389/fnhum.2015.00660

Contact Information

If you have any further questions or concerns please ask after the study or contact either:

Gina Gilpin
Department of Psychology
University of Cape Town
ginamaygilpin@gmail.com

Gosia Lipinska
Department of Psychology
University of Cape Town
gosia.lipinska@uct.ac.za

The content of the presentation may have been distressing to you. If you still feel distressed please contact the UCT Student Wellness Centre or the UCT Student Careline on the following numbers:

- UCT Student Wellness centre: 021 650 1017 or 021 650 1020
- UCT Student Careline (a free 24-hour counselling hotline): 0800 24 25 26 free from a Telkom line or send an SMS to 31393 for a call-me-back

Appendix M

The 4-Item Primary Care Post-Traumatic Stress Disorder Screen

- Please just say yes or no to the following questions:
- In your life, have you ever had any experience that was so frightening, horrible, or upsetting, that in the past month you:

Question	Yes	No
Have had nightmares or thought about it when you didn't want to?		
Tried hard not to think out it or went out of your way to avoid situations that reminded you of it?		
Were constantly on guard, watchful, or easily startled?		
Felt numb or detached from others, activities, or your surroundings?		