Sleep-dependent Emotion Regulation in Participants with Low and High Depressive Symptoms: A pilot study

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Abstract

Depressed individuals have marked difficulties with both sleep and emotion regulation, and tend to show a bias towards negative stimuli. One possibility is that sleep may contribute to emotional dysregulation in those with depression, while in healthy individuals it may reduce emotional reactivity in response to negative stimuli. However, there are few studies that test these associations directly. We recruited 26 student participants between the ages of 18-35 years and divided participants into a low depressive symptoms group (LDS; $n = 13$) and high depressive symptoms group (HDS; $n = 13$). We tested whether those in the HDS group compared to those in the LDS group would report poorer sleep quality, and greater or maintained emotional reactivity towards negative stimuli after a sleep rather than wake interval. We also investigated associations between sleep quality and emotional reactivity. Results showed no significant between-group differences in sleep quality, and emotional reactivity towards negative stimuli after a sleep rather than wake interval. However, there was a negative moderate trend-level correlation between sleep quality and emotional reactivity in response to negative stimuli, which only existed after the sleep but not the wake interval. This association specifically shows that better sleep is associated with less emotional reactivity towards negative stimuli. Hence, preliminary findings suggested that future research should investigate the role of sleep in modulating emotional reactivity.

Keywords: depressed individuals; sleep; emotion regulation; negative stimuli; emotional reactivity; depressive symptoms; sleep quality

Current literature highlights the importance of sleep for emotion regulation (Gilson et al., 2015; Gujar et al., 2010; Tempesta et al., 2010). However, research studies describe divergent results regarding the role that sleep plays in this process. Some studies show that sleep attenuates emotional reactivity in response to negative material (Gujar et al., 2010), while other studies show that sleep maintains (Tempesta et al., 2010) or enhances such reactivity (Gilson et al., 2015). One way to gain more insight into sleep-dependent emotion regulation is to study a population with known emotion dysregulation and sleep difficulties. Depressed individuals have disruptions in both these domains (Armitage, 2007; Edge, 2010; Walker & van der Helm, 2009) and tend to show a bias towards negative stimuli (Nyer et al., 2013; Palagini et al., 2012; Vandekerckhove & Wang, 2017). This suggests that out of the three possible outcomes, sleep may act to reduce emotional reactivity in response to negative stimuli. However, there are few studies that test these associations directly.

Sleep and Emotion Regulation

While there are a handful of studies that examine sleep-dependent emotion regulation difficulties in depression, a much larger literature generally investigates the role of sleep in the regulation of emotion. This literature forms the backbone of more focused studies on sleep and emotion regulation difficulties in depressed individuals. Overall, these studies examine the relationship between sleep quality and the pre-sleep to post-sleep change in emotional reactivity in response to valenced material. The majority of studies compare the change in emotional reactivity in response to negative versus neutral stimuli (Gilson et al., 2015; Gujar et al., 2010; Tempesta et al., 2010), although some compare responses to negative, positive, and neutral stimuli (Tempesta et al., 2015) or just positive and neutral stimuli (van der Helm & Walker, 2012). Here we review literature comparing emotional reactivity in response to negative versus neutral stimuli.

Studies exploring the role that sleep plays in emotion regulation have found discrepant results. A number of studies show that sleep attenuates emotional reactivity in response to negative versus neutral stimuli. Gujar and colleagues (2010) used a between-groups experimental design (n = 36; ages 18-30 years) within a Nap (n = 18) versus No-Nap (n = 18) paradigm. They set out to determine whether individuals experiencing a long nap rich in REM sleep versus a short nap, would have attenuated emotional reactivity in response to negative versus neutral images. The results showed that ratings of negative images compared to neutral images were significantly different between groups; demonstrating lower emotional reactivity in the Nap group, and higher emotional reactivity in the No-Nap group toward negative versus neutral images (Gujar et al., 2010).

Other studies show that sleep maintains emotional reactivity in response to negative versus neutral stimuli. Tempesta and colleagues (2010) used a sleep-deprivation study which included a between-groups experimental design (n = 40; ages 20-36 years), and used a sleep deprived group (n = 20) and non-sleep deprived group (n = 20). They set out to determine the effect of sleep-deprivation on the emotional rating of standardized visual stimuli (i.e., negative stimuli versus neutral images). Tempesta and colleagues (2010) found that sleep-deprived subjects perceived neutral images more negatively, and showed an increase of negative mood compared to non-sleep deprived subjects. Thus, sleep is particularly important for maintaining stable emotional reactivity. Yet other studies show that sleep enhances emotional reactivity in response to negative versus neutral stimuli. Gilson and colleagues (2015) used a between-groups experimental design (n = 24; ages 21.8 (mean) ± 1.8 years (sd)) within a Nap (n = 12) versus No-Nap (n = 12) paradigm. They set out to determine whether individuals experiencing a long nap rich in REM sleep versus a short nap, would have attenuated emotional reactivity in response to a sad story compared to a neutral story. Surprisingly, they showed the opposite relationship. That is, after a long nap, rich in REM sleep, emotional reactivity in response to the sad story was enhanced in comparison to emotional reactivity in response to the neutral story (Gilson et al., 2015).

The reviewed literature is marked by discrepancies: while Gujar et al.'s (2010) study showed reduced emotional reactivity after healthy sleep, Gilson et al.'s (2015) study showed enhanced emotional reactivity after healthy sleep. Conversely, Tempesta et al.'s (2010) study showed reduced emotional reactivity after sleep-deprivation, suggesting that sleep is important for maintaining emotional tone. In summary, to try to understand whether sleep attenuates, maintains, or enhances emotional reactivity, it is useful to turn to a population of individuals with well-known sleep disruption and emotional dysregulation.

Sleep and Depression

In a variety of sleep studies, authors emphasise the link between depression and sleep abnormalities. Polysomnographic recordings show that in depression, sleep is characterised by; (a) longer sleep onset latency, (b) interruptions in sleep continuity, and (c) longer periods of REM sleep which comprises of; shortening of REM latency (i.e., the interval between sleep onset and the occurrence of the first REM period), increased REM duration, as well as increased REM density (Armitage, 2007; Edge, 2010; Walker & van der Helm, 2009). In addition to REM sleep abnormalities, studies show that individuals with depression have difficulties falling and staying asleep. A study by Liu and colleagues (2007) amongst adolescents (n = 535) which intended to investigate sleep disturbances associated with depression, found that more than half of the adolescents suffer from insomnia. Similarly, another study conducted by Luik and colleagues (2015) amongst adults (n = 1714) with depressive symptoms found converging results. Luik and colleagues (2015) used actigraphy recordings to investigate the sleep fragmentations associated with depression, and found that they exhibited difficulties falling asleep and had frequent awakenings. In a more recent study, Tubbs and colleagues (2020) found that depression was strongly associated with short sleep duration. This short duration may be linked to frequent awakenings and difficulties falling asleep which has been previously noted (Liu et al., 2007; Luik et al., 2015; Tubbs et al., 2020). As a result of these sleep disturbances, particularly REM sleep abnormalities, individuals with depression demonstrate malfunction in emotion regulation.

Sleep-dependent Emotion Regulation in Depression

In a limited number of studies, sleep disturbances seem to contribute to dysregulation in emotional processing (Nyer et al., 2013; Palagini et al., 2012; Vandekerckhove & Wang, 2017). In a recent study by O'Leary and colleagues (2016), it was found that poor sleep was associated with increased negative emotions in individuals with depressive symptoms. In a similar study, Markarian et al. (2013) found that emotion regulation difficulties were mediated by sleep quality in depression. Hom et al. (2016) found that firefighters who reported more sleep disturbances showed emotion regulation difficulties and consequently increased negative affect and depressive symptoms. In addition, there is evidence of significant negative bias in depressed individuals compared to healthy individuals (Gollan et al., 2016). In summary, there is some preliminary evidence that disrupted sleep in depression is associated with enhanced emotional reactivity towards negative stimuli, but there are limited studies that provide robust understanding on the relationship between poor sleep and emotion regulation in individuals with depressive symptoms.

Rationale, Aims, and Hypotheses

As outlined above, healthy sleep plays a pivotal role in regulating negative affect. However, the aforementioned studies focusing on sleep and emotion regulation show vastly distinct results. Because depressed individuals show strong evidence of both sleep disruption and emotion dysregulation, and specifically a bias towards negative material, we decided to study this population to help clarify the role sleep plays in regulating negative emotion. In summary, we investigated whether sleep disruption in individuals reporting depressive symptoms contributes to their emotional dysregulation. In essence, we aimed to learn more about the role that sleep plays in emotion regulation by studying a population with known sleep disruption and emotion dysregulation.

Based on the above proposition, our hypotheses are:

H_1: Individuals experiencing significantly high depressive symptoms in comparison with those experiencing low depressive symptoms will have poorer sleep quality.

H_2: Individuals experiencing significantly high depressive symptoms in comparison with those experiencing low depressive symptoms will have greater emotional reactivity towards negative stimuli (negative bias) after a sleep rather than wake interval.

H_3: Individuals with high depressive symptoms and significant sleep disruption, in comparison with those with low depressive symptoms and minimal sleep disruption, will show maintenance or enhancement in emotional reactivity in response to negative stimuli post-sleep.

