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„Behavioral Distress in 18-month-old Toddlers"

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Table of Content

Abstract

Understanding basic emotions such as distress is a fundamental psychological research question because their development is linked to psychological illnesses such as posttraumatic stress disorder (PTSD). However, existing measures of distress in toddlers show mixed results regarding their validity. In recent studies, correlations of different distress measurements showed inconsistent results. Measurements quantifying behavioral distress have been criticized due to their one-dimensionality and because they do not take short time periods into account. Moreover, young children's social components of distress behavior has received little attention in previous research. This master's thesis addresses these gaps in the literature and investigates behavioral distress in 18-month-old children in response to their mother's simulated pain. In addition to a frequently used self-distress scale, behavioral distress was assessed with a more distinguished coding scheme including three dimensions of distress (facial distress, vocal distress and body distress). Further, we incorporated the temporal component into our analysis to disentangle the time course of behavioral distress. Results showed significant correlations across all distress measures. Over the three phases of the distress task (free play, distress, reunion) the distress dimensions showed differences in the intensity and time of occurrence. While facial and vocal distress showed peaks in the beginning of the distress phase, the peak of body distress was later during the reunion phase. Future research should aim at comparing behavioral distress dimensions to physiological markers of distress such as respiratory sinus arrhythmia (RSA).

Keywords*: distress, toddlerhood, emotion expression, micro-coding, social distress task*

Introduction

One major aim of psychological research concerns the onset and development of psychopathologies. Particularly, the development of *distress* is linked to many psychological and physiological illnesses such as posttraumatic stress disorder (PTSD) and depression (Brinkmann, 2021; Gunnar & Vasquez, 2006). Distress is often defined as a negative emotion expression or negative stress response after an environmental change (Brinkmann, 2021; Branson et al., 2019; Brooker & Buss, 2010). Early childhood is discussed as an important phase for distress and distress related pathologies (Spry et al., 2022). Especially between the age of 12 to 18 months, several skills and systems of emotions develop that are relevant for distress. Kopp (1982) suggests that in toddlerhood distress changes from a passive, caregiver focused emotion into an active and self-regulated one. Thus, the age period around 18 months is particularly relevant for understanding the development of distress. Exploring emotions and their development also forms the basis of understanding onset and development of psychopathology (Gunnar & Vasquez, 2006). In this master's thesis we aim to explore the relations and time courses of different behavioral distress measurements in 18-month-old toddlers.

The whole complexity of emotion and their behavioral expression is not fully understood yet. A metanalysis by Waxman et al. (2020) highlights current methodological issues of behavioral distress measurements in young children. Reviewing the current literature, connections between different indicators of distress such as behavioral and physiological measurements are not consistent (Waxman et al., 2020). Thus, study results of distress strongly depend on their methodical approach. However, lower reactivity and faster recovery of distress in young children could be linked to optimal learning conditions and adaptive emotion regulation strategies (e.g., Obradović & Finch, 2017; Santucci et al., 2008). Higher distress was associated with negative states such as anxiety, and aggression (e.g., Gunnar & Vasquez, 2006). Shirtcliff et al. (2009) also suggest that a constant state of low distress may be linked to dysfunctional behavior and psychopathological callousness. Hence, understanding the interactions and correlations of distress indicators is particularly important to support child development (Waxman et al. 2020).

One function of emotional expression is to inform others about one's own subjective and physiological states. Therefore, emotional expressions, such as distress, have a highly social function and influence the emotional exchange of groups as well as dyads (Decety &

Meyer, 2008). Especially the caregiver's impact on children's distress development is commonly discussed (e.g., Beauchaine, 2001). When exploring young children's distress many research studies focus on mother-child interactions. Study results have shown the influences of attachment styles on children's distress (Ahnert & Rickert, 2000). Likewise, it has been indicated that mothers' emotional state modulates their infant's behavior (Decety and Meyer, 2008). Field et al. (1990) compared mother-child interactions and behavioral states of 3-month-old children comparing nondepressed and depressed mothers (*N*=48). Study results showed that depressed mothers and their infants matched in negative states more often and less often in positive states compared to dyads with nondepressed mothers. These findings highlight the social component of distress, particularly the influence of caregivers on young children's distress.

Although distress is often linked to social interactions, little research focuses on situational distress in young children related to emotion sharing through another person's distress. Emotion sharing describes the process of feeling another person's emotion as well as reacting to it. It is often discussed in the context of empathy, whose origins are increasingly in the focus of developmental research (Decety & Meyer, 2008). Infants distress in response to someone else's distress has long been regarded as a preliminary stage of empathic behaviors only. Thus, distress as a result of emotion sharing processes in young children has been neglected (Hoffman, 2000). In 2018, Zahn-Waxler et al. postulated an alternative theory, emphasizing that children may show distress in addition to empathic and regulation behaviors. Likewise, Decety & Meyer (2008) argue that distress and empathic concern are two different reactions occurring in situations when experiencing a distressed other. Due to the novelty of these findings, little is known about young children's distress and its expression caused by social components e.g., in response to another's distress.

To address these issues, this master's thesis examines connections between behavioral measurements of distress in 18-month-old children in response to their mother's simulated pain.

Definitions of distress

Distress is often used synonymously with the terms stress, strain or psychological distress (Ridner, 2004). In the following literature review, the original term from the respective theory is used. Traditionally, stress has been defined as an external stimulus or

stressor that is followed by physiological arousal and negative affect (Folkman, 2013). Hans Selye (1974) defined stress as “the non-specific response of the body to the demands made upon it” (p. 14). He approached stress from a reaction-focused perspective and considered it unavoidable since the body is necessarily responding to environmental requirements (Le Fevre et al., 2003; Brinkmann, 2021). In 1984, Lazarus and Folkman proposed a pioneering approach to stress, considering dimensions of emotional and psychological aspects. They proposed the transactional model, which claims that stress is a reciprocal process initiated by the bidirectional interaction between people and their environment. The experience of stress is assumed to be subjective, depending on a person’s appraisal and ability to cope with a stressor. Moreover, the model distinguishes between the terms stress and distress. While stress is the umbrella term, distress describes an individual’s negative perception of stress (Lazarus & Folkman, 1984; Branson et al., 2019; Brinkmann, 2021).

Contemporary stress models conceptualize distress as negative emotion expression or negative stress response (Branson et al., 2019; Brooker & Buss, 2010, Waxman et al., 2020). Some authors distinguish distress into two related aspects: reactivity and regulation. Reactivity refers to the distress reaction, which occurs because of changes in the environment. On the contrary, regulation describes behaviors of emotion regulation and biological processes, which are used to recover from emotional challenges, such as behavioral approach/avoidance and attention (Kopp, 1982; Barrett, 2013; Waxman et al., 2020). Those reaction orientated definitions are often used for researching distress from a psychophysiological or biological perspective (Brinkmann, 2021). Likewise, Spry et al. (2022) claim distress in this context to be “a core aspect of temperament, reflecting a biologically based, socially shaped, tendency to distress that may have intergenerational origins” (p. 187).

Ridner (2004) remarks that distress is seldom defined on its own and is often embedded in related contexts. Other researchers have highlighted that distress oftentimes occurs in a social context as it can be initiated by observing another person's distress. The distress that occurs while experiencing the distress of another person is referred to as personal distress or self-distress and is characterized as an ensuing over-arousal. Moreover, it describes anxious, self-inward feelings, which reflect concerns for one’s own well-being (Davidov et al., 2021; Decety & Meyer, 2008). Personal distress is often discussed in the context of empathy since it is induced by a process of emotion sharing. In the following, the

focus is on the occurrence of distress caused by a social stressor. Furthermore, distress is conceptualized as the negative emotion expression after an environmental change. More precisely, this master's thesis assesses children's distress in response to their mother's simulated pain.

Development of distress

The development of emotion and their expressions have been a central research topic since the 19th century. Darwin (1872) claimed emotions to be relevant for adapting to environmental changes which is why he suggested that emotion expressions facilitate survival. A literature overview by Decety & Meyer (2008) implies that human beings show emotions and emotion expressions from birth onwards. Likewise, different emotion expressions including distress can already be identified through facial expressions in newborns (Decety & Meyer, 2008; Izard, 1982). Shortly after birth infants can send signals of emotions e.g., distress to other people and are also able to detect them (Field, 1989). Infants express distress from birth to communicate their needs and get attention from caregivers (Field, 1989; Tronick, 1989; Decety & Meyer, 2008). Other functions of distress in young children include social interaction and social learning (Nielsen, 2002).

