Master Thesis

The Effect of Childhood Maltreatment and Gender on Stress Susceptibility assessed by the Socially Evaluated Cold Pressure Test (SECPT)

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Abstract

Exposure to early life stressors, such as childhood maltreatment (CM) is maladaptive and can lead to enduring HPA-axis dysregulations, associated with increased stress susceptibility and a higher risk to develop psychiatric disorders in adult life. Besides CM, the factor gender is involved in the stress process and seems to be linked with CM. Therefore, based on previous research, it was hypothesized that individuals who experienced CM and women are more susceptible to stress. The 'Socially Evaluated Cold Pressor Test' (SECPT) in which a physiological, cold pressor (immersion of hand in cold water) and psychological stressor (social-evaluative threat) are combined, was used as stress paradigm.

49 participants (57.1% female; 42.9% male) took part in this randomized controlled cross-over study, 30.6% of the participants reported less severe CM (adverse childhood life events, ACLE), 51% severe CM (childhood trauma; CT). All participants were allocated in the stress- (cold water) and control condition (warm water). Analyses of variance for repeated measures were used to analyze the effect of ACLE, CT and gender on the time in water (stress susceptibility).

Results indicated a borderline significant interaction for time in water and severe CT, showing that subjects who experienced CT are more susceptible to the cold water than subjects who did not experience CT. No significant interaction for time in water and ACLE were found, thus, CT seems more indicative for enhanced stress susceptibility in adult life than ACLE. No significant interaction for time in water and gender was found. However, although the inclusion of female subjects in stress research is challenging, it is considered highly valuable. Statistically significant differences between the mean times in the cold- and warm water indicated SECPT utility in stress research.

Key words: childhood maltreatment, adverse childhood life events, childhood trauma, gender, stress susceptibility, socially evaluated cold pressor test (SECPT)

Introduction

Stress is omnipresent, unavoidable and occurs in diverse contexts, thus, it is an inevitable consequence of living (Salleh, 2008; Schwabe, Haddad & Schachinger, 2008; Selye, 1987). Fundamentally, stress serves adaptive functions and is characterized by the activation of two major neurobiological systems: the sympathetic nervous system (SNS) and the hypothalamus pituitary adrenal (HPA-) axis. When activated, the HPA-axis triggers the release of the stress hormones cortisol and catecholamine. Subsequently, the fight-or-flight response is elicited, leading to adaptive physiological changes that mobilize energy to promote escape and survival (Gunnar & Quevedo, 2007; Heim & Nemeroff, 2001; Lupien & Seguin, 2013; Schwabe, Haddad & Schachinger, 2008).

However, exposure to early life stressors, such as childhood maltreatment (CM) is maladaptive and can lead to enduring HPA-axis dysregulations, associated with increased stress susceptibility and a higher risk to develop psychiatric disorders in later life (Elzinga et al., 2007; Gunnar & Quevedo 2007; Lupien et al., 2009; McEwen, 2008; Neigh, Gillespie & Nemeroff, 2009; Salleh, 2009; Springer et al., 2007). For instance, a systematic review by Teicher & Samson (2013) revealed that individuals with depression, anxiety and substance use disorders who experienced CM showed an earlier age of onset, greater symptom severity, more comorbidity, increased suicide risk and poorer treatment response than individuals who did not experience CM. However, before further examining why CM increases stress susceptibility and the risk to develop psychiatric disorders, it is essential to clarify what the term CM exactly encompasses.

CM can be considered a broad term and various subtypes of CM have been defined (WHO, 2017). In this paper, CM will be used to refer to childhood abuse and neglect, which implies threatening or violent behavior towards a child that results in serious harm. Since CM can be active or passive, it can be divided in acts of ‘commission’ and ‘omission’.

Commission describes intentional physical, sexual or psychological abuse, whereas omission involves neglect, characterized by the failure of a child's caregiver to provide basic physical or emotional needs (Baat et al., 2011; Leeb et al., 2008). Furthermore, it needs to be considered that although CM is likely to be underestimated due to low disclosure rates, it constitutes a global problem affecting the lives of millions of individuals (Heim et al., 2010; Teicher & Samson, 2013; WHO, 2016).

But why does CM lead to deleterious effects that prevail even in adult life? A possible explanation of the detrimental long-term consequences of CM might lie in the effects of CM on the brain. Studies in animals and humans have shown that during childhood, the brain is particularly sensitive to stress since it undergoes important changes during this period of life (Lupien et al., 2009; Pechtel & Pizzagalli, 2011). A growing number of research indicated a link between CM and diverse structural and functional brain differences. CM seems to alter the development of brain regions and pathways, which in turn leads to modifications in the stress response, contributing to the emergence of psychiatric disorders in adult life (Heim & Nemeroff, 2001; Pechtel & Pizzagalli, 2010; Teicher et al., 2003; Teicher & Samson, 2016). Additionally, it is hypothesized that, from an evolutionary perspective, the changes in the brain caused by CM serve adaptive purposes. Alterations in the neural development seem to enable the occurrence of intense fight-or-flight responses to react to deprivation in harmful environments. However, these modifications become disadvantageous in benign environments, when higher stress susceptibility is not required anymore (Teicher et al., 2003).

