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FinnBrain Birth Cohort Study

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Faculty of Medicine
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FinnBrain Birth Cohort Study

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Imagination is more important than knowledge
– Albert Einstein

Shoot for the moon. Even if you miss, you will land among the stars
– Norman Vincent Peale

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ABSTRACT

Alexithymia, a personality trait characterized by difficulties in identifying (DIF) and describing feelings (DDF), a pragmatic and externally oriented thinking style (EOT), and a scarcity of fantasy and imagination, was initially observed in psychosomatic patients and has long been associated with impaired mental well-being. However, there is controversy about whether or not alexithymia serves as a predictor for mental illnesses. Thus far, knowledge surrounding alexithymia, especially its nature, etiology, and actual role in the development of mental health problems, remains limited.

This study consisted of a general population of parents from the FinnBrain Birth Cohort Study. With both cross-sectional and longitudinal approaches, using multiple analytical methods, this study aimed to explore the intricate relationship between alexithymia and mental health problems related to two specific contexts: perceived parental bonding during childhood, and the recent experience of the COVID-19 pandemic.

The results indicated that alexithymia mediated the link between perceived dysfunctional parental bonding and psychological distress, with a stronger effect among male subjects. In the context of the pandemic, while the role of alexithymia per se in the mental health changes was relatively weak, it functioned as a pronounced contributor when interacting with additional factors, such as perceived stress and existing alcohol use problems. The study also provided evidence regarding the differential role of specific dimensions of alexithymic traits, with DIF and DDF tending to predispose individuals to psychological distress, and EOT being more closely related to alcohol use.

The finding suggests alexithymia as a potential mechanism explaining current mental health problems related to early perceived parenting factors. Furthermore, in the context of the pandemic, this study based on longitudinal data with employing different modeling techniques provides more comprehensive insights from several perspectives into the nature of alexithymia and its role in shaping mental health, which highlights the significance of identifying alexithymia and justifies it as a potential target for intervention strategies.

KEYWORDS: Alexithymia traits, Depressive symptoms, Anxiety symptoms, Alcohol use, Mental health, Parental bonding, COVID-19 pandemic

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TIIVISTELMÄ

Aleksitymia on persoonallisuuden piirteistö, jolle on ominaista vaikeus tunnistaa (DIF) ja kuvailla tunteita (DDF), pragmaattinen ja ulkokohtainen ajattelutapa (EOT) sekä mielikuvituksen vähyys. Se todettiin alun perin psykosomaattisilla potilailla, ja sillä on pitkään havaittu olevan yhteys mielenterveyteen ja sen häiriöihin. On kuitenkin kiistanalaista, toimiiko aleksitymia mielenterveyden häiriöiden riskitekijänä. Tietoa aleksitymiasta, erityisesti sen luonteesta, etiologiasta ja todellisesta roolista mielenterveyden riskitekijänä, kaivataan edelleen lisää.

Tämän tutkimuksen aineistona toimi FinnBrain-syntymäkohorttitutkimuksen vanhemmat. Tutkimuksessa käytettiin useita tilastollisia menetelmiä niin poikkileikkaus- kuin pitkittäisasetelmissa aleksitymian ja mielenterveysongelmien monimutkaisen suhteen tutkimiseksi kahdessa erityisessä kontekstissa: lapsuudessa koetun vanhemmuuden ja viimeaikaisen COVID-19-pandemian suhteen.

Tulokset osoittivat, että aleksitymia toimi välittäjänä koetun ongelmallisen vanhemmuuden ja psyykkisten oireiden välillä, ja yhteys oli voimakkaampi miehillä. Pandemiaan liittyen aleksitymian itsenäinen rooli mielenterveyden muutoksissa oli suhteellisen heikko, mutta se oli merkittävä tekijä yhdessä muiden muuttujien, kuten koetun stressin ja olemassa olevien alkoholinkäyttöongelmien, kanssa. Tutkimuksessa saatiin myös näyttöä aleksitymian dimensioiden erilaisista rooleista, sillä DIF ja DDF vaikuttivat altistavan psyykkisille oireille ja EOT oli läheisemmin yhteydessä alkoholin käyttöön.

Tulokset viittaavat siihen, että aleksitymia voi toimia nykyisten mielenterveysongelmien selittäjänä varhaisiin vanhemmuuden ongelmiin liittyen. Lisäksi pandemian kontekstissa erilaisia mallinnustekniikoita pitkittäisasetelmassa hyödyntävä tutkimus tarjoaa aiempaa kattavamman näkökulman aleksitymian luonteeseen ja sen rooliin mielenterveyden muotoutumisessa, korostaen aleksitymian tunnistamisen merkitystä ja tukien sen potentiaalia interventiostrategioiden kohteena.

AVAINSANAT: Aleksitymian piirteet, Masennusoireet, Ahdistusoireet, Alkoholinkäyttö, Mielenterveys, Vanhempien kiintymyssuhde, COVID-19-pandemia

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Abbreviations

ACC	Anterior cingulate cortex
ACE	Adverse childhood experiences
AIC	Akaike information criterion
ALCP	Average latent class probabilities.
ASD	Autism spectrum disorder
ATQ	Adult Temperament Questionnaire
AUDIT	Alcohol Use Disorders Identification Test
BIC	Bayesian information criterion
B-LRT	Bootstrapping likelihood ratio test
CFI	Comparative fit index
CI	Confidence interval
CM	Child maltreatment
DDF	Difficulties describing feelings
DIF	Difficulties identifying feelings
DysMB	Dysfunctional maternal bonding
DysPB	Dysfunctional paternal bonding
EOT	Externally oriented thinking
EPDS	Edinburgh Postnatal Depression Scale
fMRI	Functional magnetic resonance imaging
gwk	Gestational week
HPA	Hypothalamic-pituitary-adrenal
LGMM	Latent growth mixture modeling
LL	Log likelihood
LLCA	Longitudinal latent class analysis
LMR-LRT	Lo-Mendell-Rubin likelihood ratio test
LPA	Latent profile analysis
LTA	Latent transition analyses
MAR	Missing at random
MCAR	Missing completely at random
MI	Multiple imputation
OCD	Obsessive-compulsive disorder

OR	Odds ratios
PBI	Parental Bonding Instrument
PC	Paternal care
PD	Personality disorders
PET	Positron emission tomography
PO	Paternal overprotection
PSS-4	Perceived Stress Scale
RMSEA	Root mean square error of approximation
SD	Standard deviation
SE	Standard error
SRMR	Standardized root mean square residual
TAS-20	20-item Toronto Alexithymia Scale
TAS-20-IF	Informant version of the 20-item Toronto Alexithymia Scale
TAS-26	26-item Toronto Alexithymia Scale
TSIA	Toronto Structured Interview for Alexithymia
VBM	Voxel-based morphometry
VLMR	Vuong-Lo-Mendell-Rubin

List of Original Publications

This dissertation is based on the following original publications, which are referred to in the text by their Roman numerals:

I Li, R., Kajanoja, J., Karlsson, L., Karlsson, H., and Karukivi, M. Sex-specific role of alexithymia in associations between parental bonding and mental health: A moderated mediation model. *Journal of Clinical Psychology*, 2022; 79 (1): 126–142.

II Li, R., Kajanoja, J., Lindblom, J., Korja, R., Karlsson, L., Karlsson, H., Nolvi, S., and Karukivi, M. The role of alexithymia and perceived stress in mental health responses to COVID-19: A conditional process model. *Journal of Affective Disorders*, 2022; 306: 9–18.

III Li, R., Karukivi, M., Lindblom, J., Korja, R., Karlsson, L., Karlsson, H., and Nolvi, S. Trajectories of COVID-19 Pandemic-related Depressive Symptoms and Potential Predictors: The FinnBrain Birth Cohort Study. *Social psychiatry and psychiatric epidemiology*, 2023. *[Epub ahead of print]*. DOI: 10.1007/s00127-023-02559-0.

IV Li, R., Kajanoja, J., Karlsson, L., Karlsson, H., Nolvi, S., and Karukivi, M. Longitudinal patterns of alcohol use and psychological symptoms during COVID-19 pandemic and role of alexithymia: A latent transition analysis in the FinnBrain Birth Cohort Study. *Journal of Affective Disorders*, 2023; 338: 440–448.

1 Introduction

Alexithymia, literally meaning “no words for feelings”, was first coined by Peter Sifneos in 1973 to describe psychosomatic patients manifesting difficulties in identifying (DIF) and describing feelings (DDF), a pragmatic and externally oriented way of thinking (EOT), as well as a scarcity of imagination (Sifneos, 1973). It is considered as a personality trait that has long been linked to a variety of mental health problems including depression, anxiety, as well as substance-related and addictive disorders (Dorard et al., 2017; Gao et al., 2018; Honkalampi et al., 2000a; Marchesi et al., 2005; Parker et al., 2005). Alexithymic traits display multifaceted features (Nemiah, 1977), as supported by studies that showed differential links of DIF, DDF, and EOT to the Big Five personality (Barańczuk, 2019; Ueno et al., 2014), as well as mental health issues (Grabe et al., 2004; Kajanoja et al., 2017a; Preece et al., 2017). In addition to its association with mental health problems, alexithymia is also relevant to poor social skills and problematic interpersonal relationships (Lumley et al., 1996; Nicolò et al., 2011), making it a noteworthy target for preventive and therapeutic interventions.

The personality–psychopathology theories propose specific personality traits as relevant factors predisposing individuals to mental health problems (Gramstad et al., 2013; Jorm et al., 2000; Kotov et al., 2010, 2007). However, the nature of alexithymia and its actual role in shaping mental health remains unclear to a certain extent. Despite the evident associations between alexithymia and mental disorders, there is research indicating no predictive effects of alexithymia on major depressive disorders and alcohol use disorders (Honkalampi et al., 2010). Previous studies provide evidence that alexithymia demonstrates a combination of trait- and state-like attributes, with a tendency to be more state-dependent among clinical samples (de Haan et al., 2012; Lumley et al., 2007; Parker et al., 1991).

The etiology of alexithymia involves complex factors, including biological factors and environmental influences (Fukunishi & Paris, 2001; Gatta et al., 2017; Grabe et al., 2008a). The determinant role of environmental factors, such as sociocultural influences, childhood trauma, or recent traumatic experiences, has been highlighted (Krystal, 1979; Taylor et al., 1997a). Alexithymia has been found to be associated with various aspects of the childhood family environment, such as the perception of dysfunctional parenting, limited emotional expressivity and safety, harsh discipline, and an unhappy home environment (Berenbaum & James, 1994; Honkalampi et al., 2004a; Karukivi & Saarijärvi, 2014; Kench & Irwin, 2000). Since a secure relationship provides emotional intimacy, support, and safety, the quality of the parent-child relationship is crucial in facilitating the capacity for developing emotion regulation (Houltberg et al., 2012; Kliewer et al., 2004; Morris, 2017). Existing evidence consistently points to a link between alexithymia and perceived parental bonding (De Panfilis et al., 2003; Fukunishi et al., 1999; Kooiman et al., 2004; Mannarini et al., 2018; Nemiah, 1977; Pedrosa Gil et al., 2008), which refers to attachment styles perceived from parents during childhood (Parker et al., 1979).

Moreover, parental bonding has also been related to mental health (Duggan et al., 1998; Heider et al., 2006; Kullberg et al., 2020). Previous research has linked perceiving both low parental care and high parental control to the development of mental disorders (Eun et al., 2018). Reportedly, there are sex differences in learning emotional expressions from parents during one's early life (Chaplin & Aldao, 2013), as well as in the prevalence of alexithymia, with it generally being more prevalent among males (Franz et al., 2008; Kokkonen et al., 2001; Mattila et al., 2006; Salminen et al., 1999). Hence, the current limited knowledge about the development of alexithymia and how alexithymia functions in contributing to mental health issues make it worthwhile to explore potential sex-specific associations between perceived parental bonding during childhood, alexithymia, and mental health.

It is well-documented that mental health problems have a multifactorial origin, in which stress, as a normal response that arises intermittently when facing diverse circumstances, plays a critical role (Caspi et al., 2003; McLaughlin et al., 2010). In addition to specific experiences during childhood, current stressful life events, such as an outbreak of a pandemic, have been associated with mental health problems (Blakey et al., 2015; Mak et al., 2010; Sim et al., 2010; Xiang et al., 2020). The outbreak of the novel coronavirus disease (COVID-19) in early 2020 has been found to be a stressor that poses impacts on mental well-being among general populations, leading to various mental health issues such as depression, anxiety, and substance use (Bridgland et al., 2021; Castellini et al., 2020; Czeisler et al., 2021; McGinty et al., 2020; Nolvi et al., 2021; Pierce et al., 2020). Nevertheless, the role of alexithymia in shaping mental health in the context of the pandemic remains largely unexplored. The stress–alexithymia hypothesis posits that alexithymia traits lead to ineffective coping, which could prolong exposure to stressors and thus induce stress-related mental health problems (Martin & Pihl, 1985). Furthermore, given that personality traits influence flexibility in adapting to unexpected changes in life, abilities to interpret or perceive stressors, and coping strategies when facing stressful situations, they can bring about differential responses (Engelhard et al., 2003; Kobasa, 1979; Suls & Martin, 2005; Yan et al., 2021). Thus, alexithymia is plausibly speculated as a predisposing factor for the change in mental health related to the pandemic.

However, based on current evidence, it remains challenging to determine causal relationships between alexithymia and mental health, given the cross-sectional design of most prior studies and the complexity of factors involved in the relationship. Moreover, as aforementioned, although alexithymia is suggested to be a highly stable personality feature over years in the adult general population (Hiirola et al., 2017; Karukivi et al., 2014a; Tolmunen et al., 2011), it can be a more state-dependent phenomenon under specific situations, such as in individuals with existing depression (Marchesi et al., 2008, 2014). Hence, studies with longitudinal settings are clearly warranted to explore the nature of alexithymia and whether alexithymia plays a role in contributing to the development of mental health problems among general populations. Thus far, little is known about the role of alexithymia in mental health development related to perceived parental bonding during childhood, as well as in the context of the recent COVID-19 pandemic. Therefore, research in this regard is expected to provide valuable insights into not only the etiology of alexithymia but also how alexithymia shapes mental health. Furthermore, such research may suggest significant clinical implications for preventive and psychotherapeutic interventions.

2 Review of the Literature

2.1 History and Characteristics of Alexithymia

In 1948, psychiatrist Jurgen Ruesch found that patients with psychosomatic diseases were unimaginative and had difficulties describing their emotional arousals and states, which was thus classified as “infantile personalities” (Ruesch, 1948). It was speculated that in these patients, the emotion was expressed via autonomic nervous system with the use of “organ language” instead of symbolical and verbal skills, thus leading to physiological diseases (MacLean, 1949). Difficulties in psychoanalytic therapy were subsequently reported in a type of patients due to lacking emotional awareness and inner experiences, as well as an externalized living style (Horney, 1952; Kelman, 1952). Nemiah and Sifneos, as well as subsequent researchers, suggested that psychosomatic patients tended to manifest difficulties in the expression of feelings, poverties in fantasy life, and literal, pragmatic, and externally oriented cognitive style (Taylor, 1984; Vogt et al., 1977; von Rad et al., 1977). In 1973, Sifneos conducted a clinical study and proposed to call these characteristics “alexithymia”, literally meaning “no words for feelings” based on Greek roots (Sifneos, 1973). Thereafter, research on alexithymia extended to different aspects such as personality, emotion regulation, and psychological distress in diverse populations but only in psychosomatics patients (Bagby & Taylor, 1997a).

The nature of alexithymia is not yet fully clear. Freyberger proposed two forms of alexithymia based on its origin (Freyberger, 1977), namely primary alexithymia and secondary alexithymia. Alexithymia is generally regarded as a stable personality trait that may stem from adverse childhood experiences or biological factors and act as a disposition to psychological diseases (de Timary et al., 2008a; Hiirola et al., 2017; Karukivi et al., 2014a; Tolmunen et al., 2011). Initially, it mainly involved difficulties in recognizing and describing feelings, an externally oriented style of thinking, and limited imagination and fantasy (Bagby & Taylor, 1997a; Sifneos, 1973). Subsequently, studies have indicated that individuals with alexithymia often show inability to experience pleasure (i.e., anhedonia) as well as feel and understand others’ emotions (i.e., poor empathic ability) (Bagby & Taylor, 1997a; Moriguchi et al., 2007; Prince & Berenbaum, 1993). According to the developmental origins, alexithymia might be accounted for by the impairment in dual-process of perceiving and feeling, so-called cognitive-experiential domain (Taylor et al., 1997a). In addition, there is evidence showing that alexithymic features are associated with low sensitivity to facial expressions, linking alexithymia to automatic processing of external emotional stimuli (Donges & Suslow, 2017; Rosenberg et al., 2020).