The occurrence of distress in young children is not only relevant for understanding its origins but also impacts a person's development until adulthood. The way children respond to distress predicts later adaptive functioning and mental health (Spry et al., 2022). More precisely, atypical distress reactivity in infants is linked to mental disorders in adulthood such as posttraumatic stress disorder (PTSD) and depression (Brinkmann, 2021; Gunnar & Vasquez, 2006). Heim et al. (1997) argue that exposures to stressful events early in life lead to increased distress in adulthood and a vulnerability for psychopathologies.

Distress and its regulation behaviors are considered to be highly malleable, especially in infancy and early childhood (Cole et al., 2004). By the end of their first year, most infants can use strategies that alter intensity and duration of distress. A more complex system of emotion expression skills develops between 12 and 18 months. During this time, infants also learn to modulate their own emotions, which leads to large developmental changes in emotion regulation (Ekas et al., 2018; Kopp, 1989; Thompson, 2011). Young children learn to express and modulate their emotions through interactions with their caregivers and

reinforcement. Especially distress behaviors are learned and maintained by caregivers' responses towards them (Huebner & Izard, 1988; Buss & Kiel, 2004).

Personal distress in response to someone else's distress is often mentioned in the context of *empathy*, which describes an intersubjective process of sharing negative and positive emotions (Hoffman, 2001; Decety & Meyer, 2008). Many theories argue that the processes of "empathy can lead to personal distress or to empathic concern (sympathy)" (Decety & Meyer, 2008, p. 1053). Hoffman (1975) hypothesized that infants feel a so-called empathic distress from birth. The foundation of this assumption was a study about "contagious" crying, which showed that already one-day-old children cried significantly more often when listening to another crying infant. Moreover, Hoffman stated that young children show empathic concern from the second year of life and react with empathic distress prior to that. For a long time, those hypotheses were not replicated by other studies (Davidov et al., 2021). Personal distress in response to someone else's distress in infants has been regarded as a preliminary stage of empathy only and was therefore not examined in more detail (Hoffman, 2001). However, new study results suggest that young children show empathic concern already at 3-month-old (Davidov et al., 2021). Those results emphasize that children may show personal distress in addition to empathic behaviors (Zahn-Waxler et al., 2018). This is supported by a longitudinal study using a commmaternal distress simulation which found no changes in distress related behaviors between the age of 3 and 18 months while concern for others increased (Davidov et al., 2021). Due to the novelty of these findings, little research has investigated young children's distress in response to another's distress. Further, as outlined above the age around 18 months might be particularly relevant, as by then a complex system of emotion as well as empathic behaviors has evolved in most children (Ekas et al., 2018; Kopp, 1989; Zahn-Waxler & Radke-Yarrow, 1990).

Distress measurements

Distress is a dynamic process involving biological, behavioral and social factors (Calkins, 2010; Ekas et al., 2018). Those different levels of distress are most commonly measured by behavioral (e.g., video observation) or by physiological (e.g., heart rate, respiratory sinus arrhythmia, skin conductance) indicators. Both distress measurement methods seem to be stable across lifetime (Gunnar & Vasquez, 2006; Matthews & Phillips,

2010). Studies of distress in young children often use behavioral measurements such as direct observations or parents' observations of their children (Waxman et al., 2020).

Still, the emotional coordination and interaction of cognitive and cardiac systems as well as behavioral strategies during distressing events is uncertain (Cole et al., 2004; Ekas et al., 2018). Although there is consent about the complexity of emotions, as biological, social and behavioral factors are integrated (Calkins, 2010; Waxman et al., 2020). However, the question of how different facets of distress such as behavioral and physiological distress interact remains debated as they might be activated in succession (Cole et al., 2004; Waxman et al., 2020). That is why several authors highlight the need for a biopsychosocial framework of distress (Calkins, 2010; Ekas et al., 2018). Perry and Calkins (2018) suggest that physiological measurements serve as a supplement to behavioral measurements in understanding the whole process of emotions such as distress. Since physiological measures are not observable from the outside, they might show underlying distress mechanisms.

In line with the evidence reported above, a recent meta-analysis by Waxman et al. (2020) reported mainly inconsistent relations between behavioral and physiological indicators of distress in toddlers concluding that study results on distress strongly depend on the employed measurements. One reason for inconsistent results is related to the operationalization of behavioral distress. Waxman et al. (2020) argue that coding schemes for behavioral indicators of distress do not represent the construct well because of their one-dimensionality. Most behavioral coding schemes measure distress with an overall score that does not consider different dimensions of distress such as body language, vocalization and facial expression (e.g., Voegtline, 2010; Zahn-Waxler & Radke-Yarrow, 1992). Those different levels of distress are often considered hierarchically in an overall score with vocal distress forming the highest score of the distress scale and facial distress forming the lowest.

Coding schemes for young children that differentiate between different facets of behavioral distress exist primarily for clinical settings such as pain assessments. For instance, the Toddler Preschooler Postoperative Pain Scale (TPPPS, Tarbell et al., 1992) scale measures vocal expressions, facial expression, body movements and an overall score. Another pain assessment scale with six dimensions of distress e.g., Cry, Facial, Child Verbal, Torso, Touch and Legs is provided by the Children’s Hospital of Eastern Ontario Pain Scale (CHEOPS) scale (McGrath et al., 1985). The Observation Scale of Behavioral Distress (OSBC, Jay et al., 1983) differentiates ten distress subscales e.g., Cry, Scream, Nervous behavior. In those scales the

most recurring dimensions of distress are vocally expressed distress, facial distress and body distress. However, these scales have been criticized as they lack objective measures of validation and information on (test-retest) reliability is rarely reported. Thus, methodological evaluations of behavioral distress scales are needed (Crellin et al., 2007). Further, the above-mentioned scales for distress were predominantly used in the setting of pain assessment which is why a broader application of dimensional distress scales is needed.

Common behavioral distress coding schemes do not distinguish between the activated emotion, e.g., facial expression and a resulting regulation, e.g., calming, gaze behavior (Cole et al., 2004). This is relevant as a reduction in distress over time during a distress episode cannot be equated with the process of emotion regulation. While there is evidence about the connection between distress expressions and certain emotion regulation strategies such as self-soothing behaviors (Beijers et al., 2017), these constructs need to be measured individually. Therefore, methodologies of distress expression and distress regulation in young children need to be revised to differentiate both processes (Gennis et al., 2022; Cole et al., 2004).

Collecting data and observing distress behavior in young children can be challenging and many authors highlight the resulting limitations. For instance, it is impossible to be sure of the children's true emotion and research results are prone to misinterpretations (Borelli et al., 2021). Especially, the interpretation of facial expressions in infancy and toddlerhood might be highly subjective (Field, 1989). A recent review emphasizes that research on facial expressions needs further development to establish reliable results. Especially facial expressions of distress in young children can be hardly isolated from other negative emotion expressions (Barrett et al., 2019).

Despite the limitations due to undefined coding schemes and their interpretation, Waxman et al. (2020) suggested that different distress measurements may have varying time processes. Moreover, the time scales of distress indicators may differ or may not be observable at the same time. That is why the authors demand the need for experiments that consider different distress phases. Shorter time units during high distress phases need to be investigated to analyze patterns of different measurements. Moreover, indicators of distress may differ between and within people (Barrett, 2015). Thus, time courses of different distress indicators could show variations. Moreover, several authors question the existence of a specific distress pattern that is generally valid (Waxman, et al. 2020; Barrett, 2015).

However, correlations of different measurements need to be explored to understand the dynamic process of distress on various levels. Furthermore, time courses and methodologies need to be addressed and further developed.