Besides CM, the factor gender should receive special consideration since CM and gender both have potent influences on stress susceptibility, and there seems to be a complex relationship between the two (Lupien et al., 2009; Teicher et al., 2003). Furthermore, both factors affect diverse aspects involved in the stress process. Firstly, gender-differences in

appraisal and coping strategies play a major role when it comes to stress susceptibility. For instance, a study on gender differences in stress and coping styles reported that women rated life events more negative and less controllable than men and suffered more stress as their coping style was more emotion-focused (Matud, 2004). In line with that, Longest & Thoits (2012) revealed that women seem more vulnerable to stressors than men. They hypothesized that the same stressors may carry different meanings for women and men, leading to different impacts on psychological and physical health. Secondly, gender seems to affect the kind of situations women and men typically encounter (Helgeson, 2011; Teicher et al., 2003), for instance, women seem to be more likely to experience sexual assault and child sexual abuse than men (Tolin & Foa, 2006). Thirdly, gender dimorphism plays an important role when it comes to divergences in stress susceptibility since CM seems to cause different neurobiological manifestations in women and men (Kudielka & Kirschbaum, 2005). For instance, previous research indicated that CM is linked to corpus callosum alterations, which leads to alterations in the communication between the cortical hemispheres. Sexual abuse seems to be associated with diminished corpus callosum size in females, while diminished corpus callosum size in males was associated with neglect (Teicher et al., 2000; Teicher et al., 2004; Teicher et al., 2003). Also, gender differences in HPA-axis functioning may be due to gender dimorphism in brain functioning (Kudielka & Kirschbaum, 2005). However, a detailed examination of the underlying mechanisms would be beyond the scope of this paper.

Much of the available information about the effects of CM and gender on stress susceptibility and psychiatric disorders was derived from valid and reliable standardized stress protocols like the Trier Social Stress Test (TSST; Kirschbaum, Pirke & Hellhammer, 1993) or the cold-pressure test (CPT; Minkley et al., 2014; Neigh, Gillipsie & Nemeroff, 2009; Schwabe, Haddad & Schachinger, 2008). The Socially Evaluated Cold Pressure Test (SECPT), an expansion of the CPT in which a physiological, cold pressor (immersion of hand

in cold water) and psychological stressor (social-evaluative threat) are combined, constitutes a relatively new paradigm. However, previous studies demonstrated that the SECPT seems a highly efficient, quick and cost-effective method to induce stress (Minkley et al., 2014; Schwabe, Haddad & Schachinger, 2008).

To sum up, considering the detrimental long-term effects of CM and the complexity of the relationship between CM and gender, it is crucial to gain a better insight in divergences in stress susceptibility caused by long-term maladaptation to stress (Heim & Nemeroff, 2001). Therefore, the effect of CM and gender on stress susceptibility will be examined by means of the SECPT as described by Schwabe, Haddad & Schachinger (2008). Stress susceptibility is measured by the duration subjects leave their hand in the water, subjects who leave their hand shorter in the cold water are considered more susceptible to stress than subjects who leave their hand longer in the cold water. Based on previous literature, it is hypothesized that:

1) Subjects who experienced CM leave their hand shorter in the cold water than subjects who did not experience CM.
2) Women leave their hand shorter in the cold water than men.
3) Women who experienced CM leave their hand shorter in the cold water than men who experienced CM.

Methods

Participants

The sample consisted of 49 participants with an average age of 23.9 years (Min 18, Max 30, SD = 2.49). 28 participants were female (57.1%) and 21 participants were male (42.9%). As shown in table 1, this study distinguished between less severe childhood maltreatment (CM) indicated by 'adverse childhood life events' (ACLE) and severe CM indicated by 'childhood trauma' (CT). 15 participants (30.6%) reported ACLE, the most common ACLE was 'divorce' (28.6%). CT was reported by 25 participants (51%) with 'emotional neglect' (22.4%) constituting the most commonly reported CT. 'Sexual abuse after age 16' was experienced by 10 participants (20.4%), 'psychological abuse' and 'physical abuse' were both experienced by 7 participants (14.3%, see table 1).

Table 1. *Frequency distributions of childhood maltreatment (CM) divided in adverse childhood life events (ACLE) and childhood trauma (CT)*

Type of CM	Number of reported events
ACLE (n = 15)	
Divorce	14 (28.6%)
Children's home	1 (2%)
Juvenile prison	1 (2%)
Foster home	1 (2%)
Ran away	0 (0%)
CT (n = 25)	
Emotional neglect	11 (22.4%)
Psychological abuse	7 (14.3%)
Physical abuse	7 (14.3%)
Sexual abuse before age 16	4 (8.2%)
Sexual abuse after age 16	10 (20.4%)

19 different nationalities were represented, however, the three most prevalent nationalities were Dutch (18.4%), German (14.3%) and Spanish (8.2%). Most of the participants were university students from Utrecht University. Participants were recruited via bulletins, flyers

and an experiment management system for research study participation (SONA). No monetary compensation was granted, but participants were compensated with research study participation credits if desired. All participants provided written informed consent and the research protocol was approved by the local ethics committee.

Measures

Socially Evaluated Cold Pressor Test (SECPT)

The SECPT constituted the laboratory stressor in this study. It is an extended version of the cold-pressor test (CPT), a laboratory stressor in which subjects place their hand in cold water to elicit SNS activation. Besides the cold-pressor element, the SECPT also includes social-evaluative elements, firstly, a female observer watching the participant and, secondly, a camera, recording the participant when placing one hand in cold water. This incorporation of social evaluative elements elevates cortisol, which indicates reactivity of the HPA-axis. In contrast, HPA-axis activation seems only moderate to low in the CPT (Schwabe, Haddad & Schachinger, 2008), therefore, the SECPT was evaluated as adequate laboratory stressor for this study.

Childhood maltreatment (CM)

CM was assessed by means of a shortened version of the 'Childhood Trauma Interview' (CTI), originally used in the Netherlands Mental Health Survey and Incidence Study (NEMESIS). The CTI is a reliable and valid structured interview which assesses 'adverse childhood life events' (ACLE) and 'childhood trauma' (CT) retrospectively (Foote & Lovejoy, 1995).