Method

Study Design

This internet-based study used a longitudinal research design to investigate whether sleep disruption in individuals reporting depressive symptoms contributed to their emotional dysregulation. The independent variables were group status (individuals with low depressive symptoms versus those with high depressive symptoms), condition (sleep versus wake), valenced material (neutral versus negative), and sleep quality (poor versus adequate). The dependent variable was emotion regulation (attenuated, enhanced, or maintained).

Participants

26 participants (low depressive symptoms group (LDS); n = 13, high depressive symptoms group (HDS); n = 13) were recruited via the University of Cape Town's (UCT) student-wide mailing list and the Student Research Participation Programme (SRPP) using convenience non-probability sampling (see Appendix A and B). To determine the sample size for this study, a power analysis was run with an effect size of f = .25 in accordance with a similar study conducted by O'Leary et al. (2016). The power was set at .80 and alpha at .05. The analysis showed that 82 participants were required for this study to be adequately powered. However, because of the current pandemic situation, we received a low online response to the study advertisement (n = 157), and after applying the eligibility criteria (eligible n = 55; non-eligible n = 102) and excluding participants who were eligible but did not complete the protocol correctly (n = 29), we recruited N = 26.

Eligibility criteria. Participants needed to be: 1) between the ages of 18 – 35 because older age is associated with circadian and sleep alterations (Musiek et al., 2018), and 2) report low to moderate depressive symptoms. Participants with severe depression were excluded as studies suggest that Major Depressive Disorder (MDD) affects emotional responses, and as a result may impact the findings of this study (Gray et al., 2006; Schaefer et al., 2010). Comorbidity was controlled for; therefore, participants who scored high on measures of Post-Traumatic Stress Disorder (PTSD) and substance use (drugs) were excluded. Individuals with these psychiatric disorders and/or substance use disorders were excluded because psychiatric and substance use disorders have been found to alter sleep patterns and emotion regulation (Alfano et al., 2013).

Measures and Materials

Screening measures. ***The 8-Item Patient Health Questionnaire depression scale* (PHQ-8; Dhingra et al., 2011).** The PHQ-8 was used to measure depression by assessing the frequency of being bothered by 8 diagnostic criteria of Major Depression within a two-week period (see Appendix C). Total scores ranged from 0-24 points. A total score of 0-4 represented no significant depressive symptoms, 5-9 represented mild depressive symptoms, 10-14 represented moderate depressive symptoms, 15-19 represented moderately severe depressive symptoms, and 20-24 represented severe depressive symptoms (Dhingra et al., 2011). Participants who scored 0-5 were recruited for the LDS group, and participants who scored 6-14 were recruited for the HDS group. The PHQ-8 has also been found to be a reliable and valid tool (Cronbach's alpha = .81; r = .76) for screening depression in a variety of culturally diverse contexts, including Southern Africa (Beutel et al., 2016).

***Generalized Anxiety Disorder Scale-7* (GAD-7; Spitzer et al., 2006)**. The GAD-7 was used to assess for the severity of self-reported Generalized Anxiety Disorder (GAD) (see Appendix D). Items on this tool were rated on a 4-point Likert scale; with a score of 0 indicating symptom absence, and a score of 3 indicating strong endorsement of symptoms (Spitzer et al., 2006). Total scores ranged from 0-21 with higher scores indicating severe GAD symptoms. Scores of 0-10 indicated a low level of GAD while scores of 11-21 indicated a high level of GAD. Participants who scored 0-10 were recruited for the LDS group, and participants who scored 11-21 were recruited for the HDS group. The GAD-7 has also been found to be a reliable and valid tool (Cronbach's alpha = .92; $r > .75$) for screening for GAD in a variety of contexts, including Southern Africa (Chibanda et al., 2016; Kertz et al., 2012).

***Alcohol Use Disorders Identification Test-Consumption* (AUDIT-C; Bush et al., 1998)**. The AUDIT-C was used to assess active alcohol use disorders (including alcohol abuse or dependence) (see Appendix E). Each item was rated from 0-4, and total scores ranged from 0-12. There was no cut-off score for eligibility purposes as alcohol use scores varied between the LDS and HDS groups. This tool has been validated in the South African context, and has favourable reliability or internal consistency values (Cronbach's alpha = .89) (Peltzer et al., 2019).

The Drug Abuse Screening Test 10-Item Version* (DAST-10; Skinner, 1982*). The DAST-10 is a self-administered 10-item brief screening tool that assesses drug use, with the exclusion of alcohol and tobacco use, in the past 12 months (see Appendix F). Each question requires a yes/no response, and a total score of 3 or more is usually indicative of substance use disorder. Drug use scores varied between the LDS and HDS groups. However, participants who responded with 'yes' to more than 3 items were not eligible and included in the study. Yudko et al. (2007) found that this measure has high internal consistency (Cronbach's alpha = .92) and high reliability ($r = .71$) within a Southern African population.

***The 5-Item Primary Care Post-Traumatic Stress Disorder Screen* (PC-PTSD-5; Prins et al., 2016)**. The PC-PTSD-5 was used to assess Post-Traumatic Stress Disorder (PTSD) symptoms, and comprises a questionnaire with 5 yes/no questions focussing on a traumatic event in the past that primarily affected the individuals daily functioning in the last month (see Appendix G). The 5 items relate to hyperarousal, re-experience, avoidance and alterations in mood and cognition. A total score of 3 or more has been shown to indicate high post-traumatic symptoms. Trauma scores varied between the LDS and HDS groups. However, participants who responded with 'yes' to 3 or more questions were not eligible and included in the study. Previous studies have shown that this measure is reliable (r = .94) and valid within a South African context (Jina et al., 2019).

***Pittsburgh Sleep Quality Index* (PSQI; Buysse et al., 1989)**. The 19-item PSQI questionnaire was used to assess sleep quality for the month prior to the experiment (see Appendix H). There was no cut-off score for eligibility purposes as sleep quality scores varied between the LDS and HDS groups (Buysse et al., 1989; Mollayeva et al., 2016). This measure has been found to be reliable with Cronbach's alpha of more than .70 within the South African population (Lipinska & Thomas, 2017).

Experimental measures. *National Sleep Foundation Sleep Diary* (National Sleep Foundation (NSF), n.d.). An online version of the National Sleep Foundation sleep diary was used to record the participants' sleeping patterns (see Appendix I). Participants completed the diary throughout the duration of the study, and included before going to bed and within an hour upon waking up in the morning. The information recorded included the time at which the participant went to bed, the time taken to fall asleep, as well as the frequency and duration of awakenings during the night.

***The South African Affective Picture System* (SA-APS; Nestadt, 2017)**. The South African Affective Picture System (SA-APS) was used to elicit emotion (see Appendix J). The SA-APS is a more culturally and contextually relevant modification of the International Affective Picture System (IAPS), specifically to the South African population (Nestadt, 2017). This modification was done by replacing pictures of objects that might be unfamiliar to the South African population (Nestadt, 2017). The subset of the IAPS consists of 340 pictures that are categorised along the valence and arousal spectrums (Nestadt, 2017). Each picture has a standardised valence and arousal rating. The SA-APS is considered a reliable emotion-eliciting measure in South Africa with an alpha coefficient of more than .95 and split half coefficient of more than .85 (Nestadt, 2017). For the purpose of this study, a subset of 180 pictures were selected from the SA-APS. Pictures were chosen on the basis of valence and arousal. Furthermore, the subset only contained pictures that were categorised as negative and neutral. The cut-off values for valence scores were 1-3.99 for negative pictures and 4-5.99 for neutral pictures. A randomised generator system was used to select the 180 pictures which were divided into two sets; one for the sleep condition (n = 90) and one for the wake condition (n = 90). A follow-up t-test was run to ensure that there was no statistical difference in valence for negative pictures in both the sleep and wake condition. In addition, the same test was run for neutral pictures for both conditions. Furthermore, a 2 x 2 ANOVA test was run to ensure that there was a difference between negative and neutral valence ratings for each condition.

***Self-Assessment Manikin* (SAM; Bradley & Lang, 1994)**. This self-report 9-point pictorial scale was used alongside the SA-APS to rate subjective valence and arousal levels in response to each of the images that were presented (see Appendix K). The valence and arousal spectrums were structured from negative (frowning face) to neutral (neutral face) to positive (smiling face) and scored from 1-9 with anchor points 1 = negative, 5 = neutral, 9 = positive. For the purpose of this study, only the negative (1) and neutral (5) spectrums were used.