To sum up, distress is defined as a negative emotion expression and already shown by infants shortly after birth. However, little is known about the complex relations and time courses of behavioral distress measurements during the first years of life. Behavioral measurements showed low coherence in previous studies, which is why a wider range of distress measurements need to be considered. The present master's thesis aims at closing this research gap by examining behavioral distress during a widely used distress task that incorporates a free play phase, a distress phase and a reunion phase. The free play phase in the beginning serves as a baseline condition. Additionally, a reunion phase was added to the task design to explore the time development of the distress response after the occurrence of the distress stimuli. We assessed a commonly used self-distress scale (Davidov et al., 2021; Zahn-Waxler et al., 1992) as well as a more detailed coding scheme with the dimensions facial distress, vocal distress and body distress. Those three dimensions were chosen as they could be identified as the most recurring dimensions of distress in the literature (e.g., Tarbell et al., 1992; McGrath et al., 1985; Jay et al., 1983). In overall distress scores those dimensions are included with vocal distress forming the highest score of the distress scale and facial distress forming the lowest (Zahn-Waxler et al., 1992). As soon as a child expresses vocal distress regardless of the length of time, the highest distress score is assigned. Differences of distress expressions between children are not considered by weighting the distress dimensions. Thus, the common score compilation is associated with methodological issues and higher integration of time factors and interindividual differences are demanded (Waxman et al., 2020; Barrett, 2015). To incorporate these aspects into our analyses, we analyze distress using a micro-coding approach that measures each distress dimension individually. The first research question explores how distress mean scores differ across the three phases of the distress paradigm. We expect mean scores of all distress measurements to vary over the three phases (self-distress, facial distress, vocal distress and body distress). More specifically, we expect lowest mean scores during free play phase, highest mean scores during the distress phase and decreasing mean scores during the reunion phase. The second research question addresses changes of facial distress, vocal distress and body distress over the three experimental phases using time series analyses and a micro-coding

approach. All distress indicators are expected to show peaks during the distress phase and to not significantly differ in intensity and time of the peaks.

Methods

Sample

This master's thesis is part of the longitudinal experimental research project "InteroSens – Interoceptive Sensitivity and Social Development in Infancy". Prior to the data collection, the study was sighted and approved by the Ethic Board of the University of Vienna (2020). The project follows dyads of mothers and their children at 9 and 18 months of age. The overall sample size of the first data collection point at 9-months of age was *N* = 90 dyads. All participants were invited to participate again at 18-months of age. For the master's thesis only the second data collection point was included. The participants were recruited through the database of the Wiener Kinderstudien (WieKi) lab of the University of Vienna. In the following, only characteristics and procedures relevant to this master's thesis are described.

The data described here was collected from June 2021 until April 2022 at the WieKi lab. Initially, the sample consisted of 40 mother-child dyads. The inclusion criterion for further data analyses was the completion of at least one variation of the distress task including all three experimental phases. All dyads with missing data in the distress task (video observations or ECG) were excluded. The final sample includes *N* = 23 toddlers at the age between 18month 0days and 19month 15days (72.22% females; M_{age} = 1.57, *SD* = 0.08) and their mothers (M_{age} = 33.17, *SD* = 4.92). Descriptive information was gathered through questionnaires filled in by the mothers prior to the testing. The questionnaires were filled in by 78.26 % of the mothers of the final sample. While all children were fluent in German, 22.22 % spoke at least one other language. Moreover, 41.18 % of the children had at least one sibling. The highest reported educational degree of the mothers was in 72.22 % a university degree, in 16.67 % an apprenticeship, in 5.56 % a high school diploma and 5.56 % did not report their education.

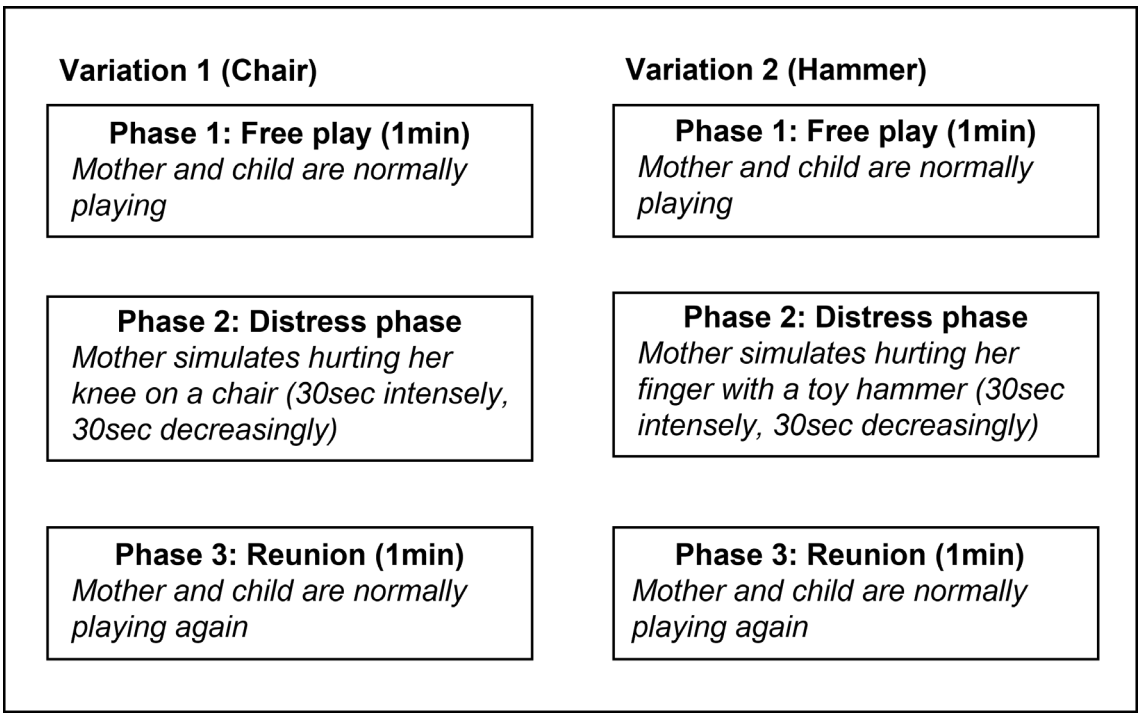
Procedure

The study was conducted by two to three researchers and/or trained master's students. After arrival, mothers filled in various forms (consent form, COVID-19 form,

instruction form) and were briefed about the exact procedure of the distress task. Subsequently, mother and child were brought to a prepared lab room. To warm up the researchers played with the child. By the time the child felt comfortable, the distress task was explained again to the mother, and she was instructed on how to attach electrocardiogram (ECG) electrodes on herself and her child. For later video coding of the distress behavior, three cameras from different angles recorded the experiment. By the time the ECG and video cameras were set up, the researchers went out of sight and the distress task was started. During the whole study, the current COVID-19 policies of the federal government of Austria were adhered to. After the study, the participants received a € 15 drug store voucher, a certificate including a picture of mother and child during the testing and a toy selected by the child.

Figure 1

Distress simulation task procedure based on Davidov et al. (2021)



We replicated a well-established distress paradigm (e.g., Zahn-Waxler et al., 1992; Davidov et al., 2021) using two variations (see figure 1). In the first variation the mother simulated hurting her knee on a chair, in the second variation she simulated hurting her finger with a toy hammer. Before the simulation, the mother was instructed to normally play with her child for 60 seconds (free play phase). Subsequently, a sound was played, which

gave the signal to start the pain simulation. For 30 seconds the mother displayed pain and distress at an intense level which was decreased in the subsequent 30 seconds. Afterwards, she played again with the child for 60 seconds (reunion phase). The mothers were instructed to avoid eye contact and communication with their children during the 60 seconds of pain simulation. The distress task includes a free play phase in the beginning, which serves as a baseline condition. Additionally, a reunion phase was added to the task design to explore the time development of the distress response. Both simulations were separated by approximately 20 minutes in which mother and child engaged in an unrelated task.

Measurements

Self-distress

To measure the overall behavioral distress of every experimental phase, we used a coding scheme commonly used for self-distress (Zahn-Waxler et al., 1992). The self-distress scale is a subscale of a coding scheme, which was created to measure distress and facets of empathic behavior in young children. In addition to self-distress, the scale measures concerned affect, inquiry behavior, prosocial behavior and avoidance. Self-distress is assessed with an overall distress score for every experimental phase on a 0-3 scale with (0 = does not occur, 1 = visible distress manifested non-vocally, through the body (fussiness, irritability, and jerkiness) or through facial expressions (wariness or fear, e.g., eyes wide, mouth open), 2 = moderate (whimpering, expressed vocally) and 3 = full blown crying).