In the first section, ACLEs were assessed. Participants were asked to indicate on a dichotomous scale whether ACLEs pertaining separation and losses before the age of 16 years were experienced (coded 1) or were not experienced (coded 0). The events assessed, were as follows: 'divorce of parents', 'placement in children's home', 'inhabitation in

juvenile prison', 'raised in foster family' and 'ran away from home' (see Appendix A). The sum of the experienced ACLEs for each participant was calculated. For this study, the variable ACLE was dichotomized, resulting in a binary variable consisting of the 'ACLE' (coded 1) and 'none ACLE' group (coded 2).

In the second section, CT was assessed on a continuous scale by measuring 'emotional neglect', 'psychological abuse', 'physical abuse', 'sexual abuse before age 16' and 'sexual abuse after age 16'. Participants were asked to indicate the frequency of occurrence on a five-point scale (0 = never, 1 = once, 2 = sometimes, 3 = regularly, 4 = often, 5 = very often). All questions, expect the last question about sexual abuse, referred to the participants first 16 years of life (see Appendix A). The continuous variable CT was also dichotomized, resulting in a binary variable containing the group 'CT' (coded 1) including individuals who experienced at least one CT and the 'none CT' group (coded 0).

Subjective stress (SS)

Self-reported SS was assessed by means of a five-item questionnaire. Participants had to indicate on a five-point scale (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree) how 'stressful' (item 1), 'painful' (item 2) and 'unpleasant' (item 3) placing the hand in the water was experienced. Furthermore, participants were asked to indicate how unpleasant they experienced the presence of the 'observer' (item 4) and the 'camera' (item 5) (see Appendix B).

The present study was embedded in a larger research project in which participants were also instructed to fill in the 'Neuroticism, Extraversion, Openness five-factor inventory' (NEO-FFI; Costa & McCrae, 1989) and to perform the 'Stroop task' to measure divided attention (Stroop, 1935). However, this is not focus of the present paper, therefore, these measures will not be elaborated in more detail.

Procedure

A randomized, controlled cross-over design was applied, thus, all participants were allocated to the stress condition (cold water) and control condition (warm water) on two different days. The sequence of the two conditions was counterbalanced to avoid confounding due to order effects. All experimental sessions were run between 11am and 6pm to control for diurnal cycle of cortisol. On the first day, the experimental procedure was explained to the participants. Subsequently, participants were asked to complete the CTI, then the SECPT was performed. Participants were randomly assigned to the cold water condition or the warm water condition. All participants were informed that they will be filmed during this part of the experiment, then the camera was turned on. Additionally, a female observer who was placed in front of the participant, stayed in the room.

Cold water condition (experimental condition; n= 49). Participants were asked to place one hand including the wrist into a bowl filled with cold water (0-4 °C). Timing began with the immersion of the hand in the water. Since placing the hand in cold water can be painful, subjects were told to keep their hand as long as possible, but not longer than three minutes in the water. Furthermore, they were instructed to withdraw their hand when the pain could no longer be endured. After three minutes, participants were asked to remove their hand from the bowl, then the camera was turned off.

Warm water condition (control condition; n=49). Participants were asked to place one hand as long as possible, but not longer than three minutes into a bowl filled with warm water (35-36 °C). After three minutes, participants were instructed to take their hand out of the water, subsequently, the camera was turned off.

In both conditions, immediately after taking the hand out of the water, participants were asked to complete the SS test.

Data analysis

Spearman's rho (r_s) was used to assess nonparametric rank correlations between the variables gender, ACLE, CT, time in cold water, time in warm water, SS in the cold- and warm water condition, age and menstrual cycle. Analyses of variance for repeated measures were used to analyse the effect of ACLE, CT and gender on the time in water (time in cold water/time in warm water). In all repeated measures 'time in water' constituted the within-subjects factor. To answer the first hypothesis, repeated measures with ACLE as between-subjects factor was performed, secondly, repeated measures with CT as within-subjects factor was used. To answer the second hypothesis, repeated measures with gender as between-subjects factor was performed. Finally, to answer the third hypothesis, repeated measures with the 4-level variable 'gender-ACLE (males/females with ACLE, males/females without ACLE) as between-subjects-factor was used. Subsequently, repeated measures with the 4-level variable 'gender-CT (males/females with CT males/females without CT) as between-subjects factor was used. All data were analysed with the statistic software 'Statistical Package for the Social Sciences 24' (SPSS). An alpha value $p < 0.05$ indicated statistical significance results for all analyses.

Results

Correlational analysis

Spearman's rho was assessed and a positive, statistically significant correlation between gender and subjective stress (SS) in the cold water condition ($r_s = 0.45$, $n = 49$, $p < 0.01$) and a negative correlation between ACLE and time in warm water ($r_s = -0.36$, $n = 49$, $p < 0.05$) was revealed. Furthermore, statistically significant negative correlations were found between time in cold water and SS in the cold water condition ($r_s = -0.51$, $n = 49$, $p < 0.01$), time in warm water and SS in the warm water condition ($r_s = -0.3$, $n = 49$, $p < 0.05$) and a positive correlation between SS in the cold water condition and SS in warm water condition ($r_s = 0.32$, $n = 49$, $p < 0.05$). All other variables did not significantly correlate with each other (see table 2).