Procedure

The study consisted of a screening and experimental phase. Before starting each one of these phases, participants completed an online consent form (see Appendix L and M) relevant to that phase. During the screening phase, participants who responded to the UCT mailing list research invitation and SRPP advertisement completed the screening measures via Google Forms. Eligible participants were invited to the experimental phase of the study. They completed an online sleep diary via Google Forms for 7 days; so that a well-formed description of their sleeping patterns could be noted. A reminder to complete the tasks expected from participants were sent via WhatsApp in order to ensure that participants adhered to the study protocol. Participants were also given a WhatsApp phone call to guide them while they completed the experimental tasks. Throughout the study protocol, participants were required to maintain their regular sleep-wake schedule (that is, abstain from unusually late activities) and refrain from drinking more than 2 units of alcohol and more than one caffeinated drink not later than 10am in the morning. On the evening of day 4, participants were asked to complete an online emotion task using the South African Affective Picture System (SA-APS) via Survey Monkey. They rated each picture for valence and arousal using the Self-Assessment Manikin (SAM). On waking in the morning, participants rated their sleep for that night using the same sleep diary they used prior to evening 4. Within 30-60 minutes of waking, participants were exposed to the same pictures from the SA-APS and asked to rate the pictures in the same way. On the morning of day 7, participants did the same protocol as the evening of day 4; except the interval was 8 hours of wake, not sleep. Participants were, however, still expected to measure their sleep via the online sleep diary on the preceding nights.

Ethical considerations. Participants were informed that their participation was entirely voluntary and that they could withdraw from the study at any given time without any harmful consequences. All participants gave informed consent and received paid compensation and psychology course credits upon completion of the study. The study protocol was approved by UCT's Department of Psychology Ethics Review Committee (reference number: PSY2020-033; see Appendix N).

Statistical Data Analyses

As previously noted, participants were divided into two groups; LDS and HDS. Participants were divided into these groups based on their scores from the PHQ-8 screening questionnaire. Participants who scored 0-5 (low to mild depressive symptoms) comprised the LDS group and participants who scored 6-14 (moderate depressive symptoms) comprised the HDS group.

R programming for data science was used for the statistical analyses of this study. Alpha was set at .05 for statistical significance decisions that were made during the analyses. We ensured that the assumptions were maintained before conducting the analyses. If the assumptions were violated, such that there was a possibility of the results being inaccurate, we used non-parametric statistical procedures (Tredoux & Durrheim, 2013).

Descriptive statistics. Descriptive statistics were conducted and tested in relation to all raw data and the underlying assumptions of parametric statistical tests. All assumptions were upheld, unless otherwise stated in the results section.

Between-group differences in sleep quality. A t-test was run to test the first hypothesis which stated that individuals experiencing significantly high depressive symptoms in comparison with those experiencing low depressive symptoms will have poorer sleep quality. A sleep quality composite score was calculated using the z-scores of the continuous variables. These were the sleep efficiency, number of awakenings, and duration of awakenings variables. To calculate the z-scores, the average of the sample was subtracted from each participant's raw score and this difference was divided by the standard deviation of the sample. The scores for both number of awakenings and duration of awakenings were derived from multiplying the z-scores of these variables by -1. This was done so that all three variables used to calculate sleep quality are all going in the same direction. The sleep quality composite score was the product of adding the three variables' z-scores and dividing the total by 3.

Sleep/wake between-group differences on emotional reactivity. A mixed-design ANOVA was run to test the second hypothesis which aimed to investigate the interaction of group x valence x condition on emotional reactivity. The aim here was to determine whether participants with high compared to low depressive symptoms have increased emotional reactivity specifically towards negative stimuli after a period of sleep in comparison to wake. Emotional reactivity scores were calculated by subtracting pre-interval scores (i.e., sleep/wake) from post-interval scores (i.e., sleep/wake) in order to get a change score as we were interested in the change in emotion regulation over a period of time.

Poor sleep quality predicts emotional reactivity in individuals with depressive symptoms. Correlations were run in relation to the third hypothesis which investigated whether sleep quality and group predict emotional reactivity. Sleep quality measures garnered from the sleep diaries and group membership were the independent variables, and neutral and negative emotional reactivity were the dependent variables.

Results

Sample and Clinical Characteristics

All participants (n = 26) were between the ages of 18-35 years. Results of participant screening showed significant between-group differences on depressive symptoms scores and anxiety scores (Table 1), in accordance with the criteria of defining participant selection into the LDS and HDS groups. Our analyses also found a trend-level significance regarding sleep quality scores (Table 1), but no significant between-group differences regarding alcohol use scores, drug use scores, and trauma symptom scores (Table 1), suggesting that both groups were similar in terms of these variables. The range of scores for levels of alcohol use fell between 0-3 except for one participant from the HDS group who scored 6, drug use fell between 0-3, and traumatic symptoms fell between 0-2. Based on the inclusion criteria of the study and the expected range of scores as noted in the method section, both groups did not obtain clinically significant levels of alcohol use, drug use, and traumatic symptoms.

Table 1

Sample and Clinical Characteristics (N = 26)

	Group					
Variable	LDS (*n* = 13)	HDS (*n* = 13)	*t*	*df*	*p*	ESE
Age (years)						
Range	18-35	18-35				
PHQ-8	3.54 (1.61)	9.08 (2.63)	6.47	19.92	<0.001***	0.64
GAD-7	3.31 (2.63)	9.31 (5.14)	3.75	17.87	0.001**	0.37
AUDIT-C	0.92 (1.04)	1.54 (1.71)	1.11	19.76	0.28	0.05
DAST-10	0.38 (0.77)	0.54 (0.97)	0.45	22.83	0.66	0.01
PC-PTSD-5	0.54 (0.78)	0.31 (0.75)	-0.77	23.97	0.45	0.02
PSQI	5.15 (2.73)	7.31 (2.78)	1.99	23.99	0.06	0.14

Note. For all variables except age (years), means are presented with standard deviations in parentheses. LDS = low depressive symptoms group. HDS = high depressive symptoms group. ESE = effect size estimate (in this case, eta squared ($\eta 2$)). PHQ-8 = The 8-Item Patient Health Questionnaire depression scale. GAD-7 = Generalized Anxiety Disorder Scale-7. AUDIT-C = The Alcohol Use Disorders Identification Test-Consumption. DAST-10 = The Drug Abuse Screening Test 10-Item Version. PC-PTSD-5 = The 5-Item Primary Care Post-Traumatic Stress Disorder Screen. PSQI = Pittsburgh Sleep Quality Index.

**$p < .01$. ***$p < .001$.

Sleep Quality Differences Between Groups

To explore whether there were between-group differences in sleep quality, an independent sample *t*-test was conducted on the sleep quality composite variable. Assumptions for this analysis were upheld. The Levene's Test result was insignificant ($p = .69$), indicating homogeneity of variance. The t-test analysis showed that there was no significant difference in sleep quality between the LDS group ($M = 0.01$, $SD = 0.93$) and the HDS group ($M = -0.01$, $SD = 0.63$) (Table 2).

Table 2

Sleep Quality Differences Between Groups (N=26)

Variable	Group		95% CI for Mean Difference		
	LDS (*n* = 13)	HDS (*n* = 13)		*t*	*df*
Number of Awakenings	0.61 (0.89)	0.77 (0.87)			
Duration of Awakenings	13.85 (32.61)	10.30 (22.96)			
Sleep Efficiency	90.07 (11.83)	86.71 (17.75)			
Sleep Quality Composite			0.62; -0.67	-0.07	21

Note. For all variables except sleep quality composite, means are presented with standard deviations in parentheses; LDS = low depressive symptoms group, HDS = high depressive symptoms group; CI = confidence interval. Duration of Awakenings = in minutes; Sleep Efficiency = in percentages; Higher sleep quality composite = better sleep.

Sleep/wake Between-group Differences in Emotional Reactivity

Before proceeding to the main analysis, descriptive statistics were conducted for each variable to test that all assumptions were upheld for ANOVA. The Levene's Test result was insignificant ($p = .67$), indicating homogeneity of variance. The assumption of normality was upheld for emotional reactivity scores according to group and emotional reactivity scores according to condition, but not for emotional reactivity scores according to valence. However, since all the other variables, except for one, met this assumption and because ANOVA is robust to such violations (Skidmore & Thompson, 2012; Tomarken & Serlin, 1986; Tredoux & Durrheim, 2013), we proceeded with our intended analysis. For the main analysis, the 2 x 2 x 2 (group x valence x condition on emotional reactivity) mixed-design ANOVA was not significant and no significant interaction was found for valence-specific sleep/wake between-group differences on emotional reactivity (Table 3).

Table 3

Sleep/wake Between-group Differences in Emotional Reactivity (N = 26)

	Condition						
	Sleep		Wake				
	LDS	HDS	LDS	HDS			
Variable	(*n* = 13)	(*n* = 13)	(*n* = 13)	(*n* = 13)	*F*	*p*	ESE
ANOVA					1.59	0.15	0.00
Valence					7.70	0.01*	0.07
Neutral Change	-0.12	-0.23	-0.01	-0.03			
	(0.35)	(0.35)	(0.90)	(0.52)			
Negative Change	0.35	0.18	0.12	0.09			
	(0.33)	(0.33)	(0.45)	(0.66)			
Group					0.68	0.41	0.01
Condition					0.00	0.97	0.00
Group: Valence					0.02	0.88	0.00
Group: Condition					0.32	0.58	0.00
Valence: Condition					2.36	0.13	0.02
Group: Valence: Condition					0.01	0.91	0.00

Note. Emotional reactivity change scores are presented with standard deviations in parentheses. LDS = low depressive symptoms group; HDS = high depressive symptoms group; ESE = effect size estimate (in this case, eta squared (η2) from ANOVA output).
*$p < .05$.