Micro-coding

In addition to commonly used distress scores, we established a more precise coding scheme that differentiates three dimensions of distress reactivity. Building up on a review of the literature, main dimensions of distress reactivity were identified as facial expression, vocalization and body language. Each dimension was continuously coded with 0 (= absent), 1 (= present) and 99 (not codable) for the duration of the task. The data was considered as not codable if the children disappeared from the camera's viewpoint or engaged in behavior, which affected identifying the distress behavior e.g., covering the face.

To investigate the time courses of facial distress, vocal distress and body distress, those three dimensions were micro-coded with the behavioral analysis software Mangold INTERACT (Mangold, 2022). Every distress behavior was coded 25 times per second which resulted in 1500 frames per experimental phase and 4500 frames per distress variation.

Afterwards, the data was down sampled to 150 frames per experimental phase and 450 frames per distress variation using averaging calculations to obtain more robust values. To compare the three dimensions of distress to the commonly used coding schemes which code larger time units, mean scores were calculated for every experimental phase.

Inter-rater reliability

To compute the inter-rater reliability for all scales, 30.43 % of the videos were double coded by two trained master's students. A coding-training was provided by the main researchers of the project. For the training, the project's pilot videos were discussed and rated until sufficient agreement was reached. Videos for reliability coding were picked by a random number generator. The inter-rater reliability of the self-distress scale was measured with Cohens kappa. Because of the zero inflated distribution of the micro-coding scales, an absolute agreement (tolerance = 0) was used to calculate an inter-rater reliability of the micro-coding scales. In table 1 the inter-rater reliability is listed for each scale. All inter-rater reliabilities indicate good agreements (Conger, 2017).

Table 1

Inter-rater reliabilities (IRR) for the distress scales

Distress measures	IRR Measure	IRR value
Self-distress	Cohen's kappa (unweighted)	.85
Facial distress	Absolute agreement	90.7 %
Vocal distress	Absolute agreement	97.6 %
Body distress	Absolute agreement	98.6 %

Statistical analyses

All data analyses were conducted with the statistic program R Studio version 1.3.1093. For the data analyses the packages *readr* (Wickham et al., 2021), *dplyr* (Wickham et al., 2021), *plyr* (Wickham, 2011), *ggplot2* (Wickham, 2016), *psych* (Revelle, 2021), *corrplot* (Simko, 2021), *tidyverse* (Wickham et al., 2019) and *readxl* (Wickham and Bryan, 2019) were used. Before analyzing the data, mean scores over the two distress task variations were calculated per participant to minimize outliers. Afterwards, missings were defined and

descriptive statistics were calculated. Furthermore, a correlation matrix was computed using Spearman correlations.

Due to its robustness, the first research question was calculated with Friedman tests. The *p* values were adjusted with Bonferroni corrections. Afterwards, post hoc tests were computed using Wilcoxon tests. To visualize the time courses of distress measurements for the second research question, the micro-coding data was plotted. Moreover, the peaks and their latencies were identified through analyses of maxima and their latencies for every participant and compared with Friedman tests. Once again, Bonferroni corrections and Wilcoxon post hoc tests were computed. Subsequently, a correlation matrix for the peaks and their latencies was calculated.

Results

Descriptive statistics

Prior to data analyses, the distributions of the scales were exploratory examined (see table 2). During the distress task, 91.3 % of the participants expressed distress in the self-distress scale developed by Zahn-Waxler et al. (1992). Facial distress was shown by 78.26 % of the participants, vocal distress by 60.87 % and body distress by 39.13 %.

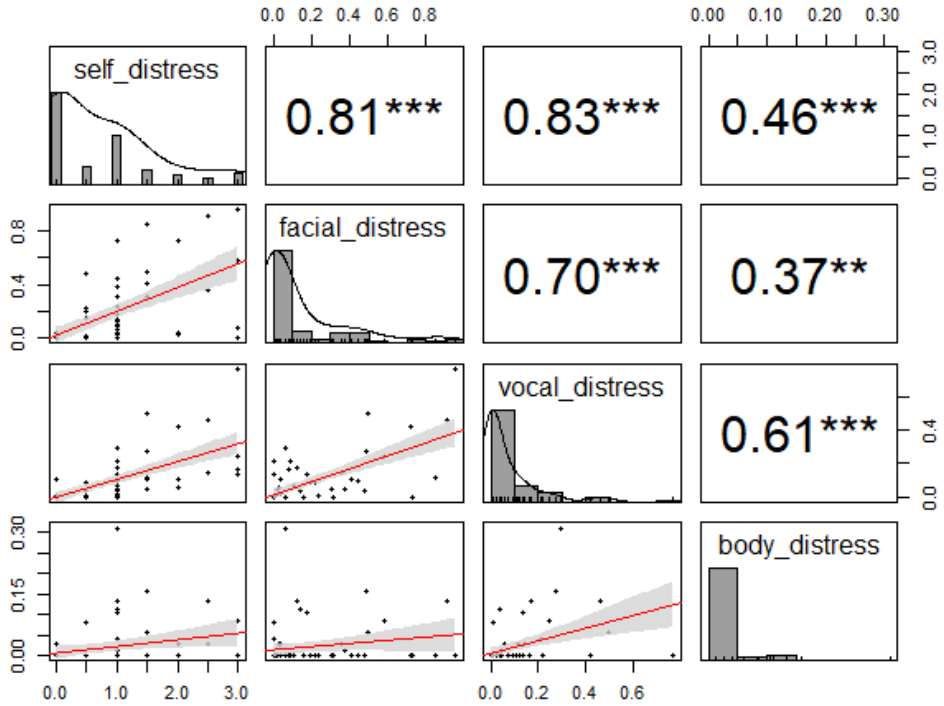
Table 2

Descriptive statistics of the distress scales (N = 23)

Distress measures	*M*	*SD*	Min.	Max.
Self-distress	0.73	0.89	0.00	3.00
Facial distress	0.15	0.25	0.00	0.96
Vocal distress	0.08	0.14	0.00	0.77
Body distress	0.02	0.05	0.00	0.31

Figure 2

Correlation matrix of the distress measurements including distributions and regression gradient



Exploratory, all distress measures were correlated using the Spearman method. Figure 2 shows the correlation matrix of all distress scales using Spearman correlations as well as the regression gradient and the scales distributions. While all correlations were significant, highest correlations could be determined between self-distress and vocal distress (r = .83) as well as between self-distress and facial distress (r = .81). Lowest correlation could be shown between body distress and facial distress (r = .37) as well as between body distress and self-distress (r = .46).

Mean distress scores

To test hypotheses one, mean differences of the distress scores (self-distress, facial distress, vocal distress and body distress) over the phases of the distress simulation task were calculated using non-parametric repeated measures Friedman tests. In case of significant results, Wilcoxon signed-rank post-hoc tests were computed using Bonferroni corrections. In the following, only adjusted p values were reported. Significant differences of the Friedman test were found for the self-distress scale (X^2 = 10.99, p = 0.004). Wilcoxon

post-hoc tests showed significantly higher mean scores of the distress phase compared to the free play phase (Z = 41.5 and p = .03), as well as significantly lower mean scores of the reunion phase compared to the distress phase (Z = 130.0 and p = .031). For facial distress, the Friedman test showed significant results with X^2 = 21.19 and p < 0.001. Here, Wilcoxon post-hoc tests revealed significant differences between all experimental phases. Mean scores of the distress phase were significantly higher in contrast to mean scores of the free play phase (Z = 0 and p = .001), mean scores of the reunion phase were significantly lower in contrast to mean scores of the distress phase (Z = 209 and p = .004), and mean scores of the free play phase were significantly lower in contrast to mean scores of the reunion phase (Z = 5 and p = .01). The third Friedman test for the vocal distress scale showed significant results with X^2 = 9.82 and p = 0.007. Post-hoc tests revealed higher mean scores in the distress phase compared to the free play phase with Z = 17 and p = .027. The last Friedman test was computed for body distress. Here, no significant results were shown with X^2 = 1.88 and p = 0.39. In figures 3, 4, 5 and 6, test summaries and boxplots of the Friedman tests are depicted for each distress scale.