On the other hand, secondary alexithymia is considered a more state-like outcome, such as alexithymic features following specific illnesses or as a defense mechanism under stressful situations (Lesser, 1981; Taylor et al., 1997a). It may serve as a way to evade psychological distress related to traumatic events (Badura, 2003; Krystal, 1982; Shipko et al., 1983), and a decreased level of alexithymia was found to be associated with alleviated depressive symptoms (de Groot et al., 1995; Honkalampi et al., 2000b). According to prior research, alexithymia has been observed to exhibit state-dependent characteristics to some extent, rather than being a completely trait-like construct, especially evident in clinical samples, such as patients with depression, anxiety, and substance use disorders (de Haan et al., 2012; Parker et al., 1991). Additionally, some studies have suggested a subtype called “organic alexithymia”, which refers to alexithymic features occurring due to organic factors such as brain damage or neurological disorders. For example, alexithymia has been associated with brain injury and stroke (Koponen et al., 2005; Messina et al., 2014). Research indicated the presence of alexithymic features in in split-brain patients, specifically referring to individuals who have undergone cerebral commissurotomy (TenHouten et al., 1986), and stroke patients with a right-hemisphere lesion (Spalletta et al., 2001). Moreover, high levels of alexithymia have been observed in patients with oncologic diseases, which may be related to lower hemoglobin levels and more advanced cancer invasion (De Vries et al., 2012; Messina et al., 2011). Hence, it is plausible that alexithymia can be a complex feature with both trait-like and state-like characteristics (Lumley et al., 2007).

Recent studies suggest that individuals with high levels of alexithymia may have high interoceptive sensibility but low interoceptive awareness, proposing a theory that alexithymic individuals have difficulties interpreting their bodily sensations instead of perceiving them (Fournier et al., 2019; Zamariola et al., 2018). In other words, alexithymic individuals may be able to perceive their physical responses more intensely than non-alexithymic individuals but are unable to link such reactions to emotions, which may account for somatization symptoms in them. This also supports the “somatosensory amplification hypothesis,” which suggests that alexithymia amplifies one’s normal somatic sensations (Wise & Mann, 1994). Additionally, the concept of affective anomia and agnosia highlights that alexithymia involves not only difficulties in naming and describing feelings but also the impaired mental representation of emotions (Lane et al., 2015; Taylor et al., 2016). Therefore, it appears that a deeper understanding of the nature of alexithymia may benefit from future research focusing on the interoceptive components and mentalization in relation to alexithymia.

Furthermore, alexithymia has been associated with the Big Five personality dimensions, namely openness, conscientiousness, extraversion, agreeableness, and neuroticism (Goldberg, 1993). Specifically, most of prior research demonstrated a positive correlation of alexithymia with neuroticism and negative with openness to experience (Bagby et al., 1994a; Messina et al., 2010; Taylor, 2012), which implies that alexithymia has a tendency towards emotional instability as well as lack of fantasy, attention to feelings, and intellectual interests. Research using cluster analysis identified two distinct groups, with one characterized by DIF and high neuroticism, and the other by EOT and low openness to experience (Ueno et al., 2014). A recent meta-analysis supported that higher levels of neuroticism were linked to more DIF and DDF, and greater openness to experience was related to lower levels of EOT (Barańczuk, 2019), highlighting the multidimensional conceptualization of alexithymic traits and suggesting potential subtypes of alexithymia. However, although alexithymia is currently believed to be multifaceted traits, some researchers have argued that it is more reasonable to consider alexithymia as a continuum construct with various degrees (Taylor et al., 2016).

2.2 Measuring Alexithymia

In clinical situations, alexithymic features can be evaluated via interviews. In 1973, Sifneos proposed the term alexithymia and first introduced the Beth-Israel Hospital Psychosomatic Questionnaire, an observation scale consisting of 17 dichotomous questions to assess alexithymia according to the opinions of the interviewer about the patients (Sifneos, 1973). Due to the inter-rater reliability of this scale being low, more questions were added, and the scale was then modified into a 7-point Likert style, which has been shown to be valid and reliable (Bagby & Taylor, 1997b). Similar observation scales including the Alexithymia Provoked Response Questionnaire (Krystal et al., 1986), the California Q-set Alexithymia Prototype (Haviland & Reise, 1996), and the Observer Alexithymia Scale (Haviland et al., 2000), were developed for observer data collecting.

Apfel and Sifneos (1979) developed a self-report questionnaire for measuring alexithymia, called the Schalling-Sifneos Personality Scale (Apfel & Sifneos, 1979). The Minnesota Multiphasic Personality Inventory also included an alexithymia scale that was used for several years (Kleiger & Kinsman, 1980). However, again, the validity across different populations was not supported by subsequent studies (Bagby et al., 1988; Federman & Mohns, 1984). In order to address the methodological problems in evaluating alexithymia, the Toronto Alexithymia Scale originally consisting of 26 items (TAS-26) rated with a 5-point Likert scale was introduced, which is an instrument assessing four dimensions of alexithymic features: difficulty identifying and describing feelings (DIF and DDF), an externally oriented thinking style (EOT), and reduced daydreaming (Taylor et al., 1985). According to research comparing the abovementioned measurements, the factor structure of the TAS-26 was found to be more stable with less response/gender bias, and this scale also showed sounder psychometric properties and stronger correlations with functional somatic symptoms than the Schalling-Sifneos Personality Scale and Minnesota Multiphasic Personality Inventory (Bagby et al., 1988).

The 20-item Toronto Alexithymia Scale (TAS-20) was later developed by omitting several items from the TAS-26, including all the items related to daydreaming, mainly due to considerable cross-loading of items and low corrected item-total correlations (Bagby et al., 1994b). The daydreaming factor has been found to have poor theoretical coherency with other dimensions of the original TAS-26 (Haviland et al., 1991), and to a certain degree, it is reflected by EOT that refers to a tendency towards external events instead of inner experience of feelings and imagination, which also echoes the concept of “concrete and reality-based cognitive style (la pensée opératoire)” (Taylor, 1990). Hence, without the daydreaming-related items, the TAS-20 comprises three dimensions (DIF, DDF and EOT). Given the good reliability and validity of the scale indicated in many subsequent studies, it has heretofore become the most widely used instrument in clinical and research work with sufficient stability across languages and populations (Bagby et al., 1994b; Joukamaa et al., 2001; Parker et al., 2003; Taylor et al., 2003), although in some studies, the internal consistency of the EOT dimension was somewhat questioned (Kooiman et al., 2002; Müller et al., 2003).

As some studies have proposed that there may be two different types of alexithymia and that the TAS-20 measurement might not capture the complete spectrum of alexithymic features, the Bermond-Vorst Alexithymia Questionnaire is developed as another reliable and valid self-reported instrument (Bermond et al., 2007; Morera et al., 2005; Vorst & Bermond, 2001). This questionnaire includes an affective component measured by the subscales of emotionalizing and fantasizing as well as a cognitive component by the subscales of identifying, analyzing, and verbalizing own emotions. Nevertheless, recent research provides support for a three-dimensional construct of alexithymia while finding no evidence to include limited emotional reactivity and fantasizing as components of alexithymia (Preece et al., 2017, 2020a; Watters et al., 2016). This is theoretically explicable. Emotionalizing refers to the degree of being emotionally aroused in response to specific stimuli, which in fact is only a correlate of alexithymia and seems to more represent the personality dimension of neuroticism (Eysenck, 1963; Vorst & Bermond, 2001; Watters et al., 2016). Moreover, to take schizophrenic patients for example, emotional blunting seems not always to reflect less emotional experience (Kring et al., 1993). On the contrary, individuals having difficulties in identifying and expressing feelings may tend to manifest higher levels of emotional arousal. For instance, there is evidence from neuroimaging research showing that labeling and verbalizing affect can effectively diminish emotional reactivity (Hariri et al., 2000; Lieberman, 2011; Lieberman et al., 2007). In addition, difficulty fantasizing has been considered a peripheral factor rather than a primary component of alexithymia, based on the hypothesis that the development of cognition and emotion processing determines the level of emotional awareness (Lane & Schwartz, 1987), independent of fantasy and daydreaming (Preece et al., 2017; Stawarczyk et al., 2012). Drawing from the attention-appraisal model proposed by Preece et al. (2017), which identifies DIF and DDF as deficits in accurately appraising emotional information, and EOT as a tendency towards a lack of attention to one's emotions and inner world, the Perth Alexithymia Questionnaire was developed (Preece et al., 2017, 2018).

The researchers who created the TAS-20 have also developed an interview-based measurement, the Toronto Structured Interview for Alexithymia (TSIA), which has demonstrated acceptable psychometric properties and a significant correlation with the TAS-20 (Bagby et al., 2006). However, the application of the structured interviews to alexithymia measuring is usually limited by several factors such as time consuming, relatively poor psychometric reliability, and lacking replicability during clinical work or empirical research with a large sample, thus obtaining less attention. Indeed, the results of the determination can be largely variable as it is likely to differ across interviewers according to their ability, making the comparisons between the conclusions difficult (Lumley et al., 2007). In addition, there are no studies on the validation of the instruments based on observations or structured interviews in Finnish language. Self-report questionnaires, especially the TAS-20 due to its good psychometric quality, continue to hold a dominant position in the application at present.

It has been argued that individuals who struggle with identifying and describing their feelings may not be able to accurately assess these characteristics on their own (Lane et al., 1997). To address this challenge, recently, an informant report version of the TAS-20 (TAS-20-IF) has been developed and validated (Bagby et al., 2021). Given its simplicity in completion, the TAS-20-IF can be a favored option in clinical practice compared to other interview-based measurements. Notwithstanding, further validation research is warranted to support this newly developed form. Research on alexithymia would benefit from simultaneously using various types of measurements due to more effective bias control, in particular for an investigation with a small sample.

2.3 Etiology of Alexithymia

There are complex factors involved in the etiology of alexithymia, in particular alexithymia has been acknowledged as a multidimensional construct (Nemiah, 1977). Decades after the term alexithymia was coined, numerous studies have suggested several risk factors for the development of alexithymic features, but sound understanding in this regard is still lacking. According to the existing evidence, the explanations of how and why an individual develops alexithymic traits mainly implicate psychosocial mechanisms. Regardless of primary or secondary alexithymia, environmental factors such as sociocultural influences, childhood trauma, or recent traumatic experiences appear to be important and have been emphasized (Krystal, 1979; Taylor et al., 1997a). For instance, dissociation, which is a coping mechanism strongly linked to traumatic events, has been found to be associated and somewhat overlapped with alexithymia (Grabe et al., 2000; Tolmunen et al., 2010). Additionally, neurobiological mechanisms may also be implicated in the etiology of alexithymia (Taylor et al., 1997a). Previous studies have indicated the intergenerational transmission of alexithymic features, which can result from a combination of biological factors (e.g., genetic factors) and environmental influences (e.g., familial and parental factors) (Fukunishi & Paris, 2001; Gatta et al., 2017; Grabe et al., 2008a). It is evident that none of these developmental factors in isolation can comprehensively account for the etiology of alexithymia. Consequently, it is crucial to acknowledge and explore the intricate interplay or interaction among these factors (Belsky & Pluess, 2009; Kendler, 2005, 2008).

2.3.1 Genetic and neurobiological base

A twin study conducted in Norway was the first to report the possible genetic factors contributing to the development of alexithymia (Heiberg & Heiberg, 1977). However, the questionable measurement and the small sample size of only 33 pairs of twins limited the power of the evidence. In 2007, a Danish study using a large sample of 8785 twin pairs, ranging in age from 20 to 71 years, demonstrated that genetic factors contribute to all dimensions of alexithymia measured by the TAS-20. They estimated the heritability to range from 30% to 33% (Jørgensen et al., 2007). Similarly, a study with an Italian sample of 729 twin pairs, using the same measurement of the TAS-20, suggested that 42% of the variance in alexithymic features may be explained by genetic effects. However, when considering depression as a covariate, the heritability estimate decreased to 33% for alexithymia (Picardi et al., 2011).

Previous research on genetic factors indicated an association between alexithymia and polymorphism within the promoter region of the serotonin transporter (5-HTTLPR). A study by Kano et al. (2012) showed higher TAS-20 total scores in individuals with the L/L genotype (Kano et al., 2012). Additionally, higher levels of alexithymia, particularly the dimensions of DIF and DDF, were found to be associated with the catechol-O-methyltransferase Val/Val genotype (Ham et al., 2005; Koh et al., 2016). This may account for the possible link between alexithymia and dysfunctional frontal lobe (McDonald & Prkachin, 1990; Stuss et al., 1992). However, mixed findings exist. For example, Terock et al. (2018) found the L allele to be associated with low levels of alexithymia, which is inconsistent with the study by Kano et al. (2012). Regarding the COMT gene, there is research suggesting no associations of COMT Val158Met, the polymorphism leading to decreased activity of the COMT enzyme, with alexithymia (Zekioglu et al., 2014). More recently, evidence based on meta-analysis indicates that alexithymia is not associated with either 5-HTTLPR or COMT Val158Met (Yang et al., 2019).

A study showed that participants carrying the derived neurotrophic factor 66Met and dopamine receptor D2/ANKK1 A1 allele were more likely to score higher on the TAS-20 (Walter et al., 2011). Interactions between these two genetic polymorphisms were found to have impacts on the anterior cingulate cortex (ACC) (Montag et al., 2010). The ACC has long been reported to play a critical role in conscious awareness or the ability to consciously experience emotions (Lane et al., 1997, 1998a; Pardo et al., 1990). Hence, impaired emotional stimuli processing in the ACC may be one of the potential neurobiological mechanisms underlying the development of alexithymic features (van der Velde et al., 2013).

Early theories have proposed deficits in interhemispheric transfer and dysfunctional left hemisphere as the neural basis of alexithymia (Bermond et al., 2005; Romei et al., 2008; Tabibnia & Zaidel, 2005; Taylor et al., 1997a). More evidence has been provided through the application of functional and structural neuroimaging techniques, such as positron emission tomography (PET) and functional magnetic resonance imaging (fMRI), which enhance our understanding of the neurobiology-related development of alexithymia. In addition to the previously mentioned ACC, specific regions of the prefrontal cortex, such as the medial prefrontal cortex and orbitofrontal cortex, as well as the ventral tegmental area, amygdala, insula, hippocampus, and thalamus, have been identified as brain areas that may be associated with alexithymia (Goerlich-Dobre et al., 2015; van der Velde et al., 2013; Xu et al., 2018).

The function of the anterior insula, a region believed to play a crucial role in perceiving internal bodily sensations, known as interoception, has received significant emphasis (Bird et al., 2010; Namkung et al., 2018). For example, low activity in the insula and precuneus (which functionally interacts with the insula) in response to positive emotional stimuli has been suggested to reflect a lack of emotional awareness and reduced experience of positive affect in individuals with alexithymia (Terasawa et al., 2013; van der Velde et al., 2013; Yelsma, 2007). However, there is research that presents conflicting findings, suggesting that alexithymia may be associated with more activated parts of the insula, as well as the motor and somatosensory cortex, in response to emotional films (Karlsson et al., 2008). Specifically, the anterior insula as a responsive region and the availability of dopamine D2 receptors in this region have been proposed to be associated with one of the key dimensions of alexithymia, namely, DIF (Lemche et al., 2013; Okita et al., 2016). These findings also support the theory that individuals with alexithymia have difficulties interpreting their bodily sensations rather than perceiving them (as discussed in section 2.1, Fournier et al., 2019; Zamariola et al., 2018).

Moreover, previous studies have provided evidence indicating a connection between alexithymia and the functioning of the medial prefrontal cortex and orbitofrontal cortex (Bermond et al., 2006; van der Velde et al., 2013; Xu et al., 2018). For instance, decreased activity in the dorsomedial prefrontal cortex in response to emotional stimuli may contribute to the impairment of emotion regulation, mentalizing, and empathic ability (Lamm et al., 2011; Moriguchi et al., 2006; van der Velde et al., 2013). Hyperactivity in the orbitofrontal cortex in response to visceral stimulation has been found to be related to alexithymia (Kano et al., 2007). However, there are mixed results when employing structural neuroimaging techniques. A study using voxel-based morphometry (VBM) and the Bermond-Vorst Alexithymia Questionnaire to assess alexithymia revealed an association between the affective dimension of alexithymia and reduced gray matter volume in the orbitofrontal cortex (van der Velde et al., 2014).

Based on the existing evidence, the neurobiological basis of specific dimensions or facets of alexithymia remains somewhat unclear. Most previous studies have utilized the TAS-20 due to its advantages (as mentioned in section 2.2), and thus, their main focus is on the three dimensions measured by the TAS-20, namely, DIF, DDF, and EOT. A PET study observed hyperactivity in the orbitofrontal cortex in individuals with higher levels of the DIF and DDF dimensions (Kano et al., 2007). Research employing fMRI demonstrated that the DIF dimension was particularly associated with the activity of areas relevant to emotion processing, such as the ventromedial prefrontal cortex and superior temporal gyrus, while the DDF dimension showed correlations with the adjacent ventral tegmental area (Duan et al., 2010; Goerlich et al., 2017). Additionally, VBM research indicated that the reduction of gray matter volume in the dorsal ACC is a key structural correlate of alexithymia, particularly the DIF dimension, implying that differences in both brain region function and structure may be important for the development of specific facets of alexithymia (Grabe et al., 2014). Nevertheless, brain areas relevant to emotion processing seemed to show limited connections to the EOT dimension, which may be due to EOT being a cognitive style that does not necessarily rely on the experience of emotions.