Associations Between Sleep Quality and Emotional Reactivity in Individuals with Low and High Depressive Symptoms

Correlation tests were conducted to investigate whether associations between sleep quality and emotional reactivity to neutral and negative stimuli after a sleep interval varied by group. Although not significant, the results indicate that there was a negative correlation between sleep quality composite and emotional reactivity to negative stimuli after sleep in both groups. However, this correlation is more pronounced in the LDS group (Table 4).

Table 4

Correlations Between Sleep Quality Composite and The Change in Emotional Reactivity (N=26)

	Group					
	Entire Sample (N = 26)		LDS (n = 13)		HDS (n = 13)	
	Sleep Quality Composite		Sleep Quality Composite		Sleep Quality Composite	
Variable	*r*	*p*	*r*	*p*	*r*	*p*
Condition						
Sleep						
Change in Neutral Picture Ratings	0.07	0.73	0.07	0.82	0.27	0.36
Change in Negative Picture Ratings	-0.36	0.07	-0.43	0.14	-0.32	0.28
Wake						
Change in Neutral Picture Ratings	0.12	0.55	0.17	0.56	-0.01	0.96
Change in Negative Picture Ratings	0.03	0.88	-0.18	0.55	0.12	0.70

Note. LDS = low depressive symptoms group; HDS = high depressive symptoms group.

Discussion

We aimed to investigate whether sleep disruption in individuals reporting depressive symptoms contributes to their emotional dysregulation. This investigation was based on literature that shows that because depressed individuals tend to show strong evidence of both sleep disruption and emotion dysregulation, and specifically a bias towards negative material, studying this population would help us clarify the role sleep plays in regulating negative emotion. We hypothesised that individuals with high depressive symptoms will experience poorer sleep quality compared to those with low depressive symptoms. Our hypothesis was not supported by the results. Although the mean sleep quality for the HDS group was lower (Table 2), further analysis revealed that this difference was not significant and therefore sleep quality between these groups was not different as our hypothesis had postulated. This finding is inconsistent with previous studies that found that there was a strong relationship between depression and sleep disturbances with individuals with these symptoms experiencing marked sleep disruption (Liu et al., 2007; Luik et al., 2015; Tubbs et al., 2020). This similarity in sleep quality between the LDS and HDS groups may be linked to the Covid-19 lockdown that occurred during this study. A recent study by Idrissi and colleagues (2020) found that lockdown periods increased the prevalence of sleep disturbances for the general population. Therefore, the sleep findings reported in our study might have been influenced by the lockdown context. Individuals in the LDS group had some sleep disturbances and the difference between those with low and high depressive symptoms is, therefore, likely to be smaller in our study than in pre-lockdown studies examining similar participants (Cellini et al., 2020; Marelli et al., 2020).

We hypothesised that individuals with high depressive symptoms in comparison with those experiencing low depressive symptoms will have greater emotional reactivity towards negative stimuli (negative bias) after a sleep rather than wake interval. No statistical significance was obtained from the overall ANOVA model. Descriptive statistics observationally showed that those with low rather than high depressive symptoms tended to respond more positively to negative pictures after sleep rather than after wake (Table 3). However, a better powered study with more participants would be necessary to determine whether this observation in the data has any statistical merit. Promisingly, sleep studies have found that disrupted sleep in individuals who display depressive symptoms enhances or results in greater negative emotional reactivity towards negative stimuli rather than neutral stimuli (Gilson et al., 2015; O'Leary et al., 2016).

We hypothesised that individuals with high depressive symptoms and significant sleep disruption, in comparison with those with low depressive symptoms and minimal sleep disruption will show maintenance or enhancement in emotional reactivity in response to negative stimuli post sleep. Our findings indicated that there was a trend-level association between sleep quality and emotional reactivity which only existed after the sleep interval but not after the wake interval (Table 4). This negative association specifically shows that sleep quality varies with emotional reactivity to negative stimuli and no such association is present for neutral stimuli. The association shows that better sleep results in less emotional reactivity towards negative stimuli. Furthermore, this association was strongest in those with low rather than high depressive symptoms, although it was not statistically significant in either group. Tentatively, these results provide some fertile ground for further investigation, suggesting that sleep is important in modulating emotional reactivity, while waking may not have the same influence. In addition, these results tentatively suggest that specifically negative emotions are modulated during sleep and that individuals with low depressive symptoms may benefit from sleep more than individuals with high depressive symptoms. These results build on some preliminary evidence of the enhancement and maintenance of negative emotional reactivity to negative stimuli in depressed individuals as a result of dysfunctional emotional regulation during sleep (Hom et al., 2016; Markarian et al., 2013; O'Leary et al., 2016).

Limitations and Directions for Future Research

This study adds to the understanding of the role of sleep in emotion regulation in depression. However, there are limitations to be noted about this study. Firstly, the Covid-19 pandemic impacted the participants. Studies show that there was an increase in mood disorder symptoms and sleep disturbances due to the lockdown (Cellini et al., 2020; Idrissi et al., 2020; Marelli et al., 2020). As a result, our findings may be influenced by this additional factor. Future research is needed to consider this additional factor in the relationship between sleep, emotion and depression.

Secondly, the sample size was small and the results cannot be generalised to the population. A larger sample is required to achieve acceptable statistical power, which would allow visualisation of any relevant relationships, which may be masked because of limited power.

Thirdly, this was an online-based study and this might have affected the procedure of the study. Even though the participants were given instructions, the intervals between the experimental tasks were not uniform and therefore the accuracy of the results might have been affected.

Fourthly, the screening phase of this study found significant between-group differences on depressive symptoms scores and anxiety scores which may be as a result of the frequent co-occurrence of mood and anxiety disorders (Kroenke et al., 2007). Thus, our study was unable to separate the effects of depression and anxiety.

Lastly, sleep quality was calculated from subjective measures, future research may consider objective measures to measure sleep quality to increase the reliability of the findings.

Conclusion

We tested whether individuals with high rather than low depressive symptoms would have poorer sleep quality, and enhanced or maintained emotional reactivity towards negative stimuli after a sleep rather than wake interval. Our analyses did not confirm these hypotheses. The findings indicated that there were no between-group differences in sleep quality and emotional reactivity. However, we found a trend-level association between sleep quality and emotional reactivity after sleep and not after wake interval. This association showed that better sleep may result in less emotional reactivity towards negative stimuli. Although it is likely that the current Covid-19 pandemic may have narrowed the range between those with and without depressive symptoms (in such a way that more people are experiencing these symptoms), our study suggests that better sleep is associated with less emotional reactivity towards negative stimuli, and that future research should investigate the role of sleep in modulating emotional reactivity.

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We would like to thank our supervisor Dr. Gosia Lipinska for all her time, support, guidance, and constructive criticism throughout this research project. This research project would not have been what it is without her continuous guidance and thorough feedback. We would also like to thank our family and friends for their unconditional love and support throughout this unexpected Honours year.

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Appendix A:
Email Sent to UCT Mailing List

Subject: Research Invitation: The Impact of Sleep on Emotion

Dear Students,

We are Honours candidates currently conducting an internet-based research study through the Department of Psychology. This research study aims to extensively investigate the role of sleep in emotion. Your participation in this study will help us understand the importance of sleep and its effects on emotion. Your participation will be greatly appreciated!

What the study entails:

- This study involves a screening and experimental phase - you will be required to complete an online screening survey (which is estimated to take **no longer than 30 minutes**). This screening survey will determine your eligibility to move on to the experimental phase, and participate in the actual study.
- You will be expected to complete this study online on your desktop or cell phone device.
- For the actual study, you will be required to complete an online sleep diary for 7 days, so that a well-formed description of your sleeping pattern could be noted. The online sleep diary takes approximately 5-10 minutes each day to complete, and is particularly important during your participation in the study. You will also be required to maintain a regular sleep pattern for the duration of your participation in the study, but of course as close as possible to your normal sleep patterns. This means avoiding unusually late activities, and refraining from drinking alcohol and more than one caffeinated drink after 10am in the morning.
- For the actual study, you will view a series of negative and neutral pictures, and then rate how each picture makes you feel on a self-report scale – this will take **no more than 2 hours (twice for one week).**

Eligibility:

- Between the ages of 18-35 (Male and Female)

If you meet the above criteria, please follow the link below and read the screening consent form, and then complete the online screening survey as it would determine your overall eligibility for this study. We will contact you if you are eligible thereafter.
https://docs.google.com/forms/d/e/1FAIpQLSeeeO5dv6jdYFs-O9i7ykaMUb6EQXB5ig8x3VRk42eLV0HUjw/viewform?usp=sf_link

- Participants who are eligible for the actual study will be offered a R20 airtime voucher to compensate for data costs.
- On completion of the study, all participants will be entered into a draw to win a R200, R300, or R500 Pick n Pay shopping voucher.

NOTE:

1. Your responses in the survey are private and confidential.
2. Participation is voluntary.
3. Participants will be allowed to withdraw from the study at any point and for any reason without any harmful consequences.

Please do not hesitate to contact us if you require any further information. We thank you in advance.