Figure 3

Friedman test of the self-distress scale over the three experimental phases

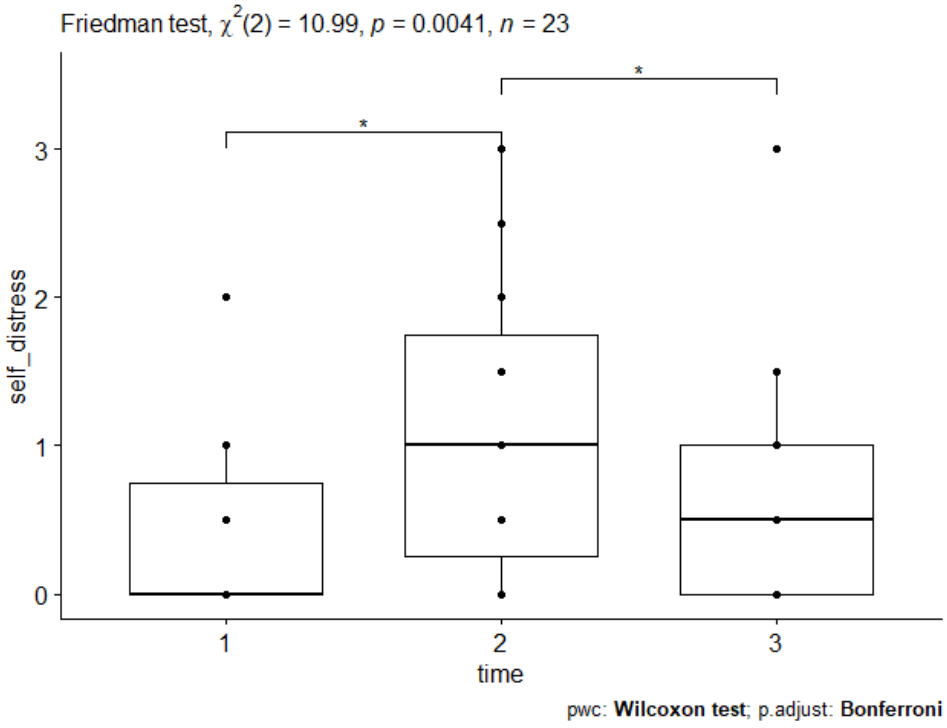


Figure 4

Friedman test of facial distress over the three experimental phases

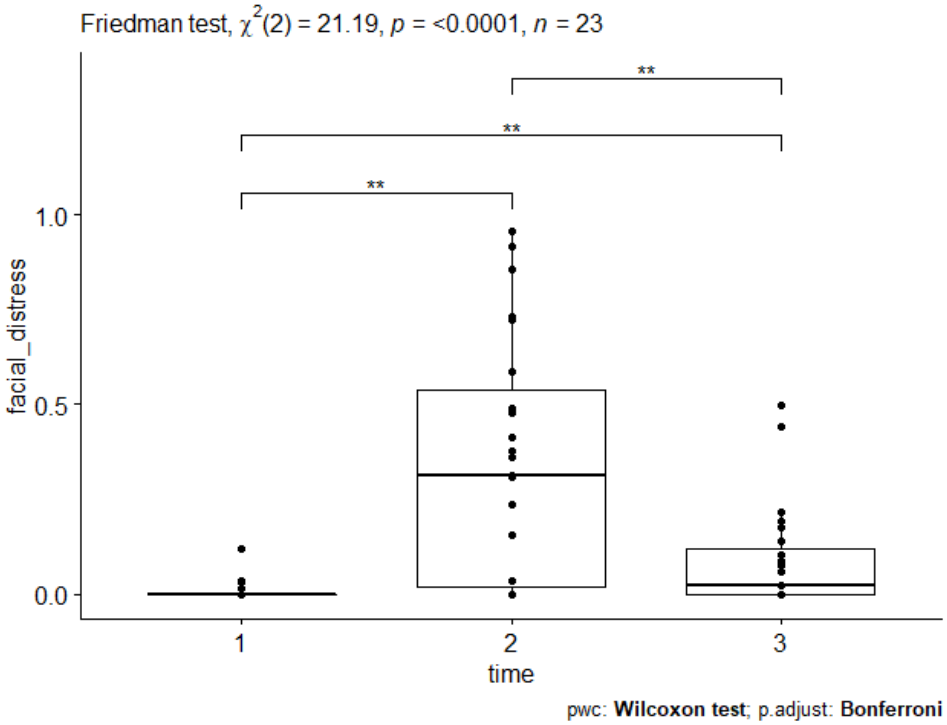


Figure 5

Friedman test of vocal distress over the three experimental phases

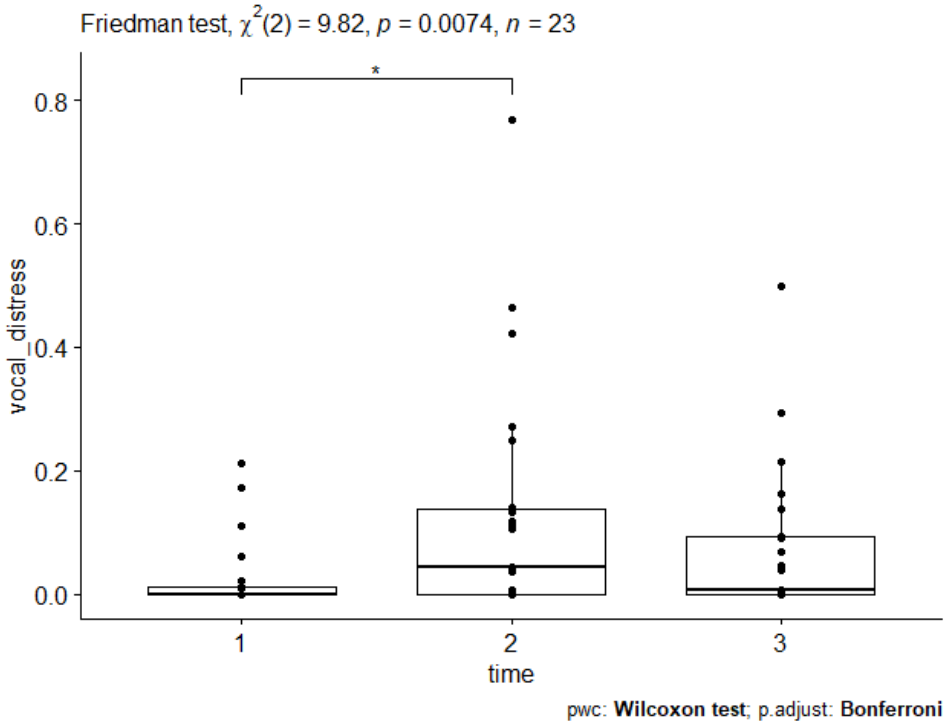
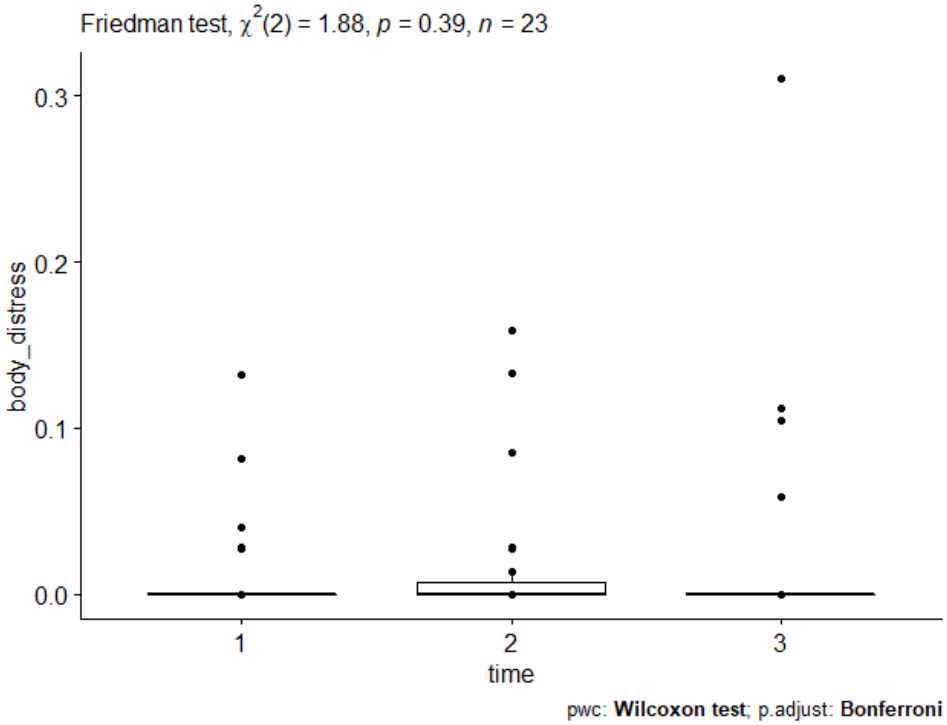