2.3.2 Gene-environment interactions

Epigenetics highlights that diverse phenotypic traits can result from modifications in gene expression related to environmental factors, rather than alterations in the genetic code or DNA sequence. In this context, the structural and functional changes in the nervous system reflect the ability of neural networks to grow or reorganize in response to internal and external factors, such as learning, stress, and environmental changes, known as neuroplasticity (Davidson & McEwen, 2012; Fuchs & Flügge, 2014; Pascual-Leone et al., 2005). While genetic studies have suggested the significance of hereditary effects in the origin of alexithymia, epigenetics provides a more comprehensive explanation by linking psychological development and outcomes to both genetic and environmental factors (Gudsnuk & Champagne, 2011; Murgatroyd & Spengler, 2011). The development of personality is believed to be a long-term and complex process throughout one's lifespan, involving the interplay between genes, epigenetics, and environments. These factors contribute to various outcomes in cognition, emotions, and behaviors, shaping specific personality features (Depue, 2009; Stallings & Neppl, 2021).

As aforementioned in section 2.3.1, Jørgensen et al. (2007) estimated the heritability of alexithymia at approximately 30%, but they found that nonshared environmental factors accounted for more than half of the remaining variance in alexithymia levels. Although alexithymic traits have been linked to genetic factors, existing findings consistently indicate stronger effects of environments than genes (Ham et al., 2005; Koh et al., 2016; Picardi et al., 2011). Moreover, a study indicated that shared genetic factors only contributed to the EOT dimension, while the DIF and DDF dimensions had stronger associations with environmental factors (Valera & Berenbaum, 2001). According to the notion of evolutionary developmental psychology, such as "biological sensitivity to context" and the related theory of the "differential susceptibility hypothesis," individuals may vary in their sensitivity to both positive and negative environments due to natural selection, leading to distinct groups with different physiological and psychological characteristics. These groups include a fixed or resilient group that is more adaptable to environments and a plastic or malleable group that is more susceptible to environmental influences (Belsky & Pluess, 2009; Boyce & Ellis, 2005). These theories not only focus on vulnerability but also emphasize the crucial role of environments in psychological development, including temperament and personality traits (Kawamoto, 2019; Rioux et al., 2018).

Despite the importance of environmental and genetic factors reported in several studies, evidence regarding the effects of gene-environment interactions on the development of alexithymia remains lacking (Baughman et al., 2013; Cairncross et al., 2013; Terock et al., 2018). Alexithymia levels may decrease during detoxification treatment in alcoholic patients with the L/L genotype (Mandelli et al., 2013), suggesting a potential interaction between genes and environmental changes. In the study by Terock et al. (2018), no interaction effects of genetic and environmental factors were observed, suggesting them to be independent contributors for alexithymia. However, in subsequent research, Terock et al. (2021) revealed that childhood traumatic experiences interacting with the single nucleotide polymorphism rs6295 of the serotonin receptor gene (5-HT1A) served as relevant factors for alexithymia in males. Furthermore, a recent study determined a moderating effect of childhood parental care on the association between the oxytocin receptor polymorphism and alexithymia (Zhao et al., 2023). These findings have improved the limited understanding of gene-environment interactions in the context of the development of alexithymia, while more research in this regard is clearly needed.

2.3.3 Adverse childhood experiences

Although the effects of interaction between genetic and environmental factors on alexithymia cannot be determined based on existing evidence, the role of adverse childhood experiences (ACE) in the etiology of alexithymia has long been considered. Child maltreatment (CM), including physical and sexual abuse, as well as psychological (or emotional) abuse and neglect, is one of the most significant ACEs. Green et al. (2010) estimated that around 45% of the onset of psychiatric disorders in childhood and 30% of later onset can be explained by ACEs, highlighting the developmental impact of CM (Green et al., 2010), highlighting the importance of CM as developmental factors. Moreover, alexithymia may serve as a mechanism underlying psychopathology in individuals with a history of CM. Research suggests that alexithymia mediates the relationship between childhood trauma experiences, including CM, and mental health disorders such as anxiety and depression (Brown et al., 2016; Weissman et al., 2020).

Childhood trauma has been related to dissociation, a state of mind that individuals feel disconnection to their emotions and cognition (Rafiq et al., 2018).

Grabe et al. (2000) observed a strong link between dissociation and alexithymia. A recent meta-analysis supports their relationship, especially in populations with psychiatric disorders (Reyno et al., 2020). Albeit being considered distinct from alexithymia, it appears to share commonality with alexithymic features (Tolmunen et al., 2010). It is suggested that alexithymia tends to indicate a deficiency in emotional capacity, whereas dissociation acts as a psychological tool to disengage from trauma-related emotional pain, reflecting a defense mechanism (Schimmenti & Caretti, 2016).

The experience of CM can have detrimental effects on affective and cognitive functioning. For instance, maltreated children often exhibit difficulties in understanding and distinguishing emotional expressions, displaying a bias towards negative facial expressions (Cicchetti & Curtis, 2005; Pechtel & Pizzagalli, 2011; Pollak et al., 2000). Neurobiological evidence suggests that CM is associated with alterations in several brain regions, including the anterior cingulate cortex, prefrontal cortex, amygdala, and hippocampus (Dong et al., 2022; Teicher et al., 2014; Teicher & Samson, 2016; van Harmelen et al., 2014), which have been implicated in emotional processing and the development of alexithymia (as previously discussed in section 2.3.1, Goerlich-Dobre et al., 2015; van der Velde et al., 2013; Xu et al., 2018).

The findings regarding the associations between different types of CM and alexithymia are mixed. Some studies have reported that child abuse experiences are associated with higher levels of alexithymia (Berenbaum, 1996; Brown et al., 2016; Scher & Twaite, 1999), while others suggest that higher levels of alexithymia are specifically observed in individuals who experienced emotional neglect during childhood, rather than abuse (Güleç et al., 2013; Kooiman et al., 2004; Paivio & McCulloch, 2004). Furthermore, research has revealed differential associations with specific dimensions of alexithymia, indicating a strong link between alexithymia and emotional neglect, whereas emotional abuse and physical neglect are associated with the dimensions of DIF and EOT, respectively (Kajanoja et al., 2021). A study conducted with clinical samples demonstrated an association between DDF and both emotional/physical abuse and neglect in patients with major depressive disorders (Honkalampi et al., 2020). A recent meta-analysis provided evidence that neglect may be a more significant factor in relation to alexithymia compared to child abuse forms (Khan & Jaffee, 2022). Notwithstanding, it is worth noticing that Vachon et al. (2015) argued that different forms of CM may have equivalent impacts on mental health (Vachon et al., 2015). Moreover, it is uncommon to find instances of single-type physical maltreatment without any emotional maltreatment, as experiences of child abuse often coincide with neglect (Lin et al., 2016; Pears et al., 2008; Witt et al., 2016).

2.3.4 Parent-child relationship

A model proposed by Morris et al. (2007) suggests a tripartite mechanism that underlies the influence of familial factors on children's emotion regulation, which may contribute to the development of alexithymic traits (Bagby & Taylor, 1997a; Morris et al., 2007). According to this model, the development of emotion regulation can be influenced through three pathways: observing parents' emotion regulation, parenting practices, and the emotional climate within the family. The family emotional climate encompasses various elements, including parenting styles, emotional expressivity, and attachment relationships (Morris et al., 2007). Early in 1982, McDougall reported that individuals with alexithymia often described a sense of emotional unavailability, denial, or repression within their caregivers, stating, "In our family, it was forbidden to be sad, or angry, or in need of anything. I still get confused if I try to grasp what I am feeling" (McDougall, 1982). Subsequently, alexithymia levels were found to be associated with aspects of the childhood family environment, such as perceiving less emotional expressivity and a lack of emotional safety, harsh discipline, and an unhappy home environment (Berenbaum & James, 1994; Honkalampi et al., 2004a; Kench & Irwin, 2000).

Extensive evidence has demonstrated a link between alexithymia and parental bonding, which reflects the perceived quality of the parent-child relationship during childhood (De Panfilis et al., 2003; Fukunishi et al., 1999; Kooiman et al., 2004; Mannarini et al., 2018; Parker et al., 1979; Pedrosa Gil et al., 2008). A meta-analysis has indicated that inadequate parental bonding, characterized by low parental care, undue parental protection or control, was associated with alexithymia, particularly the dimensions of DIF and DDF (Thorberg et al., 2011). More specifically, moderate to strong associations between maternal care and alexithymia were found, highlighting the main role of maternal care in the relation between parental bonding and alexithymia. Furthermore, a recent study suggested that alexithymia mediates the relationship between inadequate parental bonding and risky drinking behaviors (Lyvers et al., 2019). However, while both mothers and fathers are believed to play influential roles in a child's emotional development (Brand & Klimes-Dougan, 2010), specific styles of parental bonding may have differential associations with the development of alexithymia depending on individual characteristics. For example, perceived paternal bonding may have stronger associations with alexithymia in clinical samples (Kooiman et al., 1998, 2004) compared to general populations (Fukunishi, 1998; Fukunishi et al., 1997, 1999; Karukivi et al., 2011) where maternal bonding appeared to be more significant. Moreover, considering previous findings on sex differences in early-life emotional learning from parents (Chaplin & Aldao, 2013; Merz & Wolf, 2017;

Toufexis et al., 2006), it is plausible that the effects of parental bonding vary by sex (e.g., De Panfilis et al., 2003; Karukivi et al., 2011).

The quality of the parent-child relationship is crucial for effective emotion regulation, as a secure relationship or adequate parental bonding characterized by warmth and acceptance, provides emotional intimacy, support, and safety (Houltberg et al., 2012; Kliewer et al., 2004; Morris, 2017). Additionally, adequate parental bonding also encompasses the situation where parents have no excessive overprotective behaviors (Parker et al., 1979). Overprotection, usually characterized by harsh and hostile discipline, can manifest in diverse ways, including not allowing the children to take risks, intrusive monitoring of their activities, and excessive control or intervention in their lives, which may limit children's expression of feelings and ideas and impede their self-regulation capacity (Grolnick & Ryan, 1989; Joussemet et al., 2008). Moreover, caregivers who exhibit psychological control may impose their demands on their child's thoughts, expressions, or behaviors, undermining the child's autonomy and self-determination needs, thereby contributing to psychopathology (Ryan, 2006; Soenens & Vansteenkiste, 2010). The attachment theory posits that insecure attachment is a risk factor for mental health problems, as child's personality, socialization, and emotional regulation require healthy interactions with caregivers during childhood, including emotional guidance (Belsky, 2002; Galbally et al., 2020; Mikulincer & Shaver, 2012). Individuals with alexithymia are more likely to have experienced separation anxiety during childhood and exhibit insecure attachment styles in adulthood, reflecting similar attachment styles from their childhood (Fraley, 2002; Troisi et al., 2001). Furthermore, various factors have been identified that can compromise the quality of the parent-child relationship, including the perceived lack of support from a partner (de Cock et al., 2016), limited knowledge about fostering social-emotional and cognitive development (Leung & Suskind, 2020), and having alexithymic parents (Ahrnberg et al., 2021; Cuzzocrea et al., 2015; Yürümez et al., 2014).

2.3.5 Language developmental factors

Speech or language development has been suggested to play a role in the etiology of alexithymia. A study by Kokkonen et al. (2003) found that better speech ability at the age of 1 year was associated with lower levels of alexithymia at the age of 31, suggesting that speech development plays a role in the etiology of alexithymia (Kokkonen et al., 2003). Another study by Karukivi et al. (2012) showed that boys with impaired language ability at the age of 5 tended to have higher levels of alexithymia in late adolescence (Karukivi et al., 2012). Language ability is crucial for theory of mind, the capacity to understand one's own and others' mental states, including thoughts and emotions (de Villiers, 2000; Milligan et al., 2007). Moreover, children with language impairments may have difficulty identifying specific facial expressions (Spackman et al., 2005), which shares common attributes with alexithymic features. The function of the superior temporal gyrus, an area important for language processing, could provide a neurobiological explanation for this relationship (Duan et al., 2010; Friederici, 2011; Vigneau et al., 2006). In addition, the development of emotion understanding may benefit from active use of emotional state talk and varied family discourse on feelings during preschool age, highlighting the role of environmental factors (Dunn et al., 1991; Gavazzi & Ornaghi, 2011). However, establishing causal relationships between speech development and emotion understanding is challenging due to potential bidirectional effects and the interplay of other factors such as inhibitory control (Carlson et al., 2004; Shatz, 1994).

2.3.6 Sociodemographic factors

Various sociodemographic factors have been associated with alexithymic traits. For instance, studies suggest that individuals with lower levels of education and income, limited social support, and older age tend to display higher levels of alexithymia (Honkalampi et al., 2004b; Karukivi et al., 2011; Kokkonen et al., 2001; Lane et al., 1998b; Mattila et al., 2006).

It has been consistently observed that alexithymia is more common in males, with an overall prevalence of approximately 10% in the general population (Franz et al., 2008; Kokkonen et al., 2001; Levant et al., 2009; Mattila et al., 2006; Salminen et al., 1999). This gender difference in alexithymia may be attributed to gender role socialization, where boys are often discouraged from expressing negative emotions such as sadness (Chaplin et al., 2005; Le et al., 2002; Levant, 1992).

Additionally, according to previous research, living alone seems to be related to alexithymia (Nan et al., 2023). However, it is still undetermined whether living alone is a risk factor for alexithymic traits. Individuals with alexithymia tend to experience poor social skills and difficulties in interpersonal relationships (Lumley et al., 1996; Nicolò et al., 2011), potentially leading to social isolation. It is noteworthy that alexithymic individuals may have less chronic stress related to living alone compared to non-alexithymic individuals (Terock et al., 2017), which can also contribute to their preference for living alone.

Furthermore, the association of sociocultural factors with alexithymia is evident. Research examining the link between alexithymia and ethnicity has shown that individuals with Asian backgrounds tend to score higher levels of alexithymia compared to European Americans and Euro-Canadians, specifically in the dimension of EOT (Dere et al., 2012; Le et al., 2002; Ryder et al., 2008). This may be due to cultural norms that discourage the expression of personal emotions and emphasize the importance of social harmony (Dion, 1996; Heine, 2001). The sociocultural context significantly influences emotional experience and expression (Eid & Diener, 2001; Matsumoto et al., 2008), and EOT has been suggested to be more strongly associated with sociocultural contexts compared to the other dimensions of alexithymia (Dere et al., 2012; Ryder et al., 2008). In addition, despite prior research linking alexithymia to older age, it remains somewhat unclear whether the increase of alexithymia is primarily associated with changes in neuropsychological functions related to aging or influenced by early growth environment within specific sociocultural circumstances, such as World War II, during which the subjects experienced migration and faced resource scarcity, leading to a situation where discussions about feelings were not prioritized (Mattila et al., 2006; Onor et al., 2010). Traumatic experiences have been linked to higher levels of alexithymia (Eichhorn et al., 2014). Hence, considering sociodemographic characteristics is crucial when conducting and interpreting research on alexithymic traits.

2.4 Alexithymia and Mental Health

Alexithymia has long been associated with a variety of mental health problems including depression (Honkalampi et al., 2000a; Li et al., 2015), anxiety (Berthoz et al., 1999; Marchesi et al., 2005), substance-related and addictive disorders (Dorard et al., 2017; Thorberg et al., 2009), eating disorders (Westwood et al., 2017), and even schizophrenia (Kubota et al., 2012; O'Driscoll et al., 2014). The stress-alexithymia hypothesis suggests that the lack of emotional awareness contributes to prolonged exposure to stressors, thereby increasing the risk of developing mental health problems (Martin & Pihl, 1985). It has been proposed that dysfunction in the hypothalamic-pituitary-adrenal (HPA) axis, which is involved in the stress response, may serve as a potential mechanism underlying this relationship (Alkan Härtwig et al., 2013; de Timary et al., 2008b). Some longitudinal research has supported the notion that alexithymia can act as a risk factor predicting future mental health problems (Karukivi et al., 2014b; Patwardhan et al., 2019). However, there are conflicting findings, with some studies suggesting that alexithymia may not function as a significant predictor for mental disorders (Honkalampi et al., 2010; McCaslin et al., 2006). Notwithstanding, the available evidence regarding the actual role of alexithymia in predisposing individuals to mental health problems based on longitudinal studies is limited (Honkalampi et al., 2022; Li et al., 2015).

2.4.1 Depression and anxiety

The association between depression and alexithymia has been extensively investigated in previous research. A meta-analysis reported a significant relationship between depression levels and alexithymia (Li et al., 2015). In a study by Honkalampi et al. (2000) with a sample from the Finnish general population, approximately 32.1% of individuals who scored above the cutoff point on the Beck Depression Inventory were found to have alexithymia, which was approximately eight times higher than the prevalence of alexithymia in non-depressive participants (Honkalampi et al., 2000a). Moreover, research suggests that alexithymic features, particularly the dimensions of DIF and DDF, change with variations in depression levels (Saarijärvi et al., 2001). Kajanoja et al. identified two subtypes of alexithymia, with higher DIF levels being associated with depressive symptoms (Kajanoja et al., 2017a). Thus, it is suggested that the link between alexithymia and depression is primarily explained by the affective component of alexithymic traits. However, findings from longitudinal studies are mixed. While Tolmunen et al. found that alexithymia predicted later depression (Tolmunen et al., 2011), Honkalampi et al. (2010) did not find evidence supporting the predictive role of alexithymia in major depressive disorders (Honkalampi et al., 2010). Additionally, alexithymia levels have been found to decrease when depressive symptoms improve (de Groot et al., 1995; Honkalampi et al., 2000b), suggesting a concurrent and strong link between alexithymic features and depression.