Kindest regards,

Kaolin Lunga (Researcher) – LNGAKAO001@myuct.ac.za
Mikayler Cloete (Researcher) – CLTMIK003@myuct.ac.za
Dr. Gosia Lipinska (Supervisor) - gosia.lipinska@uct.ac.za

Appendix B:
SRPP Advertisement

Announcement: Get next year's SRPP points early!

Subject: The Impact of Sleep on Emotion

Dear Students,

We are Honours candidates currently conducting an internet-based research study through the Department of Psychology. This research study aims to extensively investigate the role of sleep in emotion. Your participation in this study will help us understand the importance of sleep and its effects on emotion. So, if you are eager to score early SRPP points for next year, your participation in our study will be greatly appreciated!

Eligibility:

- Between the ages of 18-35 (Male and Female)

If you meet the above criteria, please follow the link below and read the screening consent form, and then complete the online screening survey as it would determine your overall eligibility for this study. We will contact you if you are eligible thereafter.

https://docs.google.com/forms/d/e/1FAIpQLSeeeO5dv6jdYFs-O9i7ykaMUb6EQXB5ig8x3VRk42eLV0HUjw/viewform?usp=sf_link

6 SRPP points will be awarded to you once you have completed the entire study. If you have any further questions about this study, please email any one of us:

1) Kaolin Lunga (Researcher) – LNGAKAO001@myuct.ac.za
2) Mikayler Cloete (Researcher) – CLTMIK003@myuct.ac.za
3) Dr. Gosia Lipinska (Supervisor) - gosia.lipinska@uct.ac.za

Thank you in advance!

Appendix C:

The 8-Item Patient Health Questionnaire depression scale (PHQ-8)

Mood Screening Questionnaire

Instructions:

Below is a list of common symptoms of depression. Please read each item in the list carefully. Indicate how much you have been bothered by that symptom over the last two weeks, including today. Please select ONLY ONE rating per item.

1. Little interest or pleasure in doing things *

- 0 - Not at all
- 1 - Several days
- 2 - More than half the days
- 3 - Nearly every day

2. Feeling down, depressed, or hopeless *

- 0 - Not at all
- 1 - Several days
- 2 - More than half the days
- 3 - Nearly every day

3. Trouble falling or staying asleep, or sleeping too much *

- 0 - Not at all
- 1 - Several days
- 2 - More than half the days
- 3 - Nearly every day

4. Feeling tired or having little energy *

- 0 - Not at all
- 1 - Several days
- 2 - More than half the days
- 3 - Nearly every day

5. Poor appetite or overeating *

- 0 - Not at all
- 1 - Several days
- 2 - More than half the days
- 3 - Nearly every day

6. Feeling bad about yourself, or that you are a failure, or have let yourself or your family down *

- 0 - Not at all
- 1 - Several days
- 2 - More than half the days
- 3 - Nearly every day

7. Trouble concentrating on things, such as reading the newspaper or watching television *

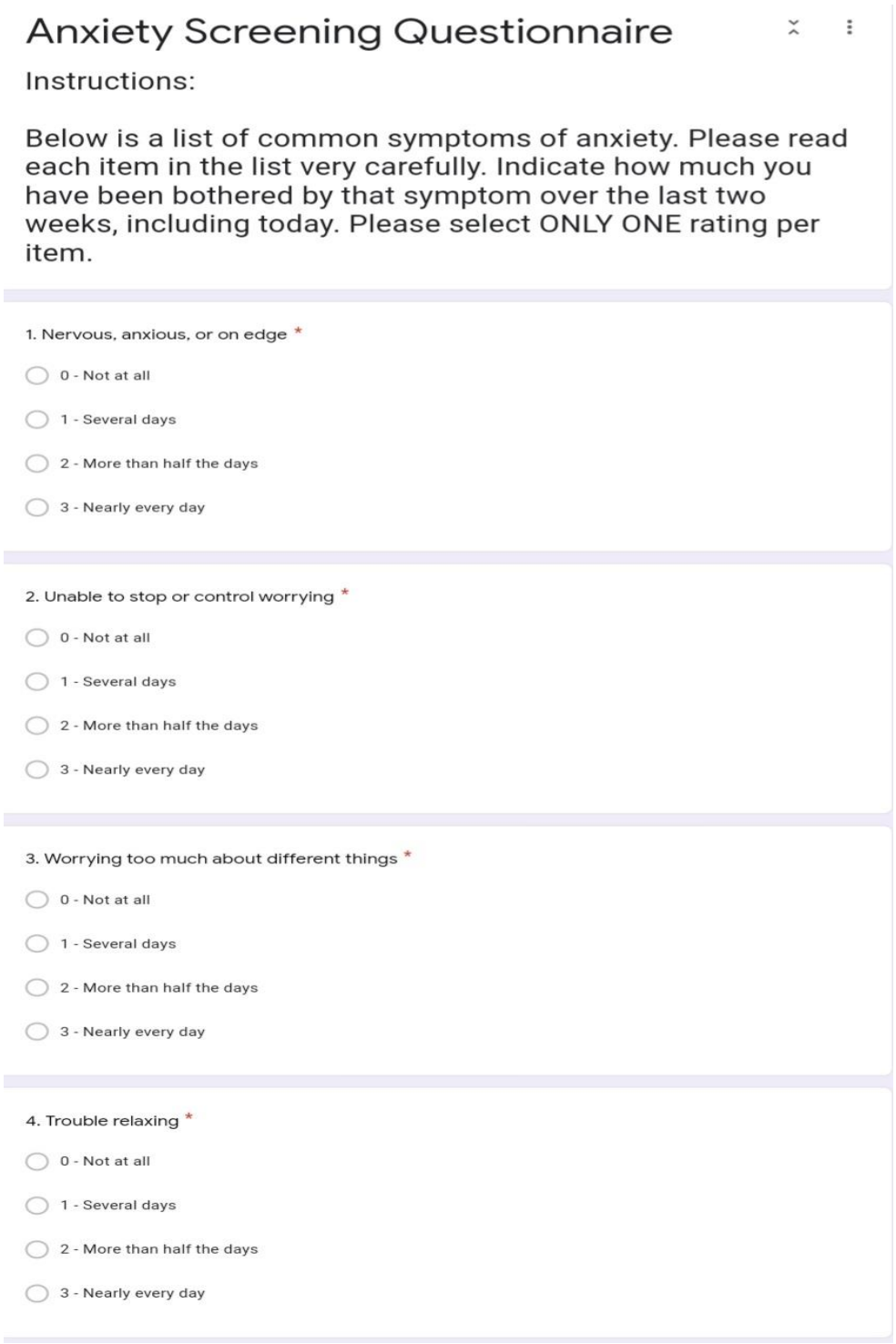
- 0 - Not at all
- 1 - Several days
- 2 - More than half the days
- 3 - Nearly every day

8. Moving or speaking so slowly that other people could have noticed OR being so fidgety or restless that you have been moving around a lot more than usual *

- 0 - Not at all
- 1 - Several days
- 2 - More than half the days
- 3 - Nearly every day

Appendix D:

Generalized Anxiety Disorder Scale-7 (GAD-7)



Anxiety Screening Questionnaire

Instructions:

Below is a list of common symptoms of anxiety. Please read each item in the list very carefully. Indicate how much you have been bothered by that symptom over the last two weeks, including today. Please select ONLY ONE rating per item.

1. Nervous, anxious, or on edge *

- 0 - Not at all
- 1 - Several days
- 2 - More than half the days
- 3 - Nearly every day

2. Unable to stop or control worrying *

- 0 - Not at all
- 1 - Several days
- 2 - More than half the days
- 3 - Nearly every day

3. Worrying too much about different things *

- 0 - Not at all
- 1 - Several days
- 2 - More than half the days
- 3 - Nearly every day

4. Trouble relaxing *

- 0 - Not at all
- 1 - Several days
- 2 - More than half the days
- 3 - Nearly every day

5. Being so restless that it is hard to sit still *

- 0 - Not at all
- 1 - Several days
- 2 - More than half the days
- 3 - Nearly every day

6. Becoming easily annoyed or irritable *

- 0 - Not at all
- 1 - Several days
- 2 - More than half the days
- 3 - Nearly every day

7. Feeling afraid, as if something awful might happen *

- 0 - Not at all
- 1 - Several days
- 2 - More than half the days
- 3 - Nearly every day

If you have selected any problem, how difficult have they made it for you to do your work, take care of things at home, or get along with other people? *

- Not difficult at all
- Somewhat difficult
- Very difficult
- Extremely difficult

Appendix E:

Alcohol Use Disorder Identification Test-Consumption (AUDIT-C)

Alcohol Use Screening Questionnaire

Instructions:

Because alcohol use can affect your sleep and sleeping patterns. It is important that we ask some questions about your use of alcohol, so please be honest.
Please select ONLY ONE answer for each question that best describes your use of alcohol.