Figure 6

Friedman test of body distress over the three experimental phases



Micro-coding analyses

To test hypotheses two, we used a micro-coding approach for the different distress dimensions. First, aggregations of the micro-coding data were plotted for all distress dimensions (see figure 7). The first 150 frames represent the free play phase, frames 150 to 300 represent the distress phase and frames 300 to 450 represent the reunion phase. Mean values per frame of every distress dimension were calculated to explore distress peaks and their latencies in coding frames (table 3). To compute significance tests of the time series, maxima of each scale and their latencies were calculated for every participant. Table 4 shows the correlation matrix of all individual maxima and their latencies. If no distress was expressed by a participant, the time frame was coded as NA. Significant correlations were found between maximum scores of facial distress and maximum scores of vocal distress (r = 0.54). Higher maximum scores of vocal distress were also associated with higher maximum scores in body distress (r = 0.51). A significant correlation was also found between the peak latencies of vocal and body distress (r = 0.77).

Figure 7

Time courses of the distress dimensions

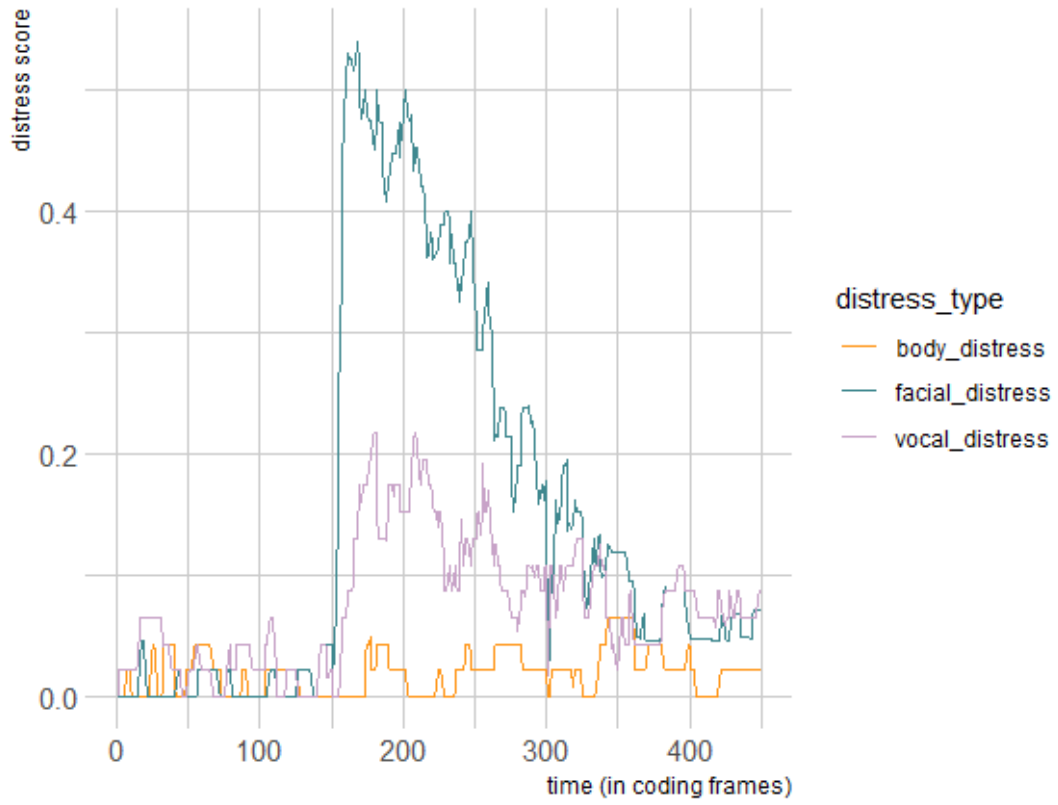


Table 3

Correlation matrix of the maximum distress per distress dimension and their latencies

	1	2	3	4	5	6
1. Maximum facial distress	–	-0.09	0.54**	-0.05	0.14	0.21
2. Latency of the peak	-0.09	–	0.21	0.03	0.10	0.07
3. Maximum vocal distress	0.54**	0.21	–	0.01	0.51**	0.36
4. Latency of the peak	-0.05	0.03	0.01	–	-0.50*	0.77**
5. Maximum body distress	0.14	0.10	0.51**	-0.50*	–	-0.41
6. Latency of the peak	0.21	0.07	0.36	0.77**	-0.41	–

Table 4

Distress peaks and their latencies of the distress dimensions (computed by mean values)

	Facial distress	Vocal distress	Body distress
Distress peak (mean scale values)	0.54	0.22	0.07
Latency of peak	168	180	343

Due to the within subject design of the measures, two non-parametric repeated measures Friedman tests were computed to determine significant differences between the peaks of the three distress dimensions and between the peak latencies. To assess the time differences of the peaks, the second Friedman test compared means of maxima time points. Post-hoc tests were computed using Wilcoxon signed-rank tests with Bonferroni corrections. Once again, only adjusted *p* values are reported in the following. Significant differences between the peaks of the distress dimensions were shown by the first Friedman test with $X^2 = 24.5$ and $p < 0.001$. Wilcoxon post-hoc tests showed significantly lower mean scores of body distress compared to facial distress ($Z = 0$ and $p = .001$), as well as significantly lower mean scores of body distress compared to vocal distress ($Z = 0$ and $p = .008$). The second Friedman test of the peak latencies showed significant results with $X^2 = 6.1$ and $p < 0.047$. The results of the Wilcoxon post-hoc tests showed significantly lower mean scores of body distress compared to facial distress ($Z = 0$ and $p = .005$).

Discussion

This master's thesis aimed to address methodological issues of behavioral distress measurements in toddlerhood. Especially the one-dimensionality and broad time intervals of common distress coding schemes has been repeatedly criticised and might be an important factor for inconsistent relations between different distress measurements in young children (Waxman et al., 2020). Thus, we investigated time courses of distress measurements with a commonly used self-distress scale (Zahn-Waxler et al., 1992) as well as three dimensions of distress (facial distress, vocal distress, and body distress) during a social distress task. Additionally, we used a micro-coding approach for the three distress dimensions to explore their time courses more accurately.

All different distress measurements correlated significantly with each other. The highest correlations were found between self-distress and vocal distress ($r = .83$) as well as

between self-distress and facial distress (r = .81). Contrary to this, lowest correlations were shown between self-distress and body distress (r = .46), and between body distress and facial distress (r = .37). In line with these results, only 39.13 % of the participants showed indicators of body distress, while facial distress and vocal distress were indicated by 78.26 % and 60.87 % of the participants, respectively. According to the self-distress scale by Zahn-Waxler et al. (1992) 91.3 % of the participants expressed self-distress. Additionally, mean values of the distress scales differed from each other. While body distress had a mean of M = 0.02 (SD = 0.05), vocal distress and facial distress had mean values of M = 0.08 (SD = 0.14) and M = 0.15 (SD = 0.25). The mean of the self-distress scale (Zahn-Waxler et al., 1992) was M = 0.73 (SD = 0.89). Future research should investigate these different distress scores and compare them to other distress indicators e.g., physiological measurements. The differences within behavioral measurements could be one reason for inconsistent results between behavioral and physiological distress measurements (Waxman, 2020) and should be further investigated.