Table 2. *Values of Spearman's rho correlations between gender, adverse childhood life events (ACLE), childhood trauma (CT), time in cold- and warm water, subjective stress (SS) rating in cold- and warm water condition, age and menstrual phase (n = 49)*

	1	2	3	4	5	6	7	8	9
1 Gender									
2 ACLE	0.2								
3 CT	0.04	0.12							
4 Time in cold water	-0.17	0.02	-0.23						
5 Time in warm water	-0.05	-0.36*	-0.14	0.27					
6 SS in cold water	0.45**	0.07	0.022	-0.51**	-0.1				
7 SS in warm water	0.05	-0.01	-0.005	-0.23	-0.3*	0.32*			
8 Age	-0.18	0.006	0.09	-0.11	-1.5	-0.15	0.1		
9 Menstrual cycle [a]	-	0.09	0.08	0.05	-0.34	0.13	0.08	-0.29	

[a]. n = 27, women

**. Correlation is significant at the 0.01 level (2-tailed)

*. Correlation is significant at the 0.05 level (2-tailed)

Repeated measures

The mean time in the cold water was 123.86 seconds (SD=64.28), whereas the mean time in warm water was 177.25 seconds (SD=8.78; see table 4). A statistically significant difference between the two mean times was revealed by all repeated measures analyses performed (see table 3).

ACLE and CT (hypothesis 1)

ACLE was reported by 15 participants (30.6%), whereas CT was reported by 25 participants (51%, see table 1). Firstly, repeated measures with ACLE as between-subjects factor was performed, revealing no statistically significant effect for the ACLE x time in water interaction, $F(1, 47) = 0.15$, $p = 0.7$.

Secondly, repeated measures with CT as between-subjects factor was performed, revealing a borderline significant effect for the CT x time in water interaction, $F(1, 47) = 2.95$, $p = 0.09$ (see table 3).

Gender (hypothesis 2)

28 participants were female (57.1%) and 21 participants were male (42.9%, see table 1). Mean times in cold water were higher in men (137.48, SD=61.41) than in women (113.65, SD=65.57; see table 4), however, repeated measures with gender as between-subjects factor, revealed no statistically significant gender x time in water interaction, $F(1, 47) = 1.62$, $p = 0.21$ (see table 3).

Gender-ACLE and gender-CT (hypothesis 3)

Four men (2%) and eleven women (5.4%) reported ACLE, whereas nine men (4.4%) and 16 women (7.8%) reported CT (see table 4). Repeated measures with the four-level ACLE-gender variable as between-subjects factor, revealed no statistically significant gender-ACLE x time in water interaction, $F(3, 45) = 0.73$, $p = 0.54$. Post-hoc analysis using Fisher's least significant difference (LSD) test also did not indicate significant results (see Appendix C).

Repeated measures with the four-level variable gender-CT as between-subjects factor also indicated no statistically significant gender-CT x time in water interaction, $F(3, 45) = 1.63$, $p = 0.2$ (see table 3). The post-hoc LSD test indicated that men without CT left their hand significantly longer in the water than women without CT ($M = 27.76$, $SD = 12.7$, $p = 0.03$). Furthermore, the post-hoc LSD test revealed a borderline significant effect indicating that time in water of men who experienced CT was higher than the time in water of men who did not experience CT ($M = 28.7$, $SD = 14.66$, $p = 0.07$, see Appendix D).

Additionally, repeated measures analyses were performed with subjective stress (SS) rating as within-subjects factor to examine whether SS ratings differ between the two conditions (cold water condition, warm water conditions). A significant difference between SS rating in the cold water condition and warm water condition was found, no other significant results were revealed (see Appendix E).

Table 3. *Interactions between time in water and childhood trauma (CT), adverse childhood life events (ACLE), gender and the four level variables CT-gender and ACLE-gender*

	df	F-value	p-value
Time in water (ACLE)	1	28.65	<0.05
Time in water * ACLE	1	0.15	0.7
Time in water (CT)	1	37.3	<0.05
Time in water * CT	1	2.95	0.09
Time in water (gender)	1	33.84	<0.05
Time in water * gender	1	1.62	0.21
Time in water (gender-ACLE)	3	20.08	<0.05
Time in water * gender-ACLE	3	0.73	0.54
Time in water (gender-CT)	3	35.54	<0.05
Time in water * gender-CT	3	1.63	0.2

However, looking at the mean times in the water conditions revealed multiple insights. Regarding hypothesis 1, individuals who experienced ACLE left their hand slightly shorter in the cold water (122.81, SD=65.65) than individuals who did not experience ACLE (124.33, SD=64.66). In contrast, individuals who experienced CT always left their hand considerably shorter in the cold water (107.83, SD=67.41) than individuals who did not experience CT (140.57, SD=57.52), also mirrored by the borderline significant effect found for the CT x time in water interaction (see table 3). Although mean times between individuals with and without CT are notably different, the SS mean scores did not differ much between individuals with CT (10.6, SD=2.63) and without CT (9.75, SD=2.58, see table 4).

Regarding hypothesis 2, men (137.48, SD=61.41) left their hand longer in the cold water than women (113.65, SD=65.57). Thus, based on the mean scores, women seem more susceptible to the cold water then men. SS ratings were accordingly, with women scoring higher (11.14, SD=2.69) than men (8.9, SD=1.9; see table 4).

Regarding hypothesis 3, men with ACLE (148.84, SD=62.32) and CT (108.61, SD=67.91) left their hands longer in the cold water than women with ACLE (113.34, SD=67.07) and with CT (M=107.38, SD=69.91), though differences in mean times of men and women with CT were small. However, as presented in figure 2, it seems remarkable that men who experienced CT seem more susceptible to the cold water (108.61, SD=67.91) than men without CT (159.13, SD=48.06) compared to women with CT (107.36, SD=69.36) and without CT (122.02, SD=62.11; see table 4; figure 2).