1. How often do you have a drink containing alcohol? *

- 0 - Never
- 1 - Monthly or less
- 2 - Two to four times a month
- 3 - Two to three times a week
- 4 - Four or more times a week

2. How many drinks containing alcohol do you have on a typical day when you are drinking? *

- N/A
- 0 - One or two
- 1 - Three or four
- 2 - Five or six
- 3 - Seven to nine
- 4 - Ten or more

3. How often do you have six or more drinks on one occasion? *

- N/A
- 0 - Never
- 1 - Less than monthly
- 2 - Monthly
- 3 - Weekly
- 4 - Daily or almost daily

Appendix F:

The Drug Abuse Screening Test 10-Item Version (DAST-10)

Drug Use Screening Questionnaire

Instructions:

Because drug use can affect your sleep and sleeping patterns. It is important that we ask some questions about your use of drugs, so please be honest. Below is a list of questions concerning information about your potential involvement with drugs, excluding alcohol and tobacco, during the past 12 months.

When the words "drug abuse" are used, they mean the use of prescribed or over-the-counter medications/drugs in excess of the directions and any non-medical use of drugs. The various classes of drugs may include:
a) Cannabis (e.g. marijuana and hash)
b) Solvents
c) Tranquilizers (e.g. Valium)
d) Barbiturates
e) Cocaine
f) Stimulants (e.g. speed)
g) Hallucinogens (e.g. LSD)
h) Narcotics (e.g. heroin)

It is important to remember that the questions DO NOT include alcohol or tobacco.
If you have difficulty with a statement, then select the response that is mostly right or accurate. You are required to answer ALL of the questions.

The following questions refer to the past 12 months:

1. Have you used drugs other than those required for medical reasons? *

- ◯ 0 - No
- ◯ 1 - Yes

2. Do you abuse more than one drug at a time? *

- ◯ 0 - No
- ◯ 1 - Yes

3. Are you always able to stop using drugs when you want to? (If never use drugs, select "Yes") *

- ◯ 0 - Yes
- ◯ 1 - No

4. Have you had "blackouts" or "flashbacks" as a result of drug use? *

- 0 - No
- 1 - Yes

5. Do you ever feel bad or guilty about your drug use? (If never use drugs, select "No") *

- 0 - No
- 1 - Yes

6. Does your spouse (or parents) ever complain about your involvement with drugs? *

- 0 - No
- 1 - Yes

7. Have you neglected your family because of your use of drugs? *

- 0 - No
- 1 - Yes

8. Have you engaged in illegal activities in order to obtain drugs? *

- 0 - No
- 1 - Yes

9. Have you ever experienced withdrawal symptoms (felt sick) when you stopped taking drugs? *

- 0 - No
- 1 - Yes

10. Have you had medical problems as a result of your drug use (e.g. memory loss, hepatitis, convulsions, bleeding, etc.)? *

- 0 - No
- 1 - Yes

Appendix G:

The 5-item Primary Care Post-Traumatic Stress Disorder Screen (PC-PTSD-5)

Trauma Screening Questionnaire

Instructions:

This measure begins with an item designed to assess whether you had any exposure to traumatic events. If you did not have any exposure, the screening questionnaire is complete with a score of 0.
If you indicate a trauma history (i.e. experienced a traumatic event over the course of your life), you are instructed to answer five additional yes/no questions (see below) about how that trauma has affected you over the past month.

Sometimes things happen to people that are unusually or especially frightening, horrible, or traumatic. For example: (1) a serious accident or fire, (2) physical or sexual assault or abuse, (3) an earthquake or flood, (4) a war, (5) seeing someone be killed or seriously injured, or (6) having a loved one die through homicide or suicide. Have you ever experienced this kind of event? (If no, screen total = 0. Please stop here. If yes, please answer the five additional questions that follow) *

- ◯ Yes
- ◯ No

1. In the past month, have you had nightmares about the event(s) or thought about the event(s) when you did not want to?

- ◯ Yes
- ◯ No

2. In the past month, have you tried hard not to think about the event(s) or went out of your way to avoid situations that reminded you of the event(s)?

- ◯ Yes
- ◯ No

3. In the past month, have you been constantly on guard, watchful, or easily startled?

- ◯ Yes
- ◯ No

4. In the past month, have you felt numb or detached from people, activities, or your surroundings?

- ◯ Yes
- ◯ No

5. In the past month, have you felt guilty or unable to stop blaming yourself or others for the event(s) or any problems the event(s) may have caused?

- ◯ Yes
- ◯ No

Appendix H:

Pittsburgh Sleep Quality Index (PSQI)

Sleep Quality Screening Questionnaire

Instructions:

The following questions relate to your usual sleep habits during the past month only. Your answers should indicate the most accurate reply for the majority of days and nights in the past month.
Please answer ALL questions.

1. During the past month, what time have you usually gone to bed at night? *

Short-answer text

2. During the past month, how long (in minutes) has it usually taken you to fall asleep each night? *

Short-answer text

3. During the past month, what time have you usually gotten up in the morning? *

Short-answer text

4. During the past month, how many hours of actual sleep did you get at night? (This may be different than the number of hours you spent in bed) *

Short-answer text

5a. During the past month, how often have you had trouble sleeping because you cannot get to sleep within 30 minutes? *

- ◯ Not during the past month
- ◯ Less than once a week
- ◯ Once or twice a week
- ◯ Three or more times a week

5b. During the past month, how often have you had trouble sleeping because you wake up in the middle of the night or early morning? *

- ◯ Not during the past month
- ◯ Less than once a week
- ◯ Once or twice a week
- ◯ Three or more times a week

5c. During the past month, how often have you had trouble sleeping because you have to get up to use the bathroom? *

- Not during the past month
- Less than once a week
- Once or twice a week
- Three or more times a week

5d. During the past month, how often have you had trouble sleeping because you cannot breathe comfortably? *

- Not during the past month
- Less than once a week
- Once or twice a week
- Three or more times a week

5e. During the past month, how often have you had trouble sleeping because you cough or snore loudly? *

- Not during the past month
- Less than once a week
- Once or twice a week
- Three or more times a week

5f. During the past month, how often have you had trouble sleeping because you feel too cold? *

- Not during the past month
- Less than once a week
- Once or twice a week
- Three or more times a week

5g. During the past month, how often have you had trouble sleeping because you feel too hot? *

- Not during the past month
- Less than once a week
- Once or twice a week
- Three or more times a week

5h. During the past month, how often have you had trouble sleeping because you have bad dreams? *

- Not during the past month
- Less than once a week
- Once or twice a week
- Three or more times a week

5i. During the past month, how often have you had trouble sleeping because you have pain? *

- Not during the past month
- Less than once a week
- Once or twice a week
- Three or more times a week

5j. During the past month, how often have you had trouble sleeping because of other reason(s)? Please describe: *

Long-answer text

6. During the past month, how often have you taken medicine to help you sleep (prescribed or "over-the-counter")? *

- Not during the past month
- Less than once a week
- Once or twice a week
- Three or more times a week

7. During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity? *

- Not during the past month
- Less than once a week
- Once or twice a week
- Three or more times a week

8. During the past month, how much of a problem has it been for you to keep up enough enthusiasm to get things done? *

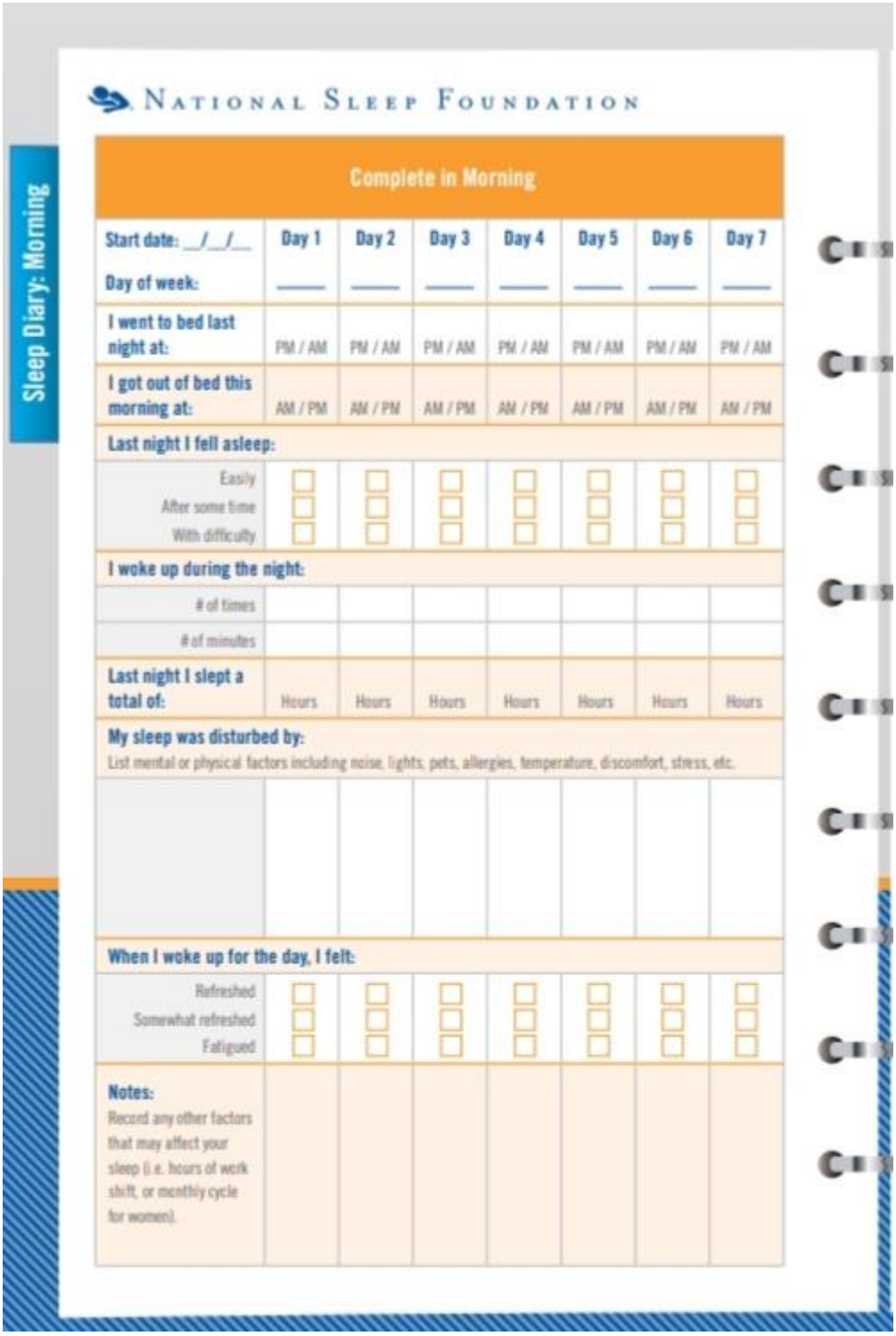
- No problem at all
- Only a very slight problem
- Somewhat of a problem
- A very big problem