There is an inevitable overlap in item content between alexithymia and depression due to the nature of personality traits being strong precursors of mental health outcomes. For instance, a recent longitudinal study showed that higher levels of depressive symptoms were associated with less reduction in alexithymia (Kekkonen et al., 2021). Nonetheless, evidence strongly suggests alexithymia to be a stable personality trait that is distinct from depression (Marchesi et al., 2000; Parker et al., 1991; Saarijarvi et al., 2006). This was also supported by neuroimaging research showing differences in insula activity between alexithymic individuals with and without depression (Wiebking & Northoff, 2015). In addition, alexithymia has been found to predispose individuals with depression to more severe physical and psychological outcomes, such as higher levels of somatic symptoms (Sayar et al., 2003) and suicidality (Hintikka et al., 2004), as well as poorer treatment efficiency (Ozsahin et al., 2003). However, to gain deeper understanding of the relationship between alexithymia and depression, more longitudinal research is needed.

In addition, prior studies have also reported relationships between alexithymia and various types of anxiety disorders. For example, patients with generalized anxiety disorder were found to be more likely to exhibit alexithymic traits compared to non-clinical subjects (Onur et al., 2013; Paniccia et al., 2018). In a Finnish population-based pregnancy cohort, a higher level of alexithymia was associated with more postpartum anxiety symptoms, and this effect was found to be stronger in fathers (Karukivi et al., 2015). Higher rates of alexithymia have also been observed in patients with panic disorder, both during acute phases and remission, compared to healthy controls (Marchesi et al., 2005). There is also evidence suggesting a relationship between alexithymia and obsessive-compulsive disorder (OCD) (Carpenter & Chung, 2011; Robinson & Freeston, 2014). A study considering OCD dimensions found that only one dimension, “sexual/religious obsessions”, was linked to alexithymia in OCD patients (Roh et al., 2011). However, prospective research has shown that alexithymia does not predict the long-term outcome of OCD or the treatment response to cognitive-behavioral therapy (Rufer et al., 2004, 2006).

2.4.2 Substance use and addictive disorders

Alexithymia has been consistently linked to substance use disorders. Several studies have demonstrated that approximately half of individuals with alcohol use disorders exhibit alexithymia (Loas et al., 2000; Thorberg et al., 2009; Uzun et al., 2003). In a study with middle-aged male subjects, both acute heavy alcohol intake and long-term alcohol consumption were associated with alexithymia (Kauhanen et al., 1992). A meta-analysis found a relationship between alexithymia and risky drinking, with a stronger association in older populations (Greene et al., 2020). However, a prospective study did not support the predictive role of alexithymia in alcohol use disorders (Honkalampi et al., 2010). Kajanoja et al. (2018) found that individuals who scored high in the EOT dimension of alexithymia were associated with alcohol use per occasion and the prevalence of daily tobacco use. While there is limited research on the use of illicit drugs, a recent systematic review and meta-analysis suggested a strong link between alexithymia and substance use, including alcohol and drugs (Honkalampi et al., 2022). Studies have reported associations between alexithymia and cannabis use (Dorard et al., 2017; Lyvers et al., 2013), as well as the use of buprenorphine and methamphetamine (Huang et al., 2022a; Meziou et al., 2019). However, research in general populations is relatively scarce, and most previous studies are cross-sectional, limiting causal inferences (Honkalampi et al., 2022; Thorberg et al., 2009).

Furthermore, alexithymia has been linked to behavioral addictions. A study in 1995 found that 31% of pathological gamblers were alexithymic, which was approximately three times higher than nonproblematic individuals (Lumley & Roby, 1995). The prevalence of alexithymia in individuals with gambling problems or disorder ranges from 31% to 67% across diverse populations (Marchetti et al., 2019). Alexithymia has also been associated with problematic internet and mobile phone use (Bolat et al., 2018; Huang et al., 2022b). Although less studied thus far, individuals with food addiction have been found to exhibit higher levels of alexithymia (Li et al., 2023).

The mechanisms underlying the association between alexithymia and substance use and addictive disorders are not yet fully understood. However, they can be partially explained by the characteristics of alexithymia. Individuals with alexithymia often have difficulties in emotional regulation, and substance use and addictive behaviors may serve as coping strategies to regulate negative emotions (Marchetti et al., 2019; Morris et al., 2005). Difficulties in emotional regulation related to the DIF dimension of alexithymia have been linked to risky alcohol use (Linn et al., 2021). EOT, representing a cognitive component of alexithymia, has also been implicated in alcohol dependence (Kajanoja et al., 2018; Loas et al., 2000). According to the attention-appraisal model, individuals with high EOT levels may lack attention to their inner feelings and rely on alcohol as a means of coping with psychological distress (Kajanoja et al., 2018; Preece et al., 2017).

From a broader perspective, various factors contribute to the association between alexithymia and addictions. For example, intrusive drinking thoughts was found to mediate the relationship between alexithymia and heavier alcohol use (Lyvers et al., 2014). Subsequent investigations by Lyvers and colleagues proposed that alexithymia played a mediating role in the relationship between social anxiety and drinking motives, as well as between insecure attachment and risky alcohol use (Lyvers et al., 2018, 2019). These findings suggest that alexithymia may contribute to the development and maintenance of problematic drinking patterns in individuals with social anxiety or insecure attachment. Individuals characterized by elevated levels of alexithymia often exhibit reduced hedonic capacity, as indicated by research (Prince & Berenbaum, 1993). This diminished ability to experience pleasure is noteworthy, as anhedonia, which shares similarities with alexithymia in terms of reduced emotional reactivity, has been consistently associated with substance use and addictive disorders (Destoop et al., 2019; Garfield et al., 2014; Pettorruso et al., 2014).

Moreover, the biological perspective provides some evidence supporting the association between alexithymia and addictions. One notable factor is the dysfunction of the HPA axis, which has been proposed as playing a pivotal role in the connection between alexithymia and addictive behaviors (Alkan Härtwig et al., 2013). This highlights the significance of chronic stress in the development and maintenance of addictions (Sinha, 2008). Additionally, Lyvers et al. (2013) suggested a link between cannabis use and frontal lobe dysfunction, which has also been associated with alexithymic features. Similarly, functional changes in the

ACC and insula have been identified as explanatory factors in the relationship between alexithymia and tobacco craving (Sutherland et al., 2013).

2.4.3 Eating disorders

Eating disorders encompass severe and potentially life-threatening mental illnesses, including binge eating disorder, anorexia nervosa, and bulimia nervosa (DSM-5, 2013). Extensive research has consistently shown that individuals with eating disorders exhibit elevated levels of alexithymia (Nowakowski et al., 2013; Westwood et al., 2017). Previous research reported associations between eating disorders and the alexithymia dimensions of DIF and DDF, while EOT showed no significant relationship (Nowakowski et al., 2013). However, a meta-analysis conducted by Westwood et al. (2017) found no associations between EOT and bulimia nervosa but did establish a link between EOT and anorexia nervosa. A recent 15-year follow-up study on recovery in anorexia nervosa revealed that individuals with anorexia nervosa scored higher on all alexithymia dimensions, including DIF, DDF, and EOT, compared to individuals who had recovered (Castro et al., 2021).

Prior research has linked binge eating to emotion regulation difficulties, highlighting the importance of effective strategies for regulating emotion as well as identifying and understanding emotional states (Whiteside et al., 2007). Alexithymia, characterized by challenges in emotional regulation and awareness, is hypothesized to play a significant role in inducing and reinforcing problematic eating behaviors as maladaptive coping mechanisms (Meneguzzo et al., 2022; Spence & Courbasson, 2012). Furthermore, it was reported that DIF may act as a mediator, explaining the association between attachment insecurity and eating disorder symptoms (Redondo & Luyten, 2021). Additionally, a recent study investigating eating behavior in children and adolescents found higher levels of alexithymia to be related to increased loss of control eating and emotional eating, with these associations remaining significant even after controlling for depressive symptoms (Shank et al., 2019).

Importantly, alexithymia is believed to be associated with the prognosis of eating disorders. Longitudinal studies have highlighted correlations between changes in alexithymic features and variations in eating psychopathology and treatment outcomes (Meneguzzo et al., 2022; Speranza et al., 2007). Although alexithymia tends to be relatively stable over time, it is considered a relevant treatment target for more effectively reducing eating disorder symptoms (Meneguzzo et al., 2022; Pinna et al., 2015). However, the core features of alexithymia, such as a propensity to focus on external events while lacking internal experiences of feelings, may pose challenges to patient engagement in psychotherapy (McCallum et al., 2003). Additionally, alexithymia in patients can lead to therapists providing suboptimal treatment options, thereby compromising therapeutic efficacy and potentially contributing to noncompliance with therapy (Speranza et al., 2011).

2.4.4 Autism spectrum disorder

Autism spectrum disorder (ASD) and alexithymia display overlapping characteristics, such as difficulties in identifying and expressing emotions and deficits in social skills (Fitzgerald & Bellgrove, 2006; Poquérusse et al., 2018). Neuroimaging studies have provided evidence of functional alterations in brain regions, including the ACC, insula, and amygdala, in both ASD and alexithymia (Cascio et al., 2012; Kleinhans et al., 2009; Velasquez et al., 2017). These shared neurobiological findings partially account for the similarities and co-occurrence of ASD and alexithymia.

Despite the potential overlap between alexithymic features and core symptoms of ASD, they are considered distinct concepts that often co-occur but do not represent each other. Approximately half of individuals with ASD exhibit alexithymia, indicating the existence of a subgroup of individuals with ASD who have high levels of alexithymia, as well as a separate group of individuals with ASD who do not exhibit notable alexithymic features (Kinnaird et al., 2019). Previous research supports this distinction. For instance, a study demonstrated that the inability to recognize facial expressions was associated with alexithymia but not specifically with ASD (Cook et al., 2013). Furthermore, findings suggest that deficits in empathic brain responses and impaired interoception in individuals with ASD can be explained by the co-occurrence of alexithymia, rather than being solely attributed to ASD itself (Bird et al., 2010; Shah et al., 2016). Recent fMRI research observed reduced functional connectivity between the left ventral anterior insula and the right dorsal anterior insula in relation to increased levels of alexithymia during the perception of facial expressions, highlighting that the processing of emotions in individuals with ASD may vary depending on the severity of co-occurring alexithymia (Butera et al., 2023).

2.4.5 Psychotic disorders

Empirical studies have established a relationship between alexithymia and schizophrenia (O'Driscoll et al., 2014). However, the specific correlation between alexithymia and schizophrenia symptoms remains poorly understood. An early study suggested that, in the case of deficit schizophrenia, alexithymia appeared to be a trait unrelated to schizophrenia symptoms, but a state associated with symptoms such as poverty of speech and flattening of affect in nondeficit schizophrenia patients (Nkam et al., 1997). Fogley and colleagues proposed that both cognitive and affective processes were relevant to alexithymia in the context of schizophrenia (Fogley et al., 2014). However, a subsequent study revealed that alexithymia with low levels of identifying, expressing, and analyzing emotions but normal/high emotional arousal and imagination was a risk factor for psychosis (van der Velde et al., 2015).

Indeed, cognitive functioning has been emphasized and appears to play a significant role. For example, performance-based measures of alexithymic features assessed by the Levels of Emotional Awareness Scale were associated with schizophrenia, while self-reported alexithymia showed no such association (Henry et al., 2010). The study also found a link between performance-based alexithymia and verbal fluency and expression clarity, indicating greater cognitive demands, suggesting that deficits in cognitive function may underlie alexithymic features in individuals with schizophrenia. In a more recent study investigating the role of cognitive functioning and cognitive bias in alexithymia among schizophrenic patients, a relationship was observed between alexithymia, particularly the DIF dimension, and cognitive bias. However, this relationship was not explained by neurocognition or symptom severity (Gawęda & Krężołek, 2019). The findings further demonstrated that neurocognitive functioning, such as working memory and spatial visualization ability, was only related to the EOT dimension of alexithymia. Evidence regarding the neural basis of alexithymia in schizophrenia has also been provided by studies indicating structural alterations in several brain regions (Jáni et al., 2021; Kubota et al., 2011, 2012).

2.4.6 Personality disorders

Personality disorders (PD) are characterized by enduring and inflexible patterns of inner experience, cognition, and behavior that significantly impair daily functioning (DSM-5, 2013). Research has shown positive correlations between alexithymia and cluster A PD, including paranoid, schizoid, and schizotypal PD (Bach et al., 1994; Coolidge et al., 2013; De Rick & Vanheule, 2007), cluster B PD, including antisocial, borderline, and narcissistic PD (De Rick & Vanheule, 2007; Zlotnick et al., 2001), as well as cluster C PD, including avoidant, dependent, and obsessive-compulsive PD (Coolidge et al., 2013; Honkalampi et al., 2001). Patients with borderline PD have been observed to be highly sensitive to emotional stimuli but have impaired ability to identify and describe their own and others' feelings (New et al., 2012). Honkalampi and colleagues found that alexithymia was a state that varied along with major depressive disorder, but depressed patients with comorbid cluster C PD tended to exhibit more pronounced and stable alexithymia (Honkalampi et al., 2001). However, in a subsequent prospective study with a Finnish population-based sample, they suggested that alexithymia did not predict PD (Honkalampi et al., 2010).

Given that research on the link between alexithymia and PD is relatively limited, and some findings are mixed, the evidence remains inconclusive. For example, recent research reported a positive relationship between alexithymia and histrionic PD (Ritzl et al., 2018), which contradicts several prior studies suggesting a negative correlation between alexithymia and histrionic PD (Bach et al., 1994; Coolidge et al., 2013; Nicolò et al., 2011). However, it is worth noting that the study by Ritzl et al. (2018) included only 20 patients with histrionic PD. Additionally, the discrepancy in findings may be attributed, in part, to the measurement of alexithymia. Bach et al. (1994) and Coolidge et al. (2013) found that the negative correlation between alexithymia and histrionic PD was primarily driven by the lack of daydreaming and the distant subscale, respectively, using measures such as the TAS-26 and Observer Alexithymia Scale. Therefore, the core dimensions of alexithymia, DIF, DDF, and EOT, did not play a significant role in the relationship. Theoretically, considering that individuals with histrionic PD tend to exhibit emotional overreactions and excessive emotional expression, which is the opposite of alexithymic features characterized by difficulties in expressing emotions, a negative correlation between the two is plausible. However, this argument remains hypothetical. Thus, further investigations considering the dimensions of both alexithymia and PD are warranted to enhance our understanding of their relationship.

2.5 Treating Alexithymia

Alexithymic traits seem to be beneficial due to the plausible lack of attention to negative feelings and blunted psychological and neurological responses to stress related to some situations such as social isolation (Alkan Härtwig et al., 2014; Chester et al., 2015; Davydov, 2017; Terock et al., 2017; Wiebe et al., 2017). Notwithstanding, it is believed that alexithymia tends to protect individuals from psychological distress with maladaptive coping, such as substance use, to regulate “hidden” emotions (Kajanoja et al., 2017b; Wiebe et al., 2017). Additionally, alexithymic individuals typically have poor social skills and problematic interpersonal relationships (Lumley et al., 1996; Nicolò et al., 2011), which may contribute to chronic stress in their daily lives. Therefore, the supposed protective effect of alexithymia is apparently ineffective in the long run. Although alexithymia per se is not classified as a mental disorder and does not necessarily require treatment, its associations with various mental health conditions have been evident. Furthermore, alexithymia has been considered a potential specifier of adverse clinical outcomes in depression (Serafini et al., 2020), and most of the improvement of alexithymia is observed within the context of mental illness treatment, underscoring its significance as a crucial target in therapeutic interventions.

Sifneos, who coined the term "alexithymia", observed that alexithymic individuals tended to have poor responses to dynamic psychotherapy, likely due to their difficulties in identifying and expressing feelings, which hinders their engagement in therapy (Sifneos, 1973; Taylor, 1984). Research has also reported associations between alexithymia and less improvement in psychodynamic psychotherapy, supportive therapy, and cognitive-behavioral techniques (Lumley et al., 2007; Ogrodniczuk et al., 2011). Ogrodniczuk et al. (2011) suggested that therapists' negative reactions toward alexithymic individuals, stemming from limited emotional interaction during therapy, could be an important factor contributing to relatively poor therapy outcomes. Alexithymia was observed to be stable regardless of whether individuals had undergone psychotherapy in the past or not (Serafini et al., 2020). However, some studies have demonstrated that alexithymia does not have an adverse impact on the outcome of psychotherapy and that therapeutic interventions can lead to a decreased level of alexithymia (Rufer et al., 2010; Terock et al., 2015). In addition, recent research in adolescents with violent tendencies has shown that psychoeducation may be beneficial for addressing alexithymia (Bakan et al., 2020; Iuso et al., 2022).