Table 4. *Mean times (seconds) in cold/warm water and subjective stress (SS) ratings of cold and warm water condition of men and women with/without adverse childhood life events (ACLE) and childhood trauma (CT)*

		Cold water (SD)		Warm water (SD)	
Gender, CM type	n (%)	Mean time	SS	Mean time	SS
ACLE	15 (30.61)	122.81 (65.65)	10.4 (2.53)	171.02 (19.44)	6.87 (2.45)
No ACLE	34 (69.39)	124.33 (64.66)	10.09 (2.68)	180 (0)	6.56 (2.03)
CT	25 (51)	107.83 (67.41)	10.6 (2.63)	175.83 (14.63)	6.36 (1.89)
No CT	24 (48.98)	140.57 (57.52)	9.75 (2.58)	178.73 (6.21)	6.96 (2.39)
Men	21 (42.9)	137.48 (61.41)	8.9 (1.9)	177.9 (9.6)	6.29 (1.35)
Women	28 (57.1)	113.65 (65.57)	11.14 (2.69)	176.76 (12.58)	6.93 (2.58)
Men, ACLE	4 (1.96)	148.84 (62.32)	9 (1.41)	169 (22)	6 (1.41)
Men, no ACLE	17 (8.33)	134.81 (62.82)	8.88 (2.03)	180 (0)	6.35 (1.37)
Women, ACLE	11 (5.39)	113.34 (67.07)	10.91 (2.7)	171.75 (19.53)	7.18 (2.71)
Women, no ACLE	17 (8.33)	113.86 (66.66)	11.29 (2.76)	180 (0)	6.76 (2.56)
Men CT	9 (4.41)	108.61 (67.91)	9.44 (2.07)	175.11 (14.67)	6.22 (1.2)
Men, no CT	12 (5.88)	159.13 (48.06)	8.5 (1.73)	180 (0)	6.33 (1.5)
Women, CT	16 (7.84)	107.38 (69.36)	11.25 (2.75)	176.23 (15.08)	6.44 (2.22)
Women, no CT	12 (5.88)	122.02 (62.11)	11 (2.73)	177.46 (8.78)	7.58 (2.97)
Total	49	123.86 (64.28)	10.18 (2.61)	177.25 (11.3)	6.65 (2.15)

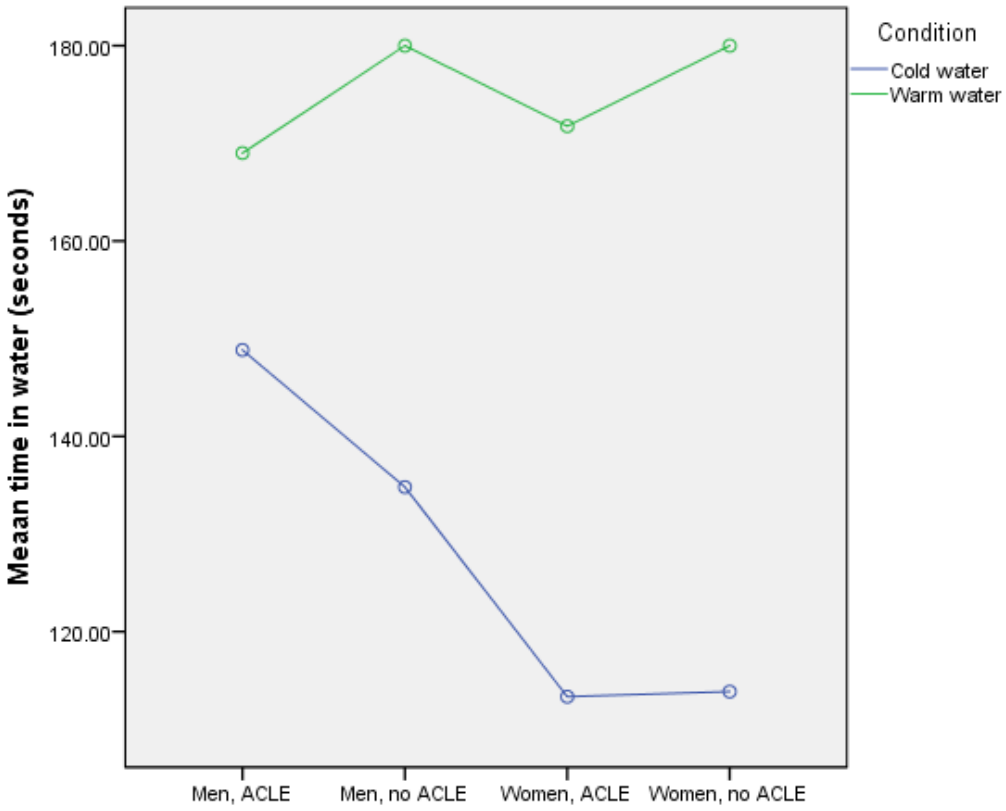

Figure 1. *Interaction between gender-adverse childhood life events (ACLE) and time in cold and warm water*