In the first research question we hypothesized that mean differences between the three experimental phases (free play, distress, reunion) differ significantly for all distress measurements. We expected lowest mean scores during free play phase, highest mean scores during the distress phase and decreasing mean scores during the reunion phase. However, this hypothesis was not confirmed for all distress measurements. While significant differences between all experimental phases were shown for facial distress, self-distress only showed significant differences between distress phase and free play phase as well as between distress and reunion phase. In the vocal distress scale differences between free play and reunion phase were found, while the phases did not show any mean differences for body distress. Those results imply the necessity to differentiate between different bahavioral distress measurements. Although the one-dimensionality of the self-distress scale has been criticized (Crellin et al., 2007; Waxman et al., 2020), its overall character provided a clear distinction between an individual's presence or absence of distress during the social distress task. In contrast, the dimensions of distress distinguished between the multifaceted characteristics of distress. These differences of the distress scales should be taken into account in further studies. Traditional self-distress scales might be particularly beneficial for research questions concerning the occurrence of distress. When examining distress behavior

and processes in greater detail, distress dimensions and their differences should be taken into consideration.

The assessment of facial distress scales has been often criticized for being subjective, highly individually and hard to differentiate from other negative emotion expressions in infants (Field, 1989; Barret et al., 2015). Contrary to this, in our results facial distress showed the clearest distinctions across experimental phases out of the distress dimensions. Thus, further research should investigate the consistency of these results. For vocal distress mean differences only differentiated significantly between the free play and distress phase. This might be due to the intensity of arousal activated for vocal distress such as full-blown crying. A higher arousal of distress might take more time and higher emotion regulation strategies to recover in contrast to other dimensions of distress e.g., facial distress (Ekas et al., 2018). In line with this, in most overall scores vocal distress forms the highest scored level of distress (Zahn-Waxler et al., 1992; Barret et al., 2015). In those scales the expression of body distress is given only little recognition or no consideration at all. Likewise, our results showed no significant mean differences of body distress across all experimental phases. Moreover, body distress showed the smallest mean values of distress occurrence and intensity. These results emphasize the need for revised coding schemes and further investigations on different distress dimensions in toddlerhood.

The second research question investigated time courses of distress with a micro-coding approach. We hypothesized that all peaks of the distress measurements will fall in the distress phase. More specifically, we expected no significant differences between the peak times and their intensity. These hypotheses were only partly confirmed. While the peaks of facial distress (frame 168) and vocal distress (frame 180) occurred in the distress phase, a later peak of body distress during the reunion phase (frame 343) was observed. The intensity of distress during the peaks differed between $M = 0.54$ (facial distress), $M = 0.22$ (vocal distress) and $M = 0.07$ (body distress). Significant correlations were computed between the peaks of vocal distress and facial distress with $r = 0.54$, between the peaks of vocal distress and body distress with $r = 0.51$ and between the peak latencies of vocal distress and body distress with $r = 0.77$. Significantly lower distress scores of body distress were shown compared to facial and vocal distress. The peak latencies significantly differed between body distress and facial distress. These results showed a lower intensity and a delay in the onset of body distress compared to vocal distress and facial distress. This time

difference of the occurrence might indicate that higher values of body distress could be assessed by a prolongation of the distress task. Further, those results highlight the need of a biopsychosocial model for explaining the multifaceted construct of distress (Calkins, 2010; Ekas et al., 2018). The dimension of body distress might also be more strongly linked to physiological measurements of distress, whose connections to overall distress scales were incoherent (Waxman et al., 2020). Additionally, the results may indicate that body distress serves as a distress regulation rather than a distress expression. This needs to be further investigated, since many authors highlight the difficulties in the differentiation of distress reactivity and regulation (Kopp, 1982; Barrett, 2013; Waxman et al., 2020). At the same time, the need for a methodological distinction of these concepts is increasingly emphasized (Cole et al., 2004; Waxman et al., 2020).

To sum up, our hypotheses were partially confirmed. Body distress showed lowest mean values of distress and peaked at a later time point compared to vocal and facial distress. Facial distress and vocal distress showed significant differences between the experimental phases and peaked as expected in the beginning of the distress phase. Although overall distress coding schemes such as the self-distress scale were repeatedly criticized in the literature (Crellin et al., 2007; Waxman et al., 2020), connections to higher distress scores of vocal distress and facial distress were found. Those results show the broad character of the self-distress scale, while the three dimensions of distress showed a differentiation in occurrence and intensity of distress in contrast to the overall self-distress scale. Additionally, our results showed strong associations between facial distress, vocal distress, and self-distress, even though the assessment of facial distress is recurrently debated (Field, 1989; Buss & Kiel, 2004).

Limitations

The assessment of behavioral distress in young children holds several limitations. As distress behavior is assessed through observations, the interpretation of the participants activated emotion may be prone to errors due to subjectivity (Davidov et al., 2021). However, for all scales in the current study good inter-rater reliabilities were indicated (Conger, 2017). Moreover, the validity of emotion expression e.g., facial distress has been questioned by several authors especially in toddlerhood (Field, 1989; Buss & Kiel, 2004). It has been argued that facial distress is hard to differentiate from other negative emotions

such as sadness, anxiety or anger (Barrett et al., 2019). Further, the experimental environment of the design in the study could influence the validity of the results (Decety & Meyer, 2008).

Not only the interpretation of distress behavior in young children can be challenging, but also the testing can lead to distortions. Since toddlers have lower attention span than older children or adults, circumstances such as fatigue or hunger can confound the testing results. To counteract these side effects, the task lengths are commonly adjusted. However, the brevity of the task could influence the study results. Some distress behaviors such as body distress might occur more frequently at later times which could not be assessed in the present study. In addition, the pain simulation of the mother might not be interpreted as a real stressor by some children, which could influence the distress behavior.

Another limitation of this master's thesis is in the sample size. Due to the small sample size, generalizations of the results to the total population should be avoided. Moreover, the distribution of the sample was not representative of the population. More specifically, with 72.22% of the participants being female, the gender distribution was not balanced. Additionally, the proportion of university degrees held by the mothers was higher than in the general population. Furthermore, the acquisition and data assessment were more complex due to the COVID-19 pandemic and resulting lockdowns and incidences. Many testings had to be postponed or cancelled.

Implications

The findings of the study indicate several directions for future research. Firstly, different dimensions of distress should be investigated with larger sample sizes. Especially distress as a consequence of another's distress in infancy and toddlerhood should be further examined. Up until now, little research distinguished distress and empathic behaviors during social distress tasks. Interactions and associations of these concepts in young children should be further developed. Additionally, connections between behavioral dimensions of distress such as facial distress, vocal distress and body distress and physiological distress measurements such as ECG should be explored as differences of behavioral distress dimensions might be a further explanation for inconsistent study results between behavioral and physiological distress in toddlerhood. The results also highlight the need to further develop and validate methodologies of distress measurements in infants and toddlers.

Conclusion

Taken together, this master's thesis addressed fundamental psychological research questions concerning the understanding and assessment of behavioral distress in toddlers**.** Investigating distress in young children is especially relevant, as it has an impact on later emotion regulation skills and is linked to psychopathologies later in life e.g., depression and anxiety (Field, 1989; Gunnar & Vazquez, 2006). We focused on distress in response to someone else's distress, since it has received little attention in previous research and is often considered in the context of empathic behaviors (Decety & Meyer, 2008; Davidov et al., 2021). Current reviews of distress measurements revealed inconsistent results and highlight the need for revised assessment methods (Waxman et al., 2020; Crellin et al., 2007). Moreover, a need to examine distress in smaller units of time was postulated by several authors to understand time courses of distress more precisely (Waxman, et al. 2020; Barrett, 2015). Therefore, we examined connections of self-distress and three dimensions of distress (facial distress, vocal distress and body distress) during a commonly used social distress task. A micro-coding approach was used to investigate shorter units of time to incorporate a temporal component. All distress measurements correlated significantly with each other. While self-distress and facial distress showed significantly changes of mean values across the three distress task phases (free play, distress, reunion), vocal distress only differed between free play and distress phase. The occurrence of body distress showed the lowest intensity and did not differ significantly between the phases. Furthermore, facial and vocal distress showed peaks in the beginning of the distress phase, while the peak of body distress occurred at a later time, during the reunion phase. Those results implicate the need of further studies to investigate dimensions of distress during social distress tasks with a larger number of participants. Additionally, dimensions of distress should be associated with distress measurements such as physiological distress.