Although existing findings on the effect of psychotherapy focusing on alexithymia are somewhat mixed, several studies have reported decreased levels of alexithymia following specific psychotherapeutic interventions (Grabe et al., 2008b; Rufer et al., 2010; Spek et al., 2008; Terock et al., 2015; Tulipani et al., 2010). As mentioned earlier, alexithymia exhibits both trait- and state-like characteristics, and it appears to be more changeable among clinical samples (de Haan et al., 2012; Lumley et al., 2007; Parker et al., 1991). Additionally, alexithymia can develop as defense mechanisms in individuals with psychological symptoms (Lesser, 1981; Taylor et al., 1997a). Hence, it is reasonable to speculate that therapeutic interventions or alleviation of psychological distress could lead to at least partial improvement in alexithymia. Moreover, it has been indicated that alexithymia tends to have relative stability but sometime lacks absolute stability, especially in patients with mental illnesses (Hiirola et al., 2017; Larsson et al., 2010; Luminet et al., 2001). Therefore, psychotherapy may not easily impact the relative stability of alexithymia but could potentially influence its absolute stability (Cameron et al., 2014; Stingl et al., 2008). Taking into account the dimensional nature of alexithymia, there is evidence indicating DIF and DDF to be less stable than EOT (Saarijärvi et al., 2001), which connotes that psychotherapy with the focus on alexithymic features may be differentially effective for specific alexithymia facets.

While optimal therapeutic interventions involving alexithymia have not been firmly established, there are several promising options based on the current understanding of alexithymic traits. Mentalization-based therapy, which focuses on understanding one's emotional states and developing reflective capacity, can be employed to improve alexithymia (Bressi et al., 2017; Löf et al., 2018). Emotion-focused therapy and skills-based therapy are also applicable to alexithymic individuals who require conscious experience and awareness of their specific emotions (Greenberg, 2004; Kennedy & Franklin, 2002; Leweke et al., 2009). Moreover, several studies have shown that the recognition, expression, and interpretation of specific emotions can be improved through the administration of oxytocin, although further research in this area is needed (Aoki et al., 2014; Guastella et al., 2010; Leppanen et al., 2017).

2.6 Mental Health

Reaffirming the significance of mental health in the global healthcare landscape is warranted, as underscored in the 2030 Agenda for Sustainable Development adopted by the United Nations (UN, 2015). "There can be no health or sustainable development without mental health," declared the World Health Organization (WHO) Special Initiative for Mental Health (WHO, 2018). Mental health encompasses emotional, psychological, and social well-being, profoundly influencing individuals' perception, cognition, and behavior in their daily lives. It extends beyond the mere absence of psychiatric disorders and encompasses overall health, quality of life, and psychological and social well-being. Mental health conditions include a range of psychosocial difficulties, stress-related mental states, and mental disorders, including psychological, neurological, and substance use disorders, cognitive and intellectual disabilities, and suicide risk, significantly impacting personal and social development (WHO, 2022a).

Throughout the lifespan, stress is a universal experience that encompasses the physical, emotional, and psychological pressure individuals encounter when confronted with challenges or obstacles in their lives. It is a normal response that arises intermittently when facing diverse circumstances. The development of mental health conditions is influenced by the interplay of individual and environmental factors, spanning from early life experiences to current stressful situations. For instance, stressful life events during childhood have been extensively implicated in the psychopathology of mental disorders (Cicchetti & Toth, 1995; Nelson et al., 2020; Sun et al., 2023). In addition, mental health problems have been associated with various current experience of traumatic or stressful events, such as natural disasters (Blanc et al., 2015; Lowe et al., 2019) and life-threatening pandemics (Blakey et al., 2015; Mak et al., 2010; Sim et al., 2010; Xiang et al., 2020).

2.6.1 Mental Health Related to Parental Bonding

The parent-child relationship during childhood has long been recognized as a crucial determinant of mental health problems (Barbour, 1970). For example, experiences of harsh parenting and maltreatment in childhood have been associated with later mental illnesses (Calhoun et al., 2019). According to attachment theory, the absence of secure attachment may pose a potential risk for developing mental health problems (Barbour, 1970; Bretherton, 1992; Mikulincer & Shaver, 2012). Functional or adequate parental bonding with secure attachment as perceived by children is considered significant in the development of mental health. It involves the presence of intimate, warm, and supportive relationships with parents, while avoiding excessive or intrusive control (Parker et al., 1979). Research has indicated that perceiving both low parental care and high parental control can contribute to the development of mental disorders (Eun et al., 2018). However, there is a relative scarcity of research investigating the potential mechanisms that underlie the associations between the perception of parental bonding during childhood and the subsequent development of mental health.

From a biological perspective, recent research has associated harsh parenting practices with smaller amygdala and prefrontal cortex volumes (Suffren et al., 2022), potentially serving as neural markers of psychiatric vulnerability (Kelly et al., 2013; Milham et al., 2005; Mueller et al., 2013). When compared to medium maternal care perceived during childhood, both low and high maternal care have been linked to lower levels of stress-induced cortisol (Engert et al., 2010). It is also suggested that perceived parental behaviors during childhood can influence the regulation of the HPA axis (Champagne & Meaney, 2001), a central neuroendocrine network that responds to stress, thereby contributing to later mental health problems (Arborelius et al., 1999; de Kloet et al., 1999; Heim et al., 2008; Normann & Buttenschøn, 2019; Risbrough & Stein, 2006; Stephens & Wand, 2012).

2.6.2 Mental Health in the Context of COVID-19 Pandemic

The experiences of stressful life events, such as an outbreak of life-threatening diseases, have a significant impact on mental health (Blakey et al., 2015; Mak et al., 2010; Sim et al., 2010; Xiang et al., 2020). Recently, the outbreak of the novel coronavirus disease (COVID-19) has had widespread impacts on mental health.

According to the existing research, the global prevalence of anxiety, depression, and substance use is found to increase in the first year of the pandemic (Czeisler et al., 2021; Nolvi et al., 2021; Santomauro et al., 2021; Smalley et al., 2021; WHO, 2022b). Worries about personal physical health, fear of infecting family members, social isolation, financial hardship, and changes in interpersonal relationships can be potential stressors during the pandemic (Brooks et al., 2020; Cai et al., 2020; Douglas et al., 2020). When individuals feel a lack of control and have limited resources to address challenges in uncertain situations that are relevant to their well-being and may lead to potential harm or loss, they perceive these events as stressful (Lazarus & Folkman, 1984; Mineka & Kihlstrom, 1978). Subsequently, elevated stress levels serve as a critical factor inducing psychological responses and, potentially, negative mental outcomes (Ehlers & Clark, 2000; Spada et al., 2008; Tomaka et al., 1993).

General mental health at the initial stage of the pandemic has been found to have deteriorated compared to pre-pandemic period (McGinty et al., 2020; Pierce et al., 2020). However, people exhibit diverse responses to stressors, resulting in varying manifestations, such as heightened levels of psychological symptoms and increased use of tobacco or alcohol (Ehlers & Clark, 2000; Mineka & Kihlstrom, 1978; Spada et al., 2008). There is research indicating that in general populations, psychological symptoms and alcohol consumption do not necessarily change significantly during the pandemic (Chodkiewicz et al., 2020; Pomazal et al., 2023; Wang et al., 2020). Intricate social factors due to the pandemic, such as quarantine measures, economic hardships, and limited availability of alcohol, are apparently involved and thus result in differential findings (Panagiotidis et al., 2020; Stanton et al., 2020). Nonetheless, while relatively small overall changes in mental health related to the pandemic may be observed, certain individuals have been more vulnerable to mental health problems compared to others (Di Gessa et al., 2022; Patel et al., 2022; Prati & Mancini, 2021; Robinson et al., 2022; Salanti et al., 2022). Particularly, studies have reported that those who experienced higher levels of pandemic-related stress are likely to exhibit more remarkable psychological distress and more alcohol use (Grossman et al., 2020; Schäfer et al., 2020), highlighting the importance of considering perceived stress levels.

Furthermore, the heterogeneity of mental health changes during the COVID-19 pandemic can be attributed to complex individual factors. The interaction of genetic and environmental factors was suggested to play a role in the impact of stressful life events on mental health problems (Caspi et al., 2003; Normann & Buttenschøn, 2019). Many nationwide studies from different countries have reported that female gender, younger age, and parenthood can be risk factors for mental health disorders during the pandemic (Guo et al., 2020; Gustafsson et al., 2021; Mazza et al., 2020; Newby et al., 2020; Peng et al., 2020). For instance, additional caregiving responsibilities placed on parents raising young children during the pandemic may make them more susceptible to mental health problems (Park et al., 2020; Pierce et al., 2020), which could be further exacerbated by their limited access to social support and resources (Gjerdingen et al., 1991; Gustafsson et al., 2021). In addition to demographic factors, specific personality traits that determine one's adaptability to unexpected life changes, abilities to interpret or perceive stressors, and employment of coping strategies are plausibly linked to mental well-being in stressful situations (Engelhard et al., 2003; Kobasa, 1979; Suls & Martin, 2005; Yan et al., 2021). Personality traits have served as a significant factor contributing to individual differences in the development of mental health problems during the pandemic (Nikčević et al., 2021; Starcevic & Janca, 2022; Xu et al., 2023), supporting one of the central ideas of this dissertation concerning the role of alexithymic traits in shaping mental health in the context of the pandemic.

2.7 Conclusions based on the Literature Review

Alexithymia, a personality trait mainly characterized by lacking capacity for emotion identification and expression, as well as a tendency towards externally oriented cognitive style, has been studied for decades. The exact etiology of alexithymia remains unclear. Diverse developmental factors, including heredity, neurobiology, and environment, are suggested to have integrated effects on alexithymia. Moreover, the understanding of the nature of alexithymia is still limited and subject to controversy. Although alexithymia is generally considered a stable trait, it has been shown to be somewhat changeable under some conditions, such as following psychological distress, which therefore connotes that alexithymic features comprise both trait- and state-like components. To date, established evidence indicating alexithymia itself as a risk factor for mental illnesses is lacking. Hence, a more comprehensive understanding of the nature of alexithymia can benefit from research that takes into account various interacting factors.

Alexithymia has long been associated with various mental health problems. However, given complex factors involved in the development of both alexithymia and mental illnesses, and limited evidence available based on longitudinal research, it is difficult to establish causal relationships regarding whether alexithymia acts as a predictor for mental health problems. Previous research has indicated that a wide range of environmental factors, including early life events, parent-child relationships, and current experience of stressful events, contribute to mental health issues. However, it is evident that these factors do not impact all individuals in the same way. It is speculated that alexithymia may partially account for this variation, making specific individuals more susceptible to mental health problems.

Furthermore, alexithymia not only predisposes individuals to mental health problems but also tends to lead to problematic interpersonal relationships, emphasizing the importance of recognizing alexithymia among general populations. Accordingly, conducting studies, especially those with a longitudinal design, to explore how alexithymia plays a role in the development of mental health problems in relation to environmental factors is clearly necessary.

3 Aims

The general aim of this thesis was to advance current knowledge about the nature and role of alexithymia in shaping mental health. To achieve more comprehensive and profound understanding of alexithymia as a potential risk factor, this thesis comprises studies employed both cross-sectional and longitudinal approaches, aiming to explore the intricate relationship between alexithymia and the development of mental health problems related to perceived parental bonding during childhood, as well as in the context of recent experience of the COVID-19 pandemic. By integrating research with multiple analytical methods, this thesis sought to provide valuable insights into the multifaceted implications of alexithymia for mental well-being, justifying alexithymia as a potential target for intervention strategies. The specific aims of this thesis were:

1. To investigate how alexithymia play a role in the impact of perceived dysfunctional parental bonding during childhood on depressive and anxiety symptoms, while also exploring potential gender differences in these associations (Study I).

2. To examine how alexithymia interacts with perceived stress in relation to the impact of the COVID-19 pandemic-related events on psychological symptoms experienced by parents of young children (Study II).

3. To identify the heterogeneity of depressive symptom trajectories from the pre-pandemic to the pandemic period in the parents, and to examine several potential predictors, including alexithymia, for the longitudinal trajectories of depressive symptoms (Study III).

4. To explore cross-sectional combination patterns of alcohol use, depressive and anxiety symptoms, as well as their longitudinal transitions over a 10-month period during the pandemic, and to investigate potential predictive role of alexithymia and its dimensions in these profile transitions (Study IV).

4 Materials and Methods

4.1 Study Design and Participants – FinnBrain Birth Cohort Study

The present study is conducted based on the FinnBrain Birth Cohort Study (www.finnbrain.fi). The FinnBrain Birth Cohort Study is a prospective cohort study initiated in 2010 aiming to explore the role of hereditary and environmental factors in child development, health, and wellbeing (Karlsson et al., 2018). It is a multidisciplinary research project involving fields such as psychology, psychiatry, and sociology, employing multimethodological approaches.

Participants were recruited between December 2011 and April 2015 during the first trimester ultrasound performed at gestational week (gwk) 12 in maternal welfare clinics in the South-Western Hospital District and the Åland Islands in Finland (N = 3808 families, including mothers, fathers, and their children yet to be born). After recruitment, the participants completed a series of measurements at three time points during pregnancy (i.e., gestational weeks 14, 24, and 34). After childbirth, the families have been followed up at 3- to 6-month intervals during the first 30 months and 12-to 36-month intervals from 36 months onward. In addition, starting from May 2020, the parents in the initial cohort were also invited to participate in the COVID-19 pandemic sub-study, wherein follow-up measurements were conducted at several time points, with an approximate interval of 3 months. A total of 856 parents responded to the pandemic sub-study. The FinnBrain Birth Cohort Study is planned to continue for decades until the children reach their late adulthood (see more detailed information in Karlsson et al., 2018).

4.2 Subjects in Study I–IV

The primary focus of the present study was on the recruited parents who had completed pertinent measurements. In Study I, we included parents completing questionnaires on parental bonding, alexithymia, and psychological symptoms. The parents who has completed the measurement for parental bonding are more likely to be female (96.0% vs. 84.1%, $p < .001$), younger (31.4 vs. 32.4, $p < .001$), and higher educated (95.2% vs. 92.8%, $p < .05$) compared to the non-responders.

However, those who completed the 6-month measurement for alexithymia tended to be older than the non-responders (described in Kajanoja et al., 2017a). Studies II–IV specifically focused on mental health during the COVID-19 pandemic. For these studies, we included those who had completed the questionnaire for alexithymia and responded to the pandemic follow-up sub-study in May or June, December 2020, and March 2021. Likewise, the parents participating in the pandemic study are older, predominantly female, and higher educated, in comparison to the non-responders in the entire cohort sample.

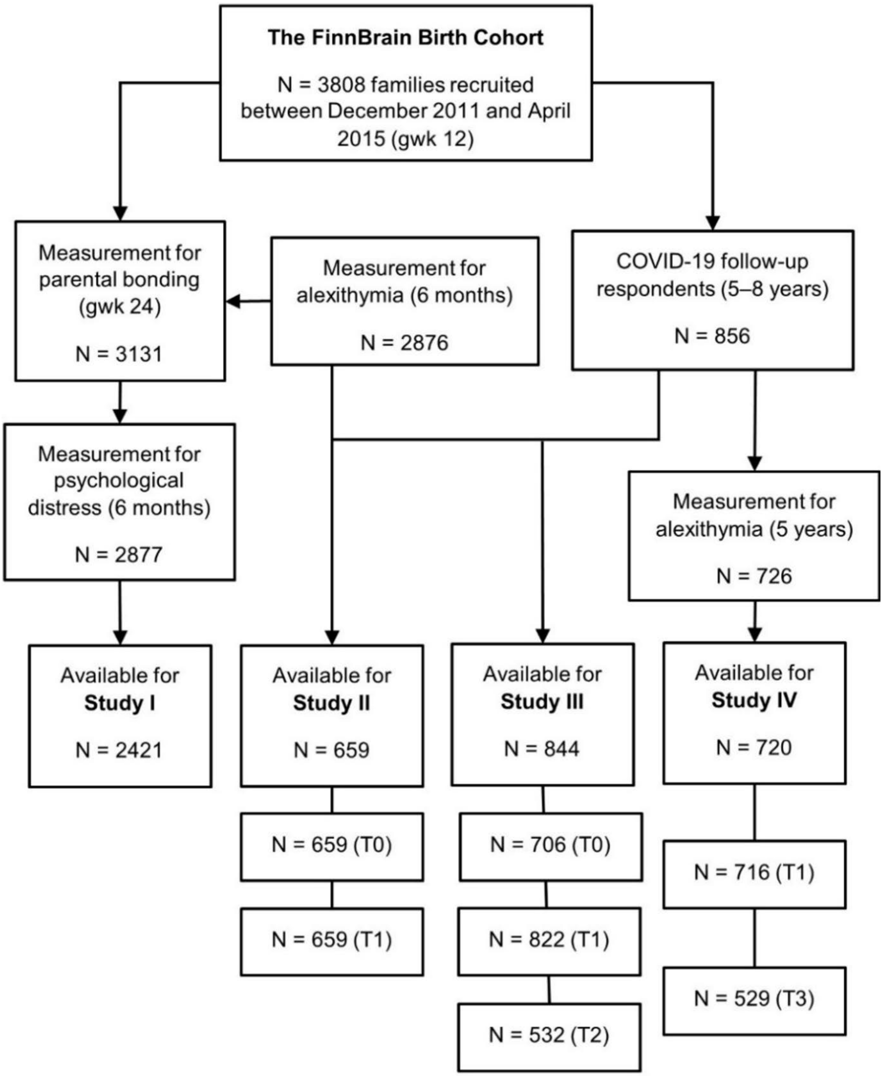

Figure 1. Flowchart presenting the enrollment of subjects in each study. T0: years 2014–2019; T1: May or June 2020; T2: December 2020; T3: March 2021.