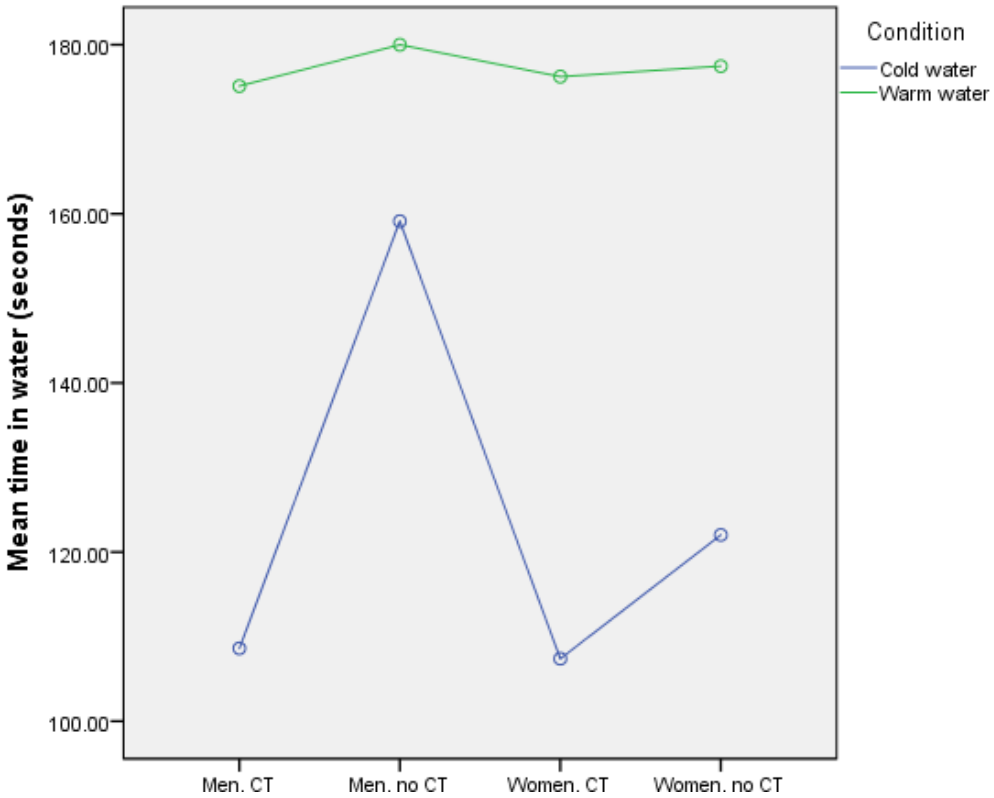

Figure 2. *Interaction between gender-childhood trauma (CT) and time in cold and warm water*

Discussion

The aim of the present study was to further examine the influence of the factors childhood maltreatment (CM) and gender on stress susceptibility in adult life. Stress was induced by means of the 'Socially Evaluated Cold Pressor Test' (SECPT), which combines a physical stressor (immersion of hand in cold water) and psychological stressors (presence of observer and camera; Schwabe, Haddad & Schachinger, 2008). Based on previous research, it was hypothesized that individuals who experienced CM (Elzinga et al., 2008; Gunnar & Quevedo 2007; Lupien et al., 2009; McEwen, 2008; Neigh, Gillespie & Nemeroff, 2009; Salleh, 2008; Springer et al., 2007; Teicher & Samson, 2013) as well as women (Longest & Thoits, 2012; Lupien et al., 2009; Matud, 2004; Teicher et al., 2003) are more susceptible to stress (time in water). The results indicated a borderline significant interaction for time in water and severe CM (childhood trauma, CT). No significant interaction for time in water and mild CM (adverse childhood life events, ACLE) or time in water and gender was found. However, post hoc tests revealed a borderline significant difference, indicating that time in water of men who experienced CT was higher than the time in water of men who did not experience CT. Besides that, a significant difference between mean times in cold water versus warm water and between subjective stress (SS) ratings of the cold water condition versus warm water condition were revealed, indicating the utility of the SECPT to induce stress. Thus, the present study revealed multiple interesting insights, which will further be discussed in terms of strengths and limitations.

A major strength of the present study was that it accounted for CM severity. A borderline significant interaction between time in water and CT was found, indicating that subjects who experienced CT are more susceptible to the cold water than subjects who did not experience CT. In contrast, no significant interaction was revealed for time in water and ACLE, therefore, according to the present study's findings it can be assumed that CT seems

more indicative for enhanced stress susceptibility in adult life than ACLE. In line with that, when looking at the mean times, it seems that individuals who experienced CT are more susceptible to the cold water than individuals who did not experience CT, whereas individuals who experienced ACLE seem not or only slightly more susceptible to the stress condition. This finding seems to corroborate previous research indicating that the more severe the CM was, the greater the long-term consequences are (Clemmons et al., 2007; Higgins, 2004). Furthermore, a borderline significant difference was found for time in water and CT-gender, indicating that stress susceptibility of men who experienced CT was higher than stress susceptibility of men without CT. Thus, it seems highly important to assess CM severity since more severe forms of CM seem to increase stress susceptibility and vulnerability to multiple types of psychiatric disorders in adult life (McLaughlin et al., 2010).

Another strength of the present study is that, to my knowledge, it constitutes the first study that examined the effect of CM and gender on stress susceptibility in adult life by means of the SECPT. The SECPT can be considered a laboratory stressor with great potential in research on CM and gender. Significant difference between mean times in cold water versus warm water and between subjective stress (SS) ratings of the cold water condition versus warm water condition were revealed, indicating the utility of the SECPT. Furthermore, previous studies indicated that the SECPT not only elicits SNS-, but also HPA-axis activation due to the combination of cold pressor and social-evaluative threats. In contrast, the CPT seems to only elicit SNS activity (Schwabe, Haddad & Schachinger, 2008). Since CM leads to lead to long-term alterations in the HPA-axis (Elzinga et al., 2008; Gunnar & Quevedo 2007; Lupien et al., 2009; McEwen, 2009; Neigh, Gillespie & Nemeroff, 2009; Teicher et al., 2003) and differences in HPA-axis reactivity in men and women have been reported by multiple studies (Kirschbaum et al., 1999; Kudielka & Kirschbaum, 2005), the HPA-axis activation triggered by the SECPT seems highly suitable, if not necessary to conduct stress

research on CM and gender.