9. During the past month, how would you rate your sleep quality overall? *

- Very good
- Fairly good
- Fairly bad
- Very bad

Appendix I:

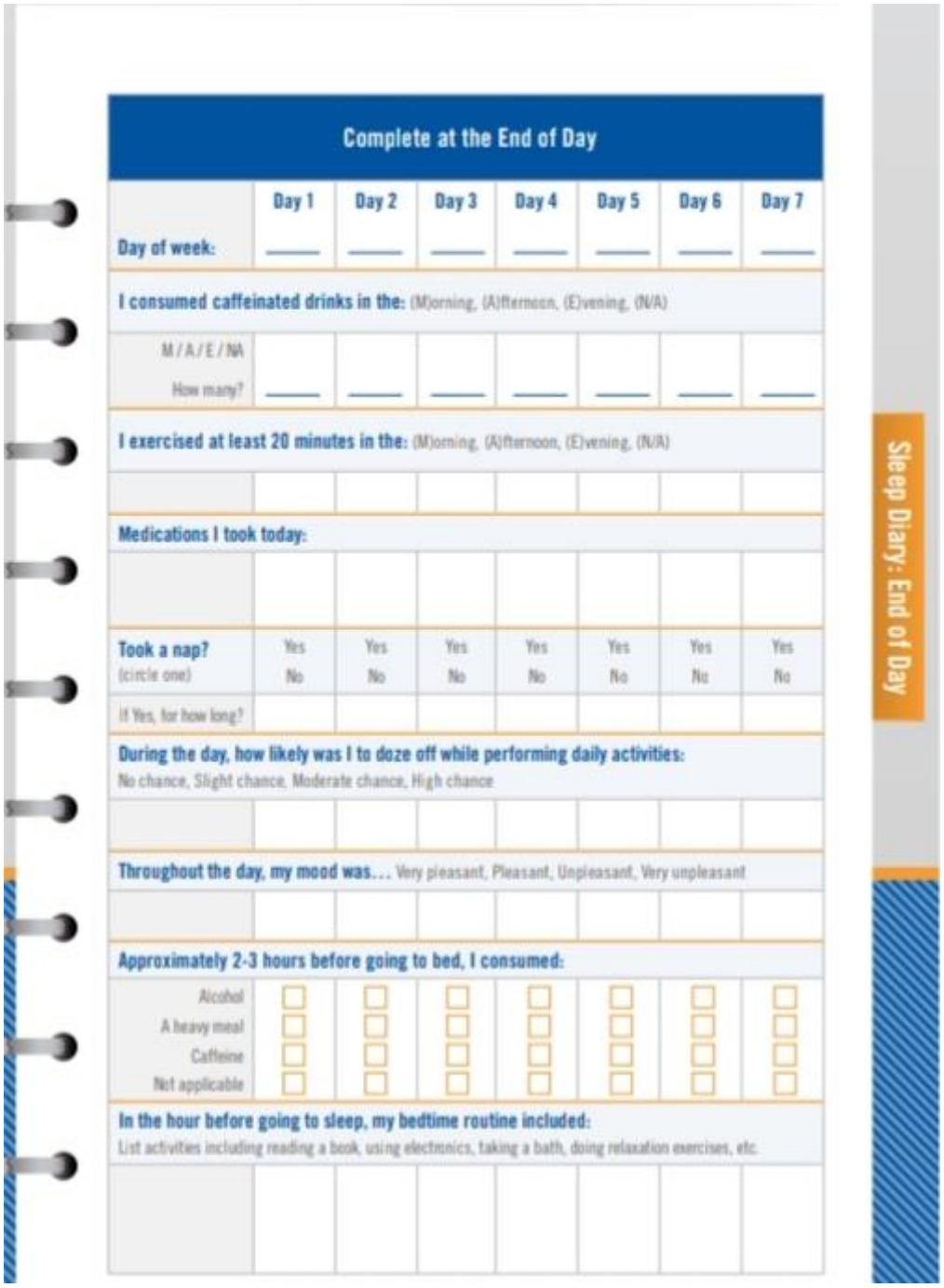
National Sleep Foundation Sleep Diary



NATIONAL SLEEP FOUNDATION

Sleep Diary: Morning

Complete in Morning							
Start date: __/__/__ Day of week:	Day 1 ____	Day 2 ____	Day 3 ____	Day 4 ____	Day 5 ____	Day 6 ____	Day 7 ____
I went to bed last night at:	PM / AM	PM / AM	PM / AM	PM / AM	PM / AM	PM / AM	PM / AM
I got out of bed this morning at:	AM / PM	AM / PM	AM / PM	AM / PM	AM / PM	AM / PM	AM / PM
Last night I fell asleep:							
Easily After some time With difficulty	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐
I woke up during the night:							
# of times							
# of minutes							
Last night I slept a total of:	Hours	Hours	Hours	Hours	Hours	Hours	Hours
My sleep was disturbed by: List mental or physical factors including noise, lights, pets, allergies, temperature, discomfort, stress, etc.							
When I woke up for the day, I felt:							
Refreshed Somewhat refreshed Fatigued	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐
Notes: Record any other factors that may affect your sleep (i.e. hours of work shift, or monthly cycle for women).							



Complete at the End of Day

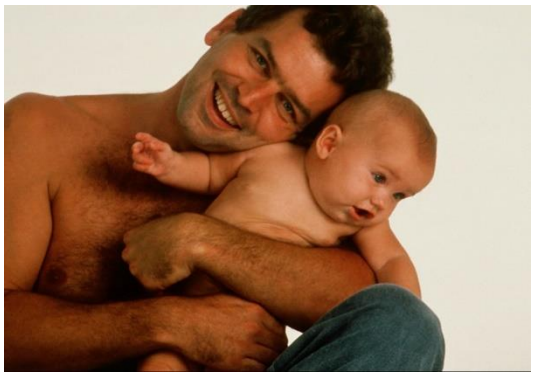
Sleep Diary: End of Day

	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Day of week:	____	____	____	____	____	____	____
I consumed caffeinated drinks in the: (M)orning, (A)fternoon, (E)vening, (N/A)							
M / A / E / NA							
How many?	____	____	____	____	____	____	____
I exercised at least 20 minutes in the: (M)orning, (A)fternoon, (E)vening, (N/A)							
Medications I took today:							
Took a nap? (circle one)	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No
If Yes, for how long?							
During the day, how likely was I to doze off while performing daily activities: No chance, Slight chance, Moderate chance, High chance							
Throughout the day, my mood was... Very pleasant, Pleasant, Unpleasant, Very unpleasant							
Approximately 2-3 hours before going to bed, I consumed:							
Alcohol	☐	☐	☐	☐	☐	☐	☐
A heavy meal	☐	☐	☐	☐	☐	☐	☐
Caffeine	☐	☐	☐	☐	☐	☐	☐
Not applicable	☐	☐	☐	☐	☐	☐	☐
In the hour before going to sleep, my bedtime routine included: List activities including reading a book, using electronics, taking a bath, doing relaxation exercises, etc.							