Figure 1 presents the flowchart illustrating the enrollment of subjects for all four studies. For Study I, a total of 2504 parents completed the questionnaires on parental bonding at gestational week 24, as well as assessments for alexithymia and psychological symptoms at 6 months after childbirth. Of these, 83 with missing demographic data were excluded. Thus, the final sample of this study consisted of 2421 parents (1599 mothers and 822 fathers). The sample of Studies II–IV were based on the COVID-19 pandemic follow-up respondents (N = 856), of which 661 parents completed the 6-month questionnaire for alexithymia, and two (0.3%) with missing data on the measurement of perceived stress and psychological symptoms during the pandemic were excluded. Hence, 659 parents (520 mothers and 139 fathers) were included in Study II. The sample of Study III comprised 844 parents (662 mothers and 182 fathers), which was obtained after excluding participants with missing data on depressive symptoms at all follow-up time points. In this study, 706 (83.6%), 822 (97.4%), and 532 (63.0%) parents completed the symptom measurements between 2014 and 2019 (T0), in May or June 2020 (T1), and in December 2020 (T2), respectively. For Study IV, 726 respondents in the pandemic sub-study completed the measurement for alexithymia 5 years after childbirth. After excluding 6 subjects with missing data on all indicators variables at either time points, the final study sample consisted of 720 parents (571 mothers and 149 fathers). Among them, 716 (99.4%) parents completed the indicator measurements at T1 and 529 (73.5%) at T3 (March 2021).

4.3 Procedures

Sociodemographic data, such as age and education levels, was collected in the first trimester of pregnancy (gwk 12). For Study I, depressive and anxiety symptoms were measured at 6 months postpartum. For Study II and III, baseline psychological symptoms were measured at 2 or 4 years postpartum (between 2014 and 2019), wherein the closest data were used unless they were not available. The measurement for alexithymia at 6 months postpartum (between 2012 and 2015) was used in Studies I–III. In Study IV, pre-pandemic depressive and anxiety symptoms, as well as alexithymia measured at 5 years after childbirth (between 2017 and 2020) were available for use.

Data related to the pandemic follow-up (T1–T3 in the current study) were collected electronically via the Research Electronic Data Capture platform (Harris et al., 2009). The first time point during the pandemic (T1) fell between May 4 and June 2, 2020, which was approximately 3 months after the identification of the first COVID-19 positive case in Finland. In Study II, the data regarding the main study variables collected at T1 included the pandemic stressors, perceived stress, as well as depressive and anxiety symptoms. In Study III, the T1 data included variables such as depressive symptoms, coping strategies, the number of children at home (coded as 1 for one child, 2 for two children, and 3 for more than two children), pandemic-related stressors, and negative life events occurring within the past year. The T2 data consisted of depressive symptoms, pandemic stressors, negative life events in the preceding months, and details about remote work (coded as 1 for less than 50% time and 2 for 50% or more than 50% time). In Study IV, the data collected during the pandemic included the measures of alcohol use, as well as depressive and anxiety symptoms at T1 and T3.

4.4 Measures

4.4.1 Alexithymic traits

In the present study, the Toronto Alexithymia Scale (TAS-20) was used for measuring alexithymia traits. The TAS-20 has been widely recognized as one of the most prominent and extensively used self-report scales for the assessment of alexithymic features (Bagby et al., 1994b; Joukamaa et al., 2001; Taylor et al., 2003). In this study, we employed the validated Finnish version of the TAS-20 (Joukamaa et al., 2001). It consists of 20 items that are divided into three subscales: difficulty identifying feelings (DIF), difficulty describing feelings (DDF), and externally oriented thinking (EOT). Each item is rated on a 5-point Likert scale, with responses ranging from 1 (Strongly disagree) to 5 (Strongly agree). Hence, the total score of the TAS-20 ranges from 20 to 100. The Cronbach's α coefficients range from 0.81 to 0.83, indicating good internal consistency of the TAS-20 in the current study.

4.4.2 Parental bonding

The perception of parental bonding during childhood was used as an independent variable in Study I, which was measured with the Parental Bonding Instrument (PBI) (Parker et al., 1979). It is applied to retrospectively assess parental attitudes and behaviors toward the respondents during their first 16 years of life. This self-report questionnaire consists of 25 items that are rated on a 4-point Likert scale from 0 to 3, and it has shown satisfactory reliability and validity (Parker, 1989). The PBI encompasses two distinct subscales, one consisting of 12 items that assess experienced care and the other comprising 13 items that measure overprotection. These subscales are administered to both mothers and fathers, resulting in the assessment of maternal care and overprotection, as well as paternal care and overprotection. Each subscale is characterized by bipolar dimensions. The care subscale of the PBI evaluates emotional warmth, support, and closeness at a positive pole, contrasted with emotional neglect, indifference, and coldness at a negative pole. On the other hand, the positive pole of overprotection is characterized by the promotion of independence and autonomy, while the negative pole entails excessive contact, overcontrol, and intrusion.

In accordance with the principle of parsimony, the scores of the items reflecting the positive pole of both subscales were reversed. This resulted in the creation of two variables used in the present study that represent dysfunctional parental bonding, with higher values indicating lower levels of parental care and/or higher levels of parental overprotection. The two newly created variables exhibited strong internal consistency, as indicated by Cronbach's α of 0.91 for dysfunctional maternal bonding (DysMB) and 0.92 for dysfunctional paternal bonding (DysPB).

4.4.3 Depressive symptoms

Depressive symptoms were evaluated utilizing the Edinburgh Postnatal Depression Scale (EPDS), a widely utilized self-report questionnaire comprising 10 items. The EPDS is well-established in screening postpartum depressive symptoms, demonstrating high validity and sensitivity (Cox et al., 1987; Gibson et al., 2009). Moreover, it has been deemed a reasonably valid instrument for assessing depressive symptoms in fathers (Edmondson et al., 2010). Participants rate their moods and other depressive symptoms experienced during the previous week. Each question is scored on a scale from 0 to 3, resulting in a total score ranging from 0 to 30 points. The EPDS was employed in Studies I–IV and showed good internal consistency with Cronbach's α ranging from 0.84 to 0.88.

4.4.4 Anxiety symptoms

Anxiety symptoms were evaluated using the Symptom Checklist-90 (SCL-90), a self-report questionnaire specifically developed to assess the intensity of symptoms across multiple dimensions (Derogatis et al., 1973; Holi et al., 1998). The anxiety subscale of the SCL-90 was used to gauge the intensity of anxiety experienced within the preceding month. This subscale comprises 10 items that individuals rate on a 5-point scale ranging from 0 to 4. The scale was used in Study I, II, and IV, which demonstrated good internal consistency, with Cronbach's α coefficients ranging from 0.85 to 0.87.

4.4.5 Perceived stress

Perceived stress was assessed in Study II using the brief 4-item version of the Perceived Stress Scale (PSS-4) developed by Cohen et al. (1983). The original

Perceived Stress Scale is a validated and reliable self-report scale used for measuring global levels of psychological stress, and it has shown favorable psychometric properties in various languages, including Finnish (Dev Bhurtun et al., 2021; Lee, 2012). The brief version, PSS-4, consists of four items rated with a 5-point Likert scale (0 = never, 4 = very often). Participants were asked to indicate how often, in the last month, they experienced the following: in the last month, how often have you felt (1) a lack of control over important aspects of their life, (2) confidence in their ability to handle personal problems, (3) a sense of things going their way, and (4) difficulties piling up to the point where they felt unable to overcome (Cohen et al., 1983). By reversing the scores of items 2 and 3, the total scores of the PSS-4 range from 0 to 16. In the current sample, the PSS-4 demonstrated a Cronbach's α coefficient of 0.69, indicating acceptable internal consistency.

We opted to use the PSS-4 instead of the original version, primarily due to the practical advantages it offers in the context of remote and large-scale data collection during the exceptional circumstances of the pandemic. The PSS-4 has been specifically designed as a brief scale that can be completed quickly and easily, making it well-suited for situations where efficiency and convenience are paramount (Cohen et al., 1983; Lee, 2012; Vallejo et al., 2018). Research has shown that different versions of the Perceived Stress Scale exhibit comparable psychometric properties. Furthermore, the internal consistency of the PSS-4, with a reliability coefficient typically around 0.7, is considered sufficient for a concise 4-item scale aimed at capturing individuals' perception of stress (Leung et al., 2010; Vallejo et al., 2018).

4.4.6 Alcohol use

In Study IV, the Alcohol Use Disorders Identification Test (AUDIT) was used to measure alcohol use-related problems during the pandemic. The AUDIT is a globally accepted and extensively validated instrument developed by the WHO for the purpose of screening alcohol use within the preceding year (Babor et al., 2001; Saunders et al., 1993). It is a 10-item questionnaire that assesses three conceptual domains: alcohol consumptions (domain 1: items 1 to 3), dependence (domain 2: items 4 to 6) and alcohol-related harm (domain 3: items 7 to 10). Scoring for the AUDIT can be performed separately for each domain or as a whole with scores ranging from 0 to 40. A proposed cut-off score of 8 was employed to identify hazardous or harmful drinking (Babor et al., 2001). To gain more detailed information regarding alcohol use-related problems, the three domains were used as separate indicators for modeling purposes. The AUDIT demonstrated satisfactory internal reliability in this study, with Cronbach's α coefficients of 0.74 for T1 and 0.71 for T2.

4.4.7 Temperament traits

In Study III, temperament traits were treated as predictor variables and assessed using the Adult Temperament Questionnaire (ATQ) (Evans & Rothbart, 2007). The 77-item version of the ATQ, which employed a 7-point Likert scale ranging from 1 (extremely untrue of you) to 7 (extremely true of you), was used in this study. It is a self-report instrument designed to measure four primary temperamental dimensions: negative affect, effortful control, extraversion/surgency, and orienting sensitivity, as well as its 13 subdimensions. Previous research has indicated satisfactory psychometric properties of the ATQ (Laverdière et al., 2010). In Study III, the four dimensions showed good internal consistency. Specifically, Cronbach's α coefficients of 0.86, 0.80, 0.74, and 0.79 were obtained for negative affect, effortful control, extraversion/surgency, and orienting sensitivity, respectively.

4.4.8 Coping strategies

The situational coping strategies of the participants were measured by the Brief COPE (Carver, 1997). The inventory comprises a total of 14 subscales, with each subscale consisting of two items. In Study III, we used 8 of these subscales, namely self-distraction, denial, behavioral disengagement, venting, positive reframing, acceptance, humor, and religion. Participants were asked to indicate the frequency of engaging in these coping strategies specifically in relation to pandemic-related problems and worries. Each item is rated on a 4-point Likert scale, ranging from 1 (I have not been doing this at all) to 4 (I have been doing this a lot).

In order to streamline the analysis in this study, an exploratory factor analysis were performed, leading to the identification of four distinct factors. These factors were defined as follows: (1) Emotion-diverting coping, comprising two items (self-distraction with a factor loading of 0.83 and venting with a factor loading of 0.81), (2) Avoidant coping, encompassing two items (denial with a factor loading of 0.80 and behavioral disengagement with a factor loading of 0.77), (3) Constructive coping, consisting of three items (positive reframing with a factor loading of 0.61, acceptance with a factor loading of 0.64, and humor with a factor loading of 0.78), and (4) Religion, represented by one item with a factor loading of 0.93. Together, these factors accounted for 68.5% of the total variance.

4.4.9 COVID-19 pandemic-related events

The assessment of COVID-19 pandemic events was conducted using a questionnaire that was adapted based on the measurement for SARS-related stressors outlined in a study (Main et al., 2011). In the present study, the questionnaire employed a binary response format ("yes" or "no") for each item, capturing the respondents' experiences in various domains. These domains included health events related to oneself, family members, friends, and acquaintances (e.g., exhibiting COVID-like symptoms, receiving treatment with or without hospitalization due to the coronavirus), free time restrictions (e.g., residing in an isolated area, having to give up significant activities or hobbies due to the pandemic), and economic influences (e.g., getting laid off from work, financial decline for oneself or one's spouse due to the pandemic). The total scores were derived by aggregating the occurrences of these events that participants experienced during the COVID-19 pandemic. In Study II, the pandemic stressors were assessed as an independent variable, whereas in subsequent Studies III and IV, they were treated as a background factor that was controlled for in analyses.

4.4.10 Sociodemographic and other background information

Participants reported their sociodemographic information, including age (continuous), education, and economic satisfaction, at the first trimester of gestation (gwk 12). Education levels were categorized into three classes (1 = Low: High school or lower, 2 = Mid: Vocational/upper secondary school degree, 3 = High: University degree). Economic satisfaction measured on a scale ranging from 0 to 10 (0 = low satisfaction, 10 = high satisfaction) was included in Studies II and III.

Additional background information included negative life events occurring within the previous year in Study II and III, number of children at home and remote work in Study III, as well as pandemic-related stressors (as mentioned above in section 4.4.9) in Studies III and IV. Pandemic stressors in Study III were derived by averaging the sum of the stressors at T1 and T2. In Study IV, only the pandemic stressors assessed at T1 were controlled for due to the modeling characteristic. In Studies II and III, given our emphasis on investigating the change in mental health from the pre-pandemic to pandemic period, the potential effects of life events that occurred in the past year were also taken into account.

The life events questionnaire comprised 18 items pertaining to various experiences that occurred within the previous year. These experiences encompassed events such as a child starting school, moving into a new house, divorce, unemployment, and serious illness or death of a child's grandparent. Furthermore, participants were requested to rate each event on a 5-point scale, where a rating of 1 or 2 denoted a perceived positive event, while a rating of 4 or 5 indicated a perceived negative event. Binary classes were assigned to each category, with a code of 0 representing the absence of any such experience, and a code of 1 indicating the presence of one or more experiences.

In Study II and IV, data on life events at T1 were used. In Study III, the score representing life events was obtained by averaging the sum of scores at T1 and T2.

Moreover, this study collected data on the number of children staying at home (coded as 1 for one child, 2 for two children, and 3 for more than two children), as well as information on remote work (coded as 1 for less than 50% time and 2 for 50% or more than 50% time).

4.5 Statistical Analyses

4.5.1 Study I

Preliminary analyses

Statistical analyses were performed using IBM SPSS 25.0. To assess the normality of distribution within variables, visual examination and the Shapiro-Wilk test were employed. Descriptive statistics were computed for the study variables, stratified by sex. Categorical variables were compared using the Chi-square test, while the Mann–Whitney U test was employed for continuous variables due to non-normally distributed data. Spearman's correlation coefficient (ρ) was used to quantify the strength of relationships between the study variables.

Moderated mediation modeling

The mediating effects of alexithymia on the relationship between dysfunctional parental bonding (DysMB and DysPB) and symptoms of depressive/anxiety symptoms were examined by using Model 4 of the PROCESS 3.5 macro for SPSS (Hayes, 2017), with age, sex and education levels being controlled for. Subsequently, the moderating effects of sex on the mediation model were preliminarily tested through moderated mediation analyses. Model 59 of the PROCESS macro was used, with sex designated as the moderator for all paths. However, the analysis revealed no significant relationships between the interaction terms and the symptoms, indicating that sex did not act as a moderator for path B (alexithymia → psychological symptoms) and path C (dysfunctional parental bonding → psychological symptoms) in the conceptual model (as illustrated in **Figure 2, A**). Consequently, Model 7 of the macro was employed (as illustrated in **Figure 2, B**).

To examine the moderating role of sex on the single path, a simple slopes analysis was conducted. The bootstrapping method with 10,000 samples was adopted to compute 95% bootstrap confidence interval (CI). Following the guidelines outlined by (Hayes & Rockwood, 2019), the significance of effects was assessed using the bootstrapped 95% CI, with its exclusion of zero indicating statistical significance. Furthermore, in the case of a significant moderated mediation effect for DysMB or DysPB being observed, we conducted additional exploratory analyses to examine the potential role of the corresponding subscales of the PBI, namely the care and overprotection subscales, in the sex-specific associations.