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Appendix

A. Abstract

Understanding basic emotions such as distress is a fundamental psychological research question because their development is linked to psychological illnesses such as posttraumatic stress disorder (PTSD). However, existing measures of distress in toddlers show mixed results regarding their validity. In recent studies, correlations of different distress measurements showed inconsistent results. Measurements quantifying behavioral distress have been criticized due to their one-dimensionality and because they do not take short time periods into account. Moreover, young children's social components of distress behavior has received little attention in previous research. This master's thesis addresses these gaps in the literature and investigates behavioral distress in 18-month-old children in response to their mother's simulated pain. In addition to a frequently used self-distress scale, behavioral distress was assessed with a more distinguished coding scheme including three dimensions of distress (facial distress, vocal distress and body distress). Further, we incorporated the temporal component into our analysis to disentangle the time course of behavioral distress. Results showed significant correlations across all distress measures. Over the three phases of the distress task (free play, distress, reunion) the distress dimensions showed differences in the intensity and time of occurrence. While facial and vocal distress showed peaks in the beginning of the distress phase, the peak of body distress was later during the reunion phase. Future research should aim at comparing behavioral distress dimensions to physiological markers of distress such as respiratory sinus arrhythmia (RSA).

Keywords: *distress, toddlerhood, emotion expression, micro-coding, social distress task*

B. Zusammenfassung

Das Verständnis von Emotionen wie Distress zählt zu den grundlegenden psychologischen Forschungsfragen, da deren Auftreten und Entwicklung mit verschiedenen psychischen Erkrankungen wie der posttraumatischen Belastungsstörung (PTSD) in Verbindung gebracht wird. Zusammenhänge bestehender Erfassungsweisen von Distress bei Kleinkindern zeigten jedoch invalide und widersprüchliche Ergebnisse. Insbesondere Skalen zur Quantifizierung von behavioralem Distress wurden mehrfach kritisiert, da sie Distress eindimensional und anhand von großen Zeitabschnitten abbilden. Darüber hinaus existiert wenig Literatur über Distress im sozialen Kontext bei Kleinkindern. Die vorliegende Masterarbeit adressiert diese Lücken in der Literatur und untersucht behavioralen Distress bei Kleinkindern im Alter von 18 Monaten, welcher durch den simulierten Schmerz der Mutter ausgelöst wurde. Behavioraler Distress wurde anhand von einer häufig verwendeten Selbstdistress erfasst sowie mit einem differenzierteren Kodierschema, welches drei Dimensionen von Distress berücksichtigt (mimischer, vokaler und körperlicher Distress). Um Zeitverläufe genauer betrachten zu können, haben wir zusätzlich einen Mikrokodieransatz verwendet. Die Ergebnisse zeigten signifikante Korrelationen zwischen allen Distresserfassungsweisen. In den drei Phasen der Distressaufgabe (freies Spiel, Distressphase, Wiedervereinigungsphase) zeigten die verschiedenen Dimensionen von Distress allerdings Unterschiede in der Intensität und dem Auftretenszeitpunkt. Während sich die Maxima von mimischem und vokalem Distress zu Beginn der Distressphase befanden, lag der Höchstwert von körperlichem Distress in der Wiedervereinigungsphase. Zukünftige Forschungen sollte Dimensionen von behavioralem Distress weiter untersuchen und diese mit physiologischen Markern von Distress wie der respiratorischen Sinusarrhythmie (RSA) vergleichen.

Schlüsselwörter: *Distress, Kleinkindalter, Emotionsausdruck, Mikrokodierung, soziale Distress-Aufgabe*

C. Tables

D. Figures

E. Instruction Self-distress task

Empathische Sorge - Paradigma

Anweisungen für Simulation einer Stresssituation

In diesem Experiment interessieren wir uns für die Reaktion Ihres Kindes auf eine vermeintliche Verletzung von Ihnen. Dabei wird es immer den folgenden Ablauf geben, der auch unten nochmals in Tabellenform dargestellt ist. Zunächst spielen Sie mit Ihrem Kind auf der Spielwiese. Nach **einer Minute** hören Sie ein **Tonsignal**. Ab diesem Zeitpunkt können Sie **selbstständig** mit der **Schmerzsimulation** beginnen. In dieser simulieren Sie in den **ersten 30 Sekunden** starke Schmerzen. Bitte vermeiden Sie falls möglich in dieser Zeit Blickkontakt zu Ihrem Kind. **Nach 30 Sekunden** hören Sie einen erneuten Ton. Nun können Sie damit beginnen langsam die **Schmerzsimulation abzuschwächen**, sodass Sie nach ca. 1 Minute wieder einen neutralen Affekt erreichen. **1 Minute nach der Schmerzsimulation** hören Sie erneut Töne. Nun bitten wir Sie für eine Minute mit Ihrem Kind zu spielen.

Der Ablauf ist also wie folgt:

Zeit	**Verhalten**
0 – 1:00	Spielen
1:00	*Tonsignal*
1:00	„Verletzen“ des Daumens mit dem **Spielzeughammer** oder **Stoßen des Knies** am Stuhl
1:00 – 1:30	- Verstörter/schmerzhafter Gesichtsausdruck - Stimmliche Äußerung von Schmerz (Weinen mittlerer Intensität) - Reiben des „verletzten“ Daumens/Knies
1:30	*Tonsignal*
1:31 – 2:00	Graduelles Abschwächen des Weinens und der Schmerzäußerungen
2:00	Erreichen von neutralem Affekt
2:00 – 3:00	Spielen

Schmerzsimulationen

In diesem Experiment bitten wir Sie jeweils eine der untenstehenden Schmerzsimulationen zu zeigen. Die Versuchsleitung wird Ihnen die Reihenfolge mitteilen.

1. Knieanstoßen

Bei dieser Simulation „stoßen“ Sie sich auf dem Weg zu Ihrem Baby an einem Möbelstück (z.B. Tischbein oder Stuhl) das Knie. Daraufhin simulieren Sie für insgesamt 60 Sekunden Schmerz. Vermeiden Sie in dieser Zeit bitte den Augenkontakt zu Ihrem Baby. Nach den ersten 30 Sekunden bekommen Sie ein Tonsignal zu hören, um Sie darüber zu informieren, dass die Hälfte der Zeit vorbei ist. Bis zum zweiten Signal (über 30 Sekunden) reduzieren Sie dann bitte Ihren Emotionsausdruck bis Sie wieder neutralen Affekt (emotionalen Ausdruck) erreicht haben. Abschließend kommunizieren Sie wieder mit Ihrem Baby und signalisieren, dass es nun nicht mehr wehtut und alles in Ordnung ist.

2. Spielzeughammer

Bei dieser Simulation „verletzen“ Sie sich beim Spielen mit Ihrem Baby mit einem Spielzeughammer an Ihrem Daumen. Beispielsweise könnten Sie sich auf die Finger klopfen. Dann simulieren Sie für insgesamt 60 Sekunden Schmerz. Vermeiden Sie in dieser Zeit bitte den Augenkontakt zu Ihrem Baby. Nach den ersten 30 Sekunden bekommen Sie ein Tonsignal zu hören, um Sie darüber zu informieren, dass die Hälfte der Zeit vorbei ist. Bis zum zweiten Signal reduzieren Sie dann bitte Ihren Emotionsausdruck über die nächsten 30 Sekunden bis Sie wieder neutralen Affekt (emotionalen Ausdruck) erreicht haben. Abschließend kommunizieren Sie wieder mit Ihrem Baby und signalisieren, dass es nun nicht mehr wehtut und alles in Ordnung ist.

F. Self-distress coding scheme (Zahn-Waxler et al., 1992)

Self-distress	Distress that is focused on the self	0-3
0	Does not occur	
1	Visible distress manifested non-vocally, through the body (fussiness, irritability, jerkiness) or through facial expressions (wariness or fear: e.g., eyes wide, mouth open), clearly expressed for several seconds	
2	Whimpering (expressed vocally)	
3	Full blown crying (If infants fully cried, the distress episode was ended)	

G. Micro-coding scheme distress dimensions

Distress - Body language	Jerkiness, excitement, fussiness	0-1
0	Does not occur	
1	Body distress occurs	
99	Not codable	

Distress - Vocalization	Whimpering, crying	0-1
0	Does not occur	
1	Vocal distress occurs	
99	Not codable	

Distress - Facial expression	Fear: big eyes, open mouth	0-1
0	Does not occur	
1	Facial distress occurs	
99	Not codable	