Appendix J:

The International Affective Picture System (IAPS) versus The South African Affective Picture System (SA-APS)

IAPS



SA-APS

Appendix K:

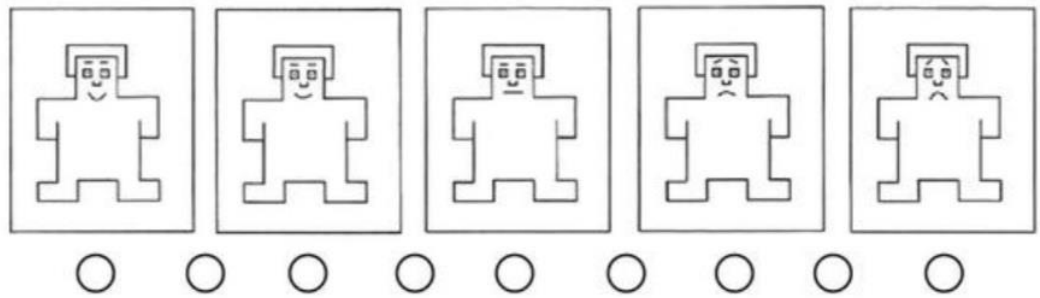
Self-Assessment Manikin (SAM)

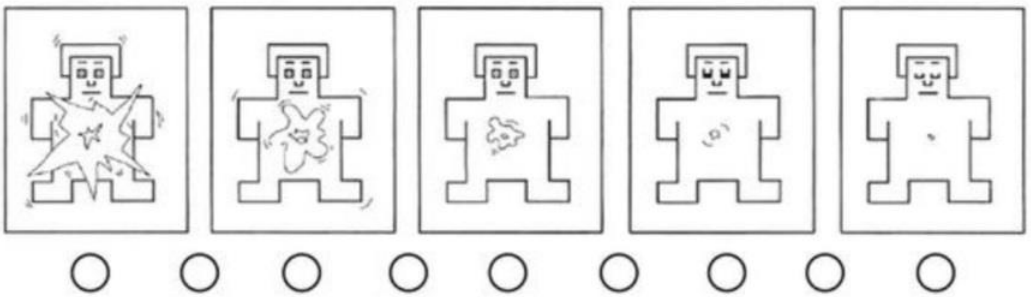
SELF ASSESSMENT MANIKIN

Indicate how you feel about the presentation by selecting the most appropriate option.

If you are unsure about what to do try and answer according to the following questions:

- Row 1: How pleasurable was the presentation for you?
- Row 2: How provoking was the presentation for you?





Appendix L:
Consent Form (Screening Phase)

Subject: The Impact of Sleep on Emotion

Dear student,

You are invited to participate in an online screening survey which forms the first part of a larger internet-based study on the impact of sleep on emotion. This study is being conducted by Honours students in the Department of Psychology at the University of Cape Town (UCT).

Screening Procedure

The screening procedure involves filling in and completing an online survey which will take 30 minutes in total. This survey is intended to gather information related to psychological symptoms, substance use (alcohol and drugs), and sleep quality. If you are eligible to participate in the second phase of the study, we will contact you to determine your interest in taking part in the actual study.

Possible Risks

By participating in this study, you may feel uncomfortable as the questions being asked might be personal. If such feelings of discomfort and distress occur or you are experiencing many psychological symptoms, you may immediately withdraw participation. If anything distresses you, please feel free to contact the Student Wellness Centre on (021) 650 1017 or book an appointment at https://outlook.office365.com/owa/calendar/STUDENTWELLNESSSERVICEPSYCHOLOGICALSERVICES@mscloudtest.uct.ac.za/bookings/. For more information, you may also visit the Student Wellness Centre website via http://www.students.uct.ac.za/students/support/health-counselling/student-wellness.

Possible benefits

There are no direct benefits for participating in this study; however, your participation will help us understand the importance of sleep and its effects on emotion.

Voluntary Participation

Participation in this screening procedure is entirely voluntary. You are free to withdraw your consent at any point during the procedure.

Confidentiality

Information obtained from this screening procedure will be kept confidential. No other party will have access to the personal information you will provide except the researchers and supervisor. To ensure safety, data will be stored in a password-protected computer. Your identity, as well as scores on the psychiatric inventories will be kept confidential.

Questions

If you have any questions or comments about the screening procedure before or after completion, please feel free to contact us:

Kaolin Lunga (Researcher) - LNGKAO001@myuct.ac.za

Mikayler Cloete (Researcher) - CLTMIK003@myuct.ac.za

Dr Gosia Lipinska (Supervisor) - gosia.lipinska@uct.ac.za

If you have any questions regarding your rights as a potential research subject, you may contact Rosalind Adams at the Psychology Department office (Tel: (021) 650 34 17 or Email: rosalind.adams@uct.ac.za).

By clicking “I agree” below; you are indicating that you have read the above information about the screening phase; including the potential risks involved, and that you are voluntarily consenting to participate in this screening phase.

I Agree ○ I Do Not Agree ○

Appendix M:
Consent Form (Experimental Phase)

Subject: The Impact of Sleep on Emotion

Dear Student,

You are invited to participate in an internet-based study on the impact of sleep on emotion. This study is being conducted by Honours students in the Department of Psychology at the University of Cape Town (UCT).

Study Purpose

This research study aims to extensively investigate the role of sleep in emotion. This investigation will allow us to learn more about the role of sleep in the regulation of emotion, especially in individuals reporting depressive symptoms.

Study Procedure

If you decide to participate in this study, you will be expected to document your sleep habits information via an online sleep diary on Google Forms for 7 days (takes approximately 5-10 minutes each day to complete). On day 1, 2, and 3, you will record your sleep via the online sleep diary. On day 4 (after 8 hours of sleep), you will view a set of pictures and then rate how they made you feel. On day 4, 5 and 6, you will continue to record your sleep via the online sleep diary. On day 7 (after 8 hours of wake), you will view and rate the same pictures you viewed on day 4.

Possible Risks

Some of the pictures in the study might be of a very sensitive nature, remind you of horrible things or make you feel uncomfortable. If such feelings of discomfort and distress occur, you may immediately withdraw from the study. If anything distresses you, please feel free to contact the Student Wellness Centre on (021) 650 1017 or book an appointment at https://outlook.office365.com/owa/calendar/STUDENTWELLNESSSERVICEPSYCHOLOGICALSERVICES@mscloudtest.uct.ac.za/bookings/. For more information, you may also visit the Student Wellness Centre website via http://www.students.uct.ac.za/students/support/health-counselling/student-wellness.

Possible benefits

A R20 airtime voucher will be offered to compensate for data costs for participating in this study. There are no direct benefits for participating in this study; however, your participation will help us understand the importance of sleep and its effects on emotion. On

completion of the study, you will be entered into a draw to win a R200, R300, or R500 Pick n Pay shopping voucher.

Voluntary Participation

Participation in this study is entirely voluntary. You are free to withdraw your consent at any point during the study.

Confidentiality

Information obtained from this study will be kept confidential. No other party will have access to the personal information you will provide except the researchers and supervisor. To ensure safety, data will be stored in a password-protected computer. In reporting the results, your identity will be kept confidential.

Questions

If you have any questions or comments about the study before or after participation, please feel free to contact the following:

Kaolin Lunga (Researcher) - LNGKAO001@myuct.ac.za

Mikayler Cloete (Researcher) - CLTMIK003@myuct.ac.za

Dr Gosia Lipinska (Supervisor) - gosia.lipinska@uct.ac.za

If you have any questions regarding your rights as a research subject, you may contact Rosalind Adams at the Psychology Department office (Tel: (021) 650 3417 or Email: rosalind.adams@uct.ac.za).

By clicking “I agree” below; you are indicating that you have read and understood this consent form, and agree to voluntarily participate in this research study.

I Agree ○ I Do Not Agree ○

Appendix N:

Ethical Approval Letter

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 2020

Mikayler Cloete and Kaolin Lunga
Department of Psychology
University of Cape Town
Rondebosch 7701

Dear Mikayler and Koalin

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, *Sleep-dependent Emotion Regulation in Depression*. The reference number is PSY2020-033.

I wish you all the best for your study.

Yours sincerely

Catherine Ward
Professor
Chair: Ethics Review Committee

Appendix O:
Debriefing Form

Subject: The Impact of Sleep on Emotion

Dear Student,

Thank you for your participation in this study. The aim of this study was to extensively investigate the impact of sleep on emotion. This investigation will allow us to learn more about the role of sleep in the regulation of emotion, especially in individuals reporting depressive symptoms. Remember that all the information you have provided during this study will be treated with strict confidentiality - this means that no other party outside of the researchers and supervisor will know of the responses provided by you in this study.

Please feel free to ask any further questions you might have by emailing any one of us: Kaolin Lunga (LNGKAO001@myuct.ac.za), Mikayler Cloete (CLTMIK003@myuct.ac.za), or Dr. Gosia Lipinska (gosia.lipinska@uct.ac.za). It is important to inform us if you have any feelings of discomfort or distress. Otherwise, you may reach out to a counsellor at the Student Wellness Centre. Sessions can be booked through the following link: https://outlook.office365.com/owa/calendar/STUDENTWELLNESSSERVICEPSYCHOLOGICALSERVICES@mscloudtest.uct.ac.za/bookings/

You may also contact the UCT Student Care Line by dialling 0800 2425 26 or SMS 31393 for a call-me-back. If you have any concerns about your rights as a research participant, you may contact the UCT Ethics committee via Rosalind Adams at (021) 650 34 17 or rosalind.adams@uct.ac.za.

Kindest regards,
Kaolin Lunga (Researcher)
Mikayler Cloete (Researcher)
Dr. Gosia Lipinska (Supervisor)