Besides that, the inclusion of women can be considered a major strength of this study. Gender seems to have potent influences on stress susceptibility, however, multiple studies on the effects of stress have only been tested in male animals and humans (Lupien et al., 2009). For instance, Schwabe, Haddad & Schachinger's (2008) study on the SECPT included only men, which was justified by the interfering menstrual effects of cortisol responses (Kirschbaum et al., 1999). Although no significant interaction between gender and time in water was found in the present study, it needs to be considered that gender differences in hand size or skin thickness may have contributed to differences in pain tolerance, respectively stress susceptibility when performing the SECPT (Hellström & Lundberg, 2000). Men's skin seems to be thicker than women's skin and there seem to be gender differences in tactile and sensorial skin perceptions, with men being less sensitive to pain and temperature extremes (Giacomoni, Mammone & Teri, 2009). Thus, including women is considered highly valuable, however, it is important to be aware that it adds more complexity to stress research. In line with that, some of the present study's limitations originated from gender-related issues, which will further be discussed.

The first limitation to be mentioned is that the observer's sex and the participant's sex were not counter-matched. The results revealed no significant interaction between gender and time in water, but it needs to be taken into account that in this study there was only a female observer present. However, previous research indicated that participants seem to tolerate cold pressor pain longer when tested by an experimenter of the opposite sex (Kállai, Barke and Voss, 2004). Especially men seem to be susceptible to the effect of an experimenter of the opposite sex, therefore, men endure cold pressor pain significantly longer when the experimenter is a woman (Levine & De Simone, 1991). Thus, it might be precluded that male subjects in this study endured the cold pressor more willingly than female subjects. In line

with that, male subjects rated SS lower, which might also be attributed to a lower willingness to disclose pain and stress. However, previous SECPT studies also contained this shortcoming, for instance, Minkley and colleagues' (2014) SECPT study included males and females, which were both observed by a male experimenter. In contrast, Schwabe, Haddad & Schachinger (2008) did counter-match the observers sex with the participants' sex, but only male subjects were included in the study. However, bypassing experimental hardships originating from gender differences by simply excluding female subjects cannot be considered the ultimate solution. Therefore, future research should include female participants, but take into account the observers sex, and optimally place a female observer in front of male subjects and vice versa.

Furthermore, pertaining gender-related issues, the inclusion of women in different menstrual cycle phases and the inclusion of women using oral contraceptives needs to be mentioned. Although the present study controlled for menstrual cycle phase and no significant correlations were found between menstrual cycle phase and time in water or SS ratings, future research should preferably include women in their luteal cycle phase. Menstrual cycle phase exerts important effects on pain sensitivity and HPA-axis responsiveness to stress, however, the stress response of women in their luteal phase seems to be most similar to men's stress response (Hellström & Lundberg, 2000; Kirschbaum et al., 1999). Additionally, oral contraceptives might change the neuroendocrine stress response (Kirschbaum et al., 1999), therefore, further research should exclude females who use oral contraceptives to guarantee the most equal HPA-axis responsiveness to stress in men and women.

In addition, the observer was familiar to some participants, and the relationship between observer and participant was relatively informal. It is possible that the participants who knew the observer had a lower willingness to endure cold pressor pain due to the more

casual relationship. This is in line with a study by Kallai, Barke and Voss (2004) who found that gender, but also the experimenter's professional status influence how participants endure cold pressor pain. According to their study, subjects tend to tolerate cold pressor pain longer when the relationship with the experimenter is formal and when the experimenter has a high professional status. When the experimenter has a lower status, for instance, when he or she is a student, which was the case in the present study, pain seems to be endured less willingly. Furthermore, familiarity with the observer might constitute an issue when it comes to the disclosure of CM. Although disclosing CM seems a major problem in general (Allnock & Miller, 2013; Heim et al., 2010; Teicher & Samson, 2013), familiarity with the observer might have further enhanced the chance that CM was not disclosed. Disclosing CM is considered highly personal and individuals who experienced CM might feel ashamed or embarrassed or are afraid to be stigmatized (Allnock & Miller, 2013). However, the problem of familiarity with the observer did not apply to the whole sample and confidential treatment and anonymization of data was highly emphasized. Nevertheless, it is suggested that in future research an unfamiliar observer, preferably, with a higher professional status is chosen.

The last limitation refers to the assessment of CM since timing and duration of CM were not or only partially assessed. In this study, all types of CM referred to the first 18 years of life, expect the CT questions assessing sexual abuse (before age 16 and after age 16), which is a relatively broad time measure. Discrepancies prevail whether earlier or later onset of CM has more deleterious consequences and it is not clear yet, at which points in time children are most vulnerable. However, developmental timing of the first occurrence of CM is considered important in shaping the risk of long-term consequences (Dunn et al., 2013; Pechtel & Pizzagalli, 2010; Teicher et al., 2003). Therefore, it would be interesting for further research to examine the onset age and duration of CM, to get more insights in how these factors influence stress susceptibility in later life.

In conclusion, the present study revealed multiple valuable insights. The borderline significant interaction between CT and stress susceptibility led to the assumption that individuals who experienced more severe forms of CM might be more susceptible to stress than individuals who experienced no or less severe forms of CM. Although no significant interactions for stress susceptibility and gender were revealed, the present study indicated interesting insights pertaining the complexity of gender in stress research, but also highlighted the importance of including both sexes in stress research. In addition, the utility of the SECPT was confirmed leading to the conclusion that the SECPT seems an adequate paradigm for research on CM and gender in the field of stress research. Nevertheless, gender needs to be treated with caution, for instance, counter-matching the sex of the observer and the participant when applying the SECPT or taking into account the menstrual cycle phase are considered important.