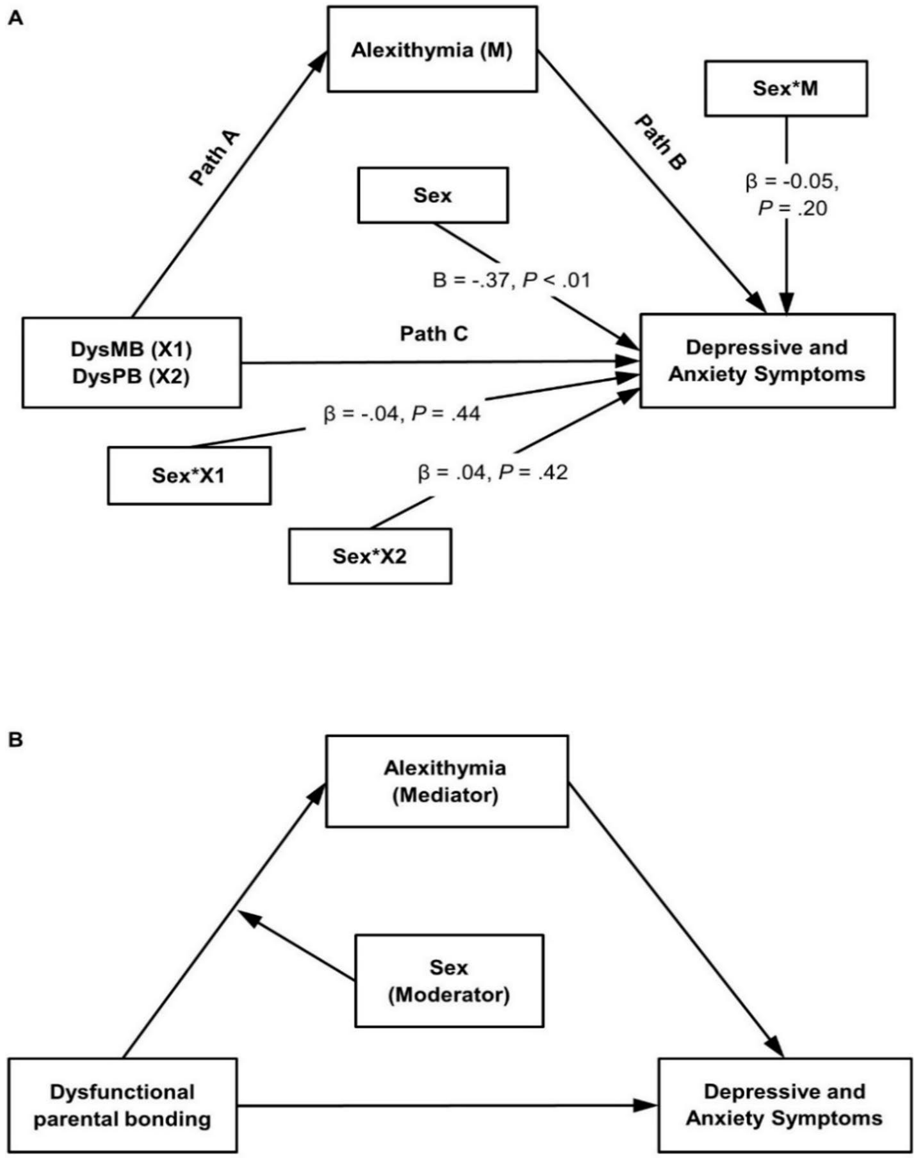

Figure 2. Moderation effects of sex in the conceptual mediation model (A) and the research moderated mediation model (B). DysMB = Dysfunctional maternal bonding; DysPB = Dysfunctional paternal bonding.

4.5.2 Study II

Preliminary analyses

Statistical analyses were conducted using IBM SPSS 25.0. In order to maintain the power of the model and avoid unnecessary reduction in sample size caused by excluding participants with missing covariate data, missing values were imputed for economic satisfaction and baseline symptoms prior to conducting subsequent analyses. Specifically, 22 (3.3%) missing values for economic satisfaction were imputed using the mean value, while 66 (10.0%) missing values for baseline psychological symptoms (T0) were imputed using hot deck imputation based on demographics, including gender, education, and economic satisfaction (Andridge & Little, 2010; Myers, 2011). In the descriptive analyses, the normality of variable distributions was evaluated both visually and through the Shapiro-Wilk test. To examine changes in symptoms, paired samples t-tests were conducted to compare the differences in EPDS and SCL-90 scores between the baseline and follow-up assessments. Spearman's correlation coefficient (ρ) was used to quantify the strength of correlations between the main variables.

Conditional process modeling

A conditional process analysis, also referred to as moderated mediation analysis in some cases, integrates both mediation and moderation to examine how the strength of a mediation effect is influenced by or varies across different situations, contexts, or individual differences. It aims to explore the conditional nature of mechanisms by investigating the moderation effect (Hayes & Rockwood, 2019; Preacher et al., 2007). To investigate the moderating role of alexithymia in the mediation effects of perceived stress on the associations between COVID-19 pandemic events and mental health problems, conditional process modeling was conducted using the PROCESS 3.5 macro for SPSS (Hayes, 2017). In exploratory analysis, no moderating effects of alexithymia were observed on the direct path from the pandemic stressful events to the symptoms and the first path (pandemic events → perceived stress). Thus, Model 14 of the macro, which includes a moderating effect on the second path of the mediation, was selected.

Sex, economic satisfaction, and past-year negative life events were included as control variables in each path of the conditional process model, based on the correlation analysis indicating potential relations between these background variables and psychological symptoms. In addition, to account for the mental health change, baseline depressive and anxiety symptoms (T0) were controlled for when examining the effects of the pandemic stressors and perceived stress on the follow-up symptoms (T1). Given that the baseline symptoms were used as controlled variables for the follow-up symptoms but not included as covariates for the association between pandemic stressors and perceived stress, a customized model based on the Model 14 was applied (Hayes, 2017). A simple slopes analysis was conducted to examine the moderating role of alexithymia in a single path, with conditional effects analyzed at low, medium, and high levels of alexithymia (i.e., mean minus one standard deviation (SD), mean, and mean plus one SD, respectively). Bootstrapping with 5,000 samples was used to compute 95% CI, and statistical significance was determined by a 95% CI that did not include zero (Hayes & Rockwood, 2019). **Figure 3** depicts the conceptual conditional process model employed in this study.

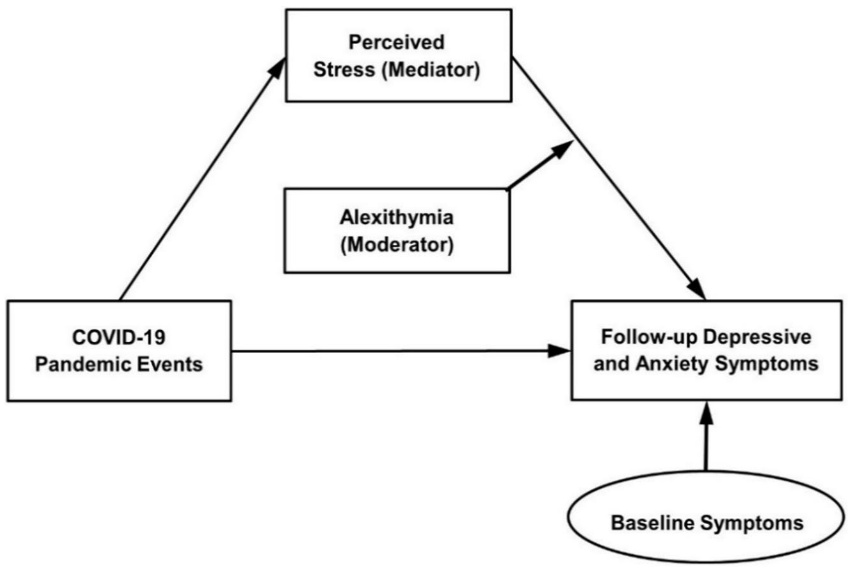

Figure 3. The conceptual conditional process model.

4.5.3 Study III

Latent growth mixture modeling

To identify latent subpopulations within the study sample with distinct growth patterns of depressive symptoms during the pandemic, Mplus 8 software was used (Muthen & Muthen, 1998-2017). This involved testing the longitudinal factor structures and conducting latent growth mixture modeling (LGMM).

First, the EPDS factor structures were examined through structural equation modeling to ensure longitudinal fit, with model evaluation based on multiple indicators, including Chi-square test, the root mean square error of approximation (RMSEA, values ≤ .06 indicating good fit), the comparative fit index (CFI, values ≥ .90 indicating suitable fit), and the standardized root mean square residual (SRMR, values ≤ .08 reflecting good fit) (Hu & Bentler, 1999). The longitudinal factor model of the EPDS at T0, T1, and T2 demonstrated a good fit with the data (χ^2 [369] = 838.878, $p < .001$, CFI = 0.93, RMSEA = 0.039, SRMR = 0.049), with correlated errors between consecutive items 1 and 2.

Second, LGMM using Robust Maximum Likelihood estimation with starting values of 500 sets was conducted. When analyzing the sample of 844 parents, it was observed that there were 15 cases with extreme values (3 standard deviations above the mean). These cases were speculated as potential influencers of trajectory identification and could contribute to the mis-specification of the model. The 15 cases with outliers were therefore excluded from the sample, resulting in a sample size of 829 parents for modeling. The best-fitting model was determined by increasing the number of latent groups and considering several indices. Higher values of log likelihood (LL) and lower values of Akaike information criterion (AIC) and Bayesian information criterion (BIC) indicated better model fit. In addition, values closer to 1.0 for Entropy indicated higher classification accuracy. The model was further evaluated using posterior probabilities of class membership and statistical tests such as the Vuong-Lo-Mendell-Rubin and Bootstrapping likelihood ratio test (VLMR- and B-LRT) for comparing k versus k-1 groups. The *p* values below 0.05 indicated significant superiority of k groups over k-1 groups.

Given the time between T0 and T1 not being associated with depressive symptom levels or changes, we used the average time of 919 days for modeling. The interval between T1 and T2 was approximately 7 months, equivalent to 210 days. We coded the first interval (T0 to T1) as 1, and the second interval (T1 to T2) as 0.23 (210 divided by 919). This coding scheme (0.00, 1.00, and 1.23) represented T0, T1, and T2 respectively, allowing for non-linear trajectories in the model. The non-linear model demonstrated a better fit than the equal-interval model, as evidenced by lower AIC (11157.09 vs. 11225.05) and BIC (11237.34 vs. 11305.29).

Additionally, to select a model that provides better clarity in understanding the trajectories, we compared several models, including latent class growth analysis, which assumes homogeneous growth trajectories within a class by restricting within-class variance (Jung & Wickrama, 2008), longitudinal latent class analysis (LLCA), which does not incorporate time trend information, and latent growth mixture modeling (LGMM). Based on the fit indices, all the models suggested a 4-class solution. Among these models, LGMM was selected as it exhibited a higher loglikelihood (LL: -5561.546) and lower BIC (11237.336), indicating a superior fit compared to latent class growth analysis (LL: -5583.94, BIC: 11261.98) and LLCA

(LL: -5814.210, BIC: 11749.707). In addition, when comparing the plot generated by LGMM with LLCA, the 4-class LLCA model exhibited similar trajectory patterns to the LGMM, including two classes with relatively stable symptoms at low and high levels, as well as one increasing and one decreasing symptoms. Therefore, the estimated time-specific residuals did not show noticeable skewness, connoting that the LGMM accurately captured the data without significantly biased estimates of the trajectories. The indices for selecting the optimal solution of the LGMM are described in the following result section **5.3.2**.

After the trajectory modeling, to preserve a large sample size for subsequent analyses on the relationship between trajectories and predictors, and considering the potential practical significance of outliers, we manually classified the 15 cases with outliers based on model-generated membership probabilities and trajectory patterns. A small number of missing values on EPDS scores were imputed using hot deck imputation based on sociodemographic information such as gender, education, economic satisfaction, and number of children.

Standard analyses for examining predictors

IBM SPSS 25.0 was used for subsequent analyses. Firstly, to handle missing values in the predictors and background factors, the multiple imputation (MI) was employed (Schafer, 1999). MI is a comprehensive method that allows for valid statistical inferences and is commonly applicable under the assumption of missing at random (MAR) (Little & Rubin, 2002; Mühlenbruch et al., 2017). Given that the separate variance t-tests showed dependencies between missing values of temperament traits and alexithymia with age, education levels, and economic satisfaction, and no relationship was found between missing data on depressive symptoms and the trajectories, the MAR assumption was reasonably fulfilled. Age, education, economic satisfaction, and gender, which represent the sample characteristics, and follow-up data related to the pandemic including number of children at home, remote work, pandemic stressors, and negative life events were empirically used as auxiliary variables in the imputation process. In this study, missing data were imputed using the Markov Chain Monte Carlo with predictive mean matching, performing 20 imputations as recommended for datasets with 10-30% missing information (Graham et al., 2007). Using the 20 MI datasets allowed for the estimation of pooled results in most statistical analyses. The relative efficiency for all predictors in the current study was greater than 99%.

Secondly, correlations between variables were preliminarily analyzed using appropriate statistical tests: the Chi-square test for categorical variables, Spearman's ρ for continuous variables, Mann-Whitney U tests for continuous variables and binary variables, Kruskal-Wallis tests or One-way ANOVA followed by S-N-K post-hoc tests for continuous variables and polytomous variables.

Thirdly, to determine the predictive factors (i.e., temperament traits, coping factors, and alexithymic traits in this study) for the trajectory groups of depressive symptoms, multinomial logistic regression was conducted, controlling for gender, education, economic satisfaction, number of children at home, remote work, as well as negative life events and pandemic stressors based on the preliminary analyses.

4.5.4 Study IV

Descriptive statistics and comparisons of variables between T1 and T3 (using Chi-square test and Mann–Whitney U test) were conducted as preliminary analyses in IBM SPSS 28. The main analysis, latent transition analysis (LTA), was performed using Mplus version 8.3 (Muthén & Muthén, 1998-2011). The LTA modeling was conducted based on five indicator variables, encompassing three domains of AUDIT (alcohol consumption, alcohol dependence, alcohol-related harm), as well as depressive and anxiety symptoms.

Missing data on the indicator variables were addressed using the full information maximum likelihood method in the modeling process. This assumes that the missing data are either MAR or missing completely at random (MCAR). While violations of this assumption may not significantly impact the parameter estimates, they are taken into consideration (Collins et al., 2001). In this study, Little's MCAR test indicated MCAR (p = .310) for missing data on the indicator variables, justifying the use of full information maximum likelihood to handle the missingness.

LTA Modeling

The modeling procedures consisted of four steps. Firstly, a latent profile analysis (LPA) was performed, which is a person-centered analysis used to identify relatively homogeneous subpopulations with distinct qualitative and quantitative features at a cross-sectional level. This step applying LPA aimed to classify individuals based on profiles that captured similar combinations of indicator values at each timepoint. To ensure comparability, all indicator variables were transformed into standardized values prior to modeling. The optimal model, characterized by the most appropriate number of latent profiles ranging from 1 to 5, was determined based on a set of key indices. A higher value of LL, and lower values of AIC and BIC indicated a superior model fit. Additionally, an entropy value approaching one signified higher classification quality, with a threshold of

0.7 considered acceptable. Furthermore, the adjusted Lo-Mendell-Rubin likelihood ratio test (LMR-LRT) yielded *p* values below 0.05, suggesting the preference for a model with "k" groups over "k-1" groups (Henson et al., 2007; Lo et al., 2001; Yang, 2006).

Secondly, measurement invariance was tested to examine whether the structure and general interpretation of the latent profiles remain consistent over time. The likelihood-ratio test was used to compare the invariant model, where measurement parameters were constrained across timepoints, with the baseline model, where all parameters were freely estimated.

Thirdly, LTA, a longitudinal extension of LPA, was used to analyze the transition of profiles over time. It should be noted that when adding an autoregressive path between mixture models (e.g., **Figure 4, Path A**), the structural model are jointly estimated, which can lead to unexpected changes in the measurement model, potentially resulting in a misleading model and obscured interpretation (Nylund-Gibson & Masyn, 2016). To address this issue and ensure the proper specification of the model, the LTA was conducted following a three-step approach, which is proposed to avert shifts in the measurement parameters (Asparouhov & Muthén, 2014; Vermunt, 2017).

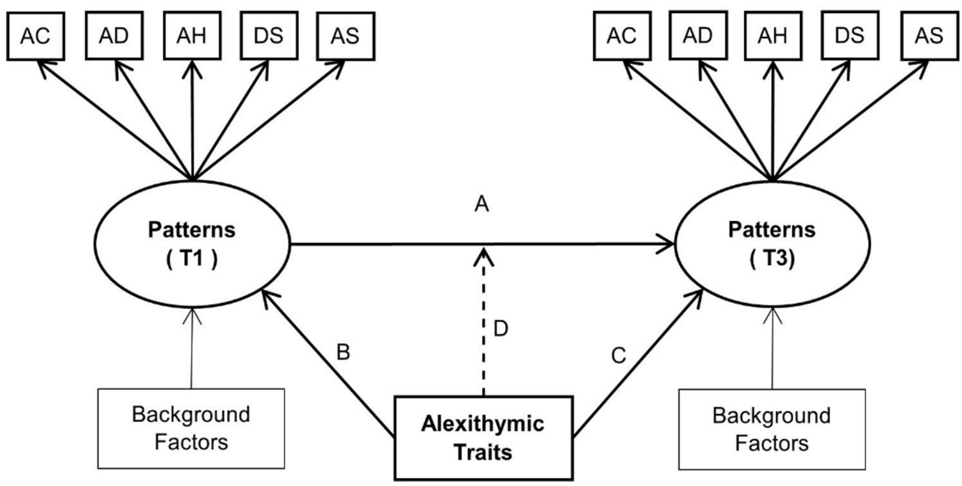

Figure 4. Latent transition modeling for combination patterns of alcohol use and psychological symptoms from T1 to T3 during the pandemic with covariates. AC = alcohol consumption; AD = alcohol dependence; AH: alcohol-related harm; DS = depressive symptoms; AS = anxiety symptoms.

In the final step of the procedures, covariates were integrated into modeling, with logistic regression analysis estimating odds ratios (OR) and 95% CI. In addition to exploring alexithymic traits, selected background factors, namely gender, age, education, pandemic stressors, and pre-pandemic psychological symptoms (5 years after childbirth) were also included for better interpretability of the findings. Predictors can be examined using two approaches (Ciarrochi et al., 2017; Morin et al., 2015). First, the effects of the predictors were freely estimated across the timepoints, examining their direct impacts on the profiles at T1 (**Figure 4, Path B**) and T3 (**Figure 4, Path C**). Subsequently, the predictors were constrained equally across the timepoints, and the group-specific effects of the predictors on the transitions were analyzed, reflecting the interaction of the predictors with the T1 profiles (**Figure 4, Path D**). When investigating the role of alexithymia, constraining the set of background factors as control variables within profiles improved the model fit (BIC = 12037.27), compared to the freely estimated model (BIC = 12153.57).

4.6 Ethical Considerations

Informed consent was obtained from every subject enrolled in the FinnBrain Birth Cohort Study. Prior to their involvement, all the participants were informed about the confidentiality of the study, the voluntary nature of their participation, and their right to discontinue their involvement without providing a specific reason. The protocol for the FinnBrain Birth Cohort Study and the COVID-19 pandemic follow-up sub-study has been approved by the Ethics Committee of the Hospital District of Southwest Finland. This study strictly adheres to the ethical standards by the national and institutional research committee on human experimentation, in accordance with the 1964 Declaration of Helsinki and its later amendments.

5 Results

5.1 Study I

5.1.1 Descriptive statistics and correlation analysis

In Study I, females reported higher levels of education in comparison to males (High education 38.9% vs. 28.5%). As presented in **Table 1**, males exhibited a higher level of alexithymia, but lower levels of DysMB/DysPB and depressive symptoms, compared to females. Perceived dysfunctional parental bonding was positively correlated with age, alexithymia, as well as depressive and anxiety symptoms. In addition, higher levels of DysMB and DysPB, alexithymia, and psychological symptoms were observed in less educated individuals ($p < .01$ for all the group comparisons).

Table 1. Descriptive statistics stratified by sex and Spearman's correlations for continuous variables.

	Females (N = 1599)	Males (N = 822)	Total (N = 2421)	2	3	4	5	6
		Mean (SD), range						
1. Age	30.7 (4.3), 18–45	32.4 (5.4)**, 19–57	31.3 (4.8), 18–57	-.04	.07**	.06**	-.03	-.03
2. TAS-20	39.8 (9.2), 21–79	42.9 (9.6)**, 21–78	40.8 (9.5), 21–79	–	.23**	.23**	.36**	.30**
3. DysMB	16.2 (11.0), 0–61	14.4 (8.9)*, 0–54	15.6 (10.3), 0–61		–	.59**	.26**	.22**
4. DysPB	18.2 (11.5), 0–69	16.8 (10.7)*, 0–56	17.8 (11.2), 0–69			–	.25**	.21**
		Median [IQR], range						
5. EPDS	4.0 (6.0), 0–27	2.0 (4.0)**, 0–21	3.0 (5.0), 0–27				–	.61**
6. SCL-90	1.0 (4.0), 0–28	1.0 (4.0), 0–25	1.0 (4.0), 0–28					–

DysMB = Dysfunctional maternal bonding. DysPB = Dysfunctional paternal bonding. TAS-20 = 20-item Toronto Alexithymia Scale; EPDS = Edinburgh Postnatal Depression Scale; SCL-90 = Symptom Checklist-90 (anxiety subscale). SD = Standard deviation. IQR = Interquartile range. Group comparisons were made based on sex. $^{*}p < 0.05$. $^{**}p < 0.01$.

5.1.2 Mediation analyses

DysMB (β = .142, $p < .001$) and DysPB (β = .144, $p < .001$) showed positive associations with alexithymia, controlling for age, sex, and education. Alexithymia was positively related to depressive (β = .382, $p < .001$) and anxiety symptoms (β = .318, $p < .001$) (**Table 2**). With the bootstrapped 95% CI that did not include zero, dysfunctional parental bonding had significant indirect effects via alexithymia on depressive (β = .054, SE = .011, 95% CI = .034–.075 for DysMB; β = .055, SE = .010, 95% CI = .036–.075 for DysPB) and anxiety symptoms (β = .045, SE = .009, 95% CI = .029–.062 for DysMB; β = .046, SE = .009, 95% CI = .029–.064 for DysPB). The model accounted for 23% of the variance in depressive symptoms [$R^2 = .23$, $F(6, 2414) = 117.36$, $p < .001$] and 15% in anxiety symptoms [$R^2 = .15$, $F(6, 2414) = 70.29$, $p < .001$].

Table 2. Parameters for mediation models.

	β	SE	95% CI	*P*
		Outcome: Alexithymia		
Constant	-.102	.082	-.266 – .063	.213
Age	-.049	.020	-.088 – -.010	.015
Education	-.180	.024	-.227 – -.132	<.001
Sex	.345	.042	.261 – .426	<.001
DysMB (X1)	**.142**	**.022**	**.093 – .192**	**<.001**
DysPB (X2)	**.144**	**.022**	**.097 – .192**	**<.001**
		Outcome: Depressive symptoms		
Constant	.477	.077	.318 – .635	<.001
Age	.003	.019	-.033 – .041	.865
Education	.015	.023	-.029 – .060	.505
Sex	-.378	.040	-.451 – -.302	<.001
DysMB (X1)	**.104**	**.021**	**.053 –.154**	**<.001**
DysPB (X2)	**.102**	**.021**	**.055 – .150**	**<.001**
Alexithymia	**.382**	**.019**	**.339 – .426**	**<.001**
X1 indirect	**.054**	**.011**	**.034 – .075**	
X2 indirect	**.055**	**.010**	**.036 – .075**	
		Outcome: Anxiety symptoms		
Constant	.110	.081	-.046 – .273	.172
Age	-.033	.020	-.071 – .005	.094
Education	.026	.024	-.020 – .072	.269
Sex	-.121	.042	-.202 – -.043	.004
DysMB (X1)	**.094**	**.022**	**.045 – .143**	**<.001**
DysPB (X2)	**.087**	**.022**	**.039 – .135**	**<.001**
Alexithymia	**.318**	**.020**	**.269 – .367**	**<.001**
X1 indirect	**.045**	**.009**	**.029 – .062**	
X2 indirect	**.046**	**.009**	**.029 – .064**	

95% CI based on bootstrapped sample size = 10,000. Sex: 1 = Females; 2 = Males. DysMB = Dysfunctional maternal bonding; DysPB = Dysfunctional paternal bonding. SE = Standard error. The focal factors are highlighted in bold.

5.1.3 Moderated mediation analyses

A significant interaction effect of sex and DysPB on alexithymia (β = .176, *p* < .001) was observed, indicating a moderating role of sex. The model accounted for 12% of the variance in alexithymia [R^2 = .12, F (7, 2413) = 48.63, *p* < .001]. However, no significant interaction effects of sex and DysMB on alexithymia were found (**Table 3**). According to the simple slopes analysis, males exhibited higher levels of alexithymia compared to females, regardless of DysPB levels (*p* = .039 for low levels; *p* < .001 for high levels). A steeper slope for males suggested that the effect of perceived DysPB on alexithymia was stronger among males (β = .266) than females (β = .090) (**Figure 5**).

Table 3. Moderating role of sex in the effects of dysfunctional parental bonding on alexithymia.

	β	SE	95% CI	*p*
Constant	-.113	.082	-.278 – .054	.167
Age	-.055	.020	-.094 – -.015	.007
Education	-.179	.024	-.227 – -.132	<.001
Sex	.356	.042	.271 – .439	<.001
DysMB (X1)	.123	.069	-.035 – .274	.076
DysPB (X2)	-.086	.068	-.229 – .061	.207
Interaction (X1*Sex)	**.015**	**.053**	**-.097 – .139**	**.774**
Interaction (X2*Sex)	**.176**	**.050**	**.065 – .282**	**<.001**

95% CI based on bootstrapped sample size = 10,000. Sex: 1 = Females; 2 = Males. DysMB = Dysfunctional maternal bonding; DysPB = Dysfunctional paternal bonding. SE = Standard error. The focal factors are highlighted in bold.

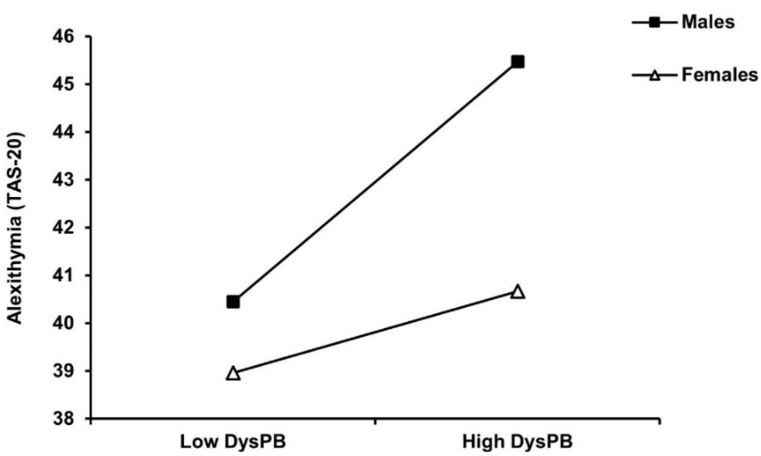

Figure 5. Effects of dysfunctional paternal bonding (DysPB) on alexithymia conditional on sex. Low = Mean - 1SD; High = Mean + 1SD.

Furthermore, when examining the complete mediation model, the indirect effect of DysPB on psychological symptoms was also significantly stronger in males than females (pairwise contrast = .067 for depressive symptoms, and .056 for anxiety symptoms), with bootstrapped 95% CI excluding zero. However, the mediation effect of alexithymia between DysMB and depressive/anxiety symptoms was not conditional on sex (**Table 4**, upper part).

Table 4. Sex differences in indirect effects of dysfunctional parental bonding and paternal bonding via alexithymia on psychological symptoms

Path		Effect	SE	95% CI	Effect	SE	95% CI
		Y: Depressive symptoms			*Y: Anxiety symptoms*		
DysMB → Y	Females	.053	.012	.031 – .076	.044	.010	.026 – .064
	Males	.059	.021	.020 – .100	.049	.018	.016 – .086
	Contrasts	.006	.023	-.038 – .052	.005	.019	-.031 – .044
DysPB → Y	Females	.034	.011	.014 – .057	.029	.009	.011 – .048
	Males	.102	.019	.064 – .140	.085	.017	.053 – .118
	Contrasts	**.067**	**.022**	**.025 – .110**	**.056**	**.018**	**.021 – .092**
PC → Y	Females	-.058	.011	-.080 – -.037	-.049	.009	-.069 – -.031
	Males	-.094	.017	-.128 – -.063	-.078	.015	-.108 – -.051
	Contrasts	-.036	.019	-.075 – .001	-.030	.016	-.061 – .002
PO → Y	Females	.015	.011	-.006 – .036	.013	.009	-.005 – .030
	Males	.068	.017	.035 – .103	.057	.015	.029 – .087
	Contrasts	**.053**	**.020**	**.014 – .093**	**.044**	**.017**	**.012 – .079**

95% CI based on bootstrapped sample size = 10,000. DysMB = Dysfunctional maternal bonding; DysPB = Dysfunctional paternal bonding. PC = Paternal care. PO = Paternal overprotection. SE = Standard error. Significant differences of effects between females and males are highlighted in bold.

Based on this finding, the role of paternal care (PC) and overprotection (PO) in the sex-moderated mediation model was further investigated. There were no significant associations between alexithymia and either PC (p = .365) or PO (p = .127) in the entire sample, controlling for sex. However, the single slopes analysis, as illustrated in **Figure 6**, revealed a moderating effect of sex on this path, suggesting a significant effect of PO on alexithymia in males (β = .173, 95% CI = .095–.252, p < .001), while no significant effect was observed in females (β = .038, 95% CI = -.010–.086, p = .118). The effect of PC on alexithymia was not moderated by sex.

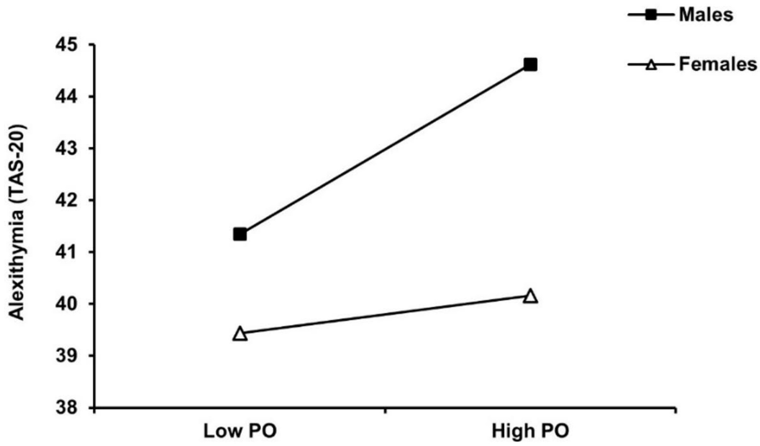

Figure 6. Effects of paternal overprotection (PO) on alexithymia conditional on sex. Low = Mean - 1SD; High = Mean + 1SD.

In turn, as presented in **Table 4** (lower part), a stronger mediation effect of alexithymia on the relationship between PO and psychological distress was observed in males, compared to females (pairwise contrast = .053, 95% CI = .014–.093 for depressive symptoms, and pairwise contrast = .044, 95% CI = .012–.079 for anxiety symptoms).

5.2 Study II

5.2.1 Descriptive statistics and correlation analysis

Table 5 shows the descriptive statistics and Spearman's correlations for continuous variables. The sample included 19 (2.9%) participants with missing data on education. Nearly half of the participants (43.4%) in this study possessed a "High" level of education, while 187 participants (28.4%) had a "Mid" education level, and 167 (25.3%) had a "Low" education level. Additionally, 101 participants (15.3%) reported positive life events experienced in the preceding year, while 198 participants (30.0%) reported negative life events.

Significant differences were observed in depressive (Δ Mean = 1.78, SD = 5.02, $p < .001$) and anxiety symptoms (Δ Mean = 1.25, SD = 5.11, $p < .001$) between the two time points. Additionally, the follow-up depressive and anxiety symptoms were positively correlated with perceived stress, pandemic events, and alexithymia (**Table 5**). Women experienced more depressive (6.98 vs. 5.12, $p < .001$) and anxiety symptoms (5.06 vs. 3.21, $p < .001$) during the pandemic, while men exhibited a higher level of alexithymia (42.83 vs. 39.53, $p < .001$). The presence of negative life events was related to higher levels of depressive symptoms (7.57 vs. 6.17, $p < .001$)

and perceived stress (4.57 vs. 3.91, $p < .001$). Age, education, and positive life events have no significant correlation with perceived stress or the follow-up symptoms, thus being excluded from further analyses.

Table 5. Descriptive statistics and Spearman's correlation for continuous variables.

		2	3	4	5	6	7	8	9
				N (%)					
Gender									
Women	520 (78.9%)								
Men	139 (21.1%)								
Education									
Low	167 (25.3%)								
Mid	187 (28.4%)								
High	286 (43.4%)								
Positive events	101 (15.3%)								
Negative events	198 (30.0%)								
				Mean (SD), range					
1. Age	38.10 (4.62), 24–50	.03	.00	.00	-.01	-.01	-.03	-.01	-.06
2. ES	6.13 (2.30), 0–10		-.20**	-.03	-.05	-.20**	-.12**	-.14**	-.12**
3. PSS-4	4.11 (2.80), 0–14			.12**	.14**	.30**	.25**	.61**	.46**
4. Pandemic events	4.43 (2.80), 0–20				-.06	.12**	.11**	.21**	.27**
5. TAS-20	40.23 (9.41), 22–72					.19**	.16**	.13**	.16**
6. EPDS (T0)	4.81 (4.60), 0–27						.60**	.46**	.37**
7. SCL-90 (T0)	3.42 (4.38), 0–31							.39**	.47**
8. EPDS (T1)	6.59 (4.75), 0–24								.67**
9. SCL-90 (T1)	4.67 (5.03), 0–24								

ES = Economic satisfaction (0 = Low satisfaction, 10 = High satisfaction). PSS-4 = 4-item Perceived Stress Scale; TAS-20 = 20-item Toronto Alexithymia Scale; EPDS = Edinburgh Postnatal Depression Scale; SCL-90 = Symptom Checklist-90 (anxiety subscale). $^{*}p < .05$; $^{**}p < .01$.

5.2.2 Conditional process modelling

Parameters for conditional process analysis

After controlling for gender, economic satisfaction, and past-year negative life events, pandemic events were positively associated with perceived stress (**Table 6**, upper part), which was further related to follow-up depressive and anxiety symptoms, controlling for the same confounders and the corresponding pre-pandemic psychological symptoms (**Table 6**, middle and lower part). Moreover, the interaction between