To sum up, the present study revealed that especially severe forms of CM seem to be linked to increased stress susceptibility, which often leads to psychiatric disorders in adult life. However, further investigating and linking the effects of CM and gender on stress susceptibility seems crucial to better understand the mechanisms through which CM and gender impact adult life. This is highly important to better recognize individuals with enhanced stress susceptibility to, ultimately, be able to provide treatment tailored to the needs of individuals whose hardships were created during their childhood.

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Appendix

Appendix A. 'NEMESIS' questionnaire assessing child maltreatment (CM)

Childhood Trauma NEMESIS Questionnaire
Stress SECPT Test

The following questions are about experiences in your childhood, before you turned 16.

Instructions: Indicate whether the statements apply to you (yes) or not (no).

		Yes	No
Q.1.1	Divorce of your parents?		
Q.1.2	You were placed in a children's home?		
Q.1.3	You have been in (juvenile) prison?		
Q.1.4	You were raised in a foster home?		
Q.1.5	You regularly ran away from home?		

Instructions: Indicate whether the statements apply to you (yes) or not (no). If not, indicate so and skip to the next question. If yes, use the scale below as a guide, write a number to indicate how often experienced.

1	2	3	4	5
Once	*Sometimes*	*Regularly*	*Often*	*Very often*

		Yes	No	How often?
Q2.	**Do you think you were EMOTIONALLY NEGLECTED?** By this I mean that at home they did not listen to you, your experiences of problems were neglected, you had the feeling you could not come to your parents for attention and support.			
Q.3	**Do you think there was PSYCHOLOGICAL, so non-physical ABUSE?** By that I mean: calling names, punishing without reason, discrimination against brothers and sisters, blackmail, and the like?			
Q.4	**Do you think there was PHYSICAL ABUSE in your case?** By that I mean: kicked, beaten with hands or object or other forms of physical neglect.			
Q.5	**Were you BEFORE you turned 16, approached in a sexually way against your will?** By that I mean you were touched sexually against your will, or had to touch someone else in a sexual way.			
Q.6	**Have you AFTER you were 16 experienced any sexual events that**			

	happened against your will? By that I mean unwanted sexual contact.			

Appendix B. Subjective stress (SS) test

Subjective Stress Questionnaire
Stress SECPT Test

The following questions are about subjective stress you experienced during the experiment.

Instructions: Using the scale below as a guide, write a number from beside each statement to indicate how much you agree with it

1	2	3	4	5
Strongly disagree	*Disagree*	*Neutral*	*Agree*	*Strongly agree*

____ Q1. I experienced the cold pressure test as stressful.

____ Q2. I experienced the cold pressure test as painful.

____ Q3. I experienced the presence of the experimenter as unpleasant.

____ Q4. I experienced the presence of the camera as unpleasant.

Appendix C. Repeated measures post-hoc LSD test with the four-level adverse childhood life events (ACLE)-gender variable as between-subjects factor

Gender, ACLE	Gender, ACLE	Mean difference (SD)	Sig.
Men, ACLE	Men, no ACLE	1.52 (19.25)	0.94
	Women, ACLE	16.37 (20.23)	0.42
	Men, no ACLE	11.99 (19.25)	0.54
Men, no ACLE	Men, ACLE	- 1.52 (19.25)	0.94
	Women, ACLE	14.86 (13.41)	0.27
	Women no ACLE	10.47 (11.88)	0.38
Women, ACLE	Men, ACLE	-16.37 (20.23)	0.42
	Men, no ACLE	-14.86 (13.41)	0.27
	Women, no ACLE	-4.38 (13.41)	0.75
Women, no ACLE	Men, ACLE	-11.99 (19.25)	0.54
	Men, no ACLE	-10.47 (11.88)	0.38
	Women, ACLE	4.38 (13.41)	0.75

Appendix D. Repeated measures post-hoc LSD test with the four-level childhood trauma (CT)-gender variable as between-subjects factor

Gender, CT	Gender, CT	Mean difference (SD)	Sig
Men, CT	Men, no CT	-27.7 (14.66)	0.07
	Women, CT	0.06 (13.86)	1.0
	Women, CT	-7.88 (14.66)	0.59
No CT, men	Men, CT	27.7 (14.66)	0.07
	Women, CT	27.76 (12.7) *	0.03
	Women, no CT	19.82 (13.58)	0.15
CT, women	Men, CT	-0.06 (13.86)	1.0
	Men, no CT	-27.76 (12.7) *	0.34
	Women, no CT	-7.93 (12.7)	0.54
No CT, women	Men, CT	7.88 (14.66)	0.59
	Men, no CT	-19.82 (13.58)	0.15
	Women, CT	7.93 (12.7)	0.54

*. The mean difference is significant at the 0.05 level

Appendix E. Repeated measures analyses with subjective stress (SS) rating as within-subjects factor

Table 3. *Interactions between subjective stress (SS) rating and childhood trauma (CT), adverse childhood life events (ACLE), gender and the four level variables CT-gender and ACLE-gender*

	df	F-value	p-value
SS (ACLE)	1	79.17	<0.05
SS * ACLE	1	<0.05	1
SS (CT)	1	100.72	<0.05
SS * CT	1	4.27	0.04
SS (gender)	1	94.85	<0.05
SS * gender	1	5.17	0.03
SS (gender-ACLE)	1	68.4	<0.05
SS * gender-ACLE	3	1.96	0.13
SS (gender-CT)	1	94.85	<0.05
SS * gender-CT	3	2.88	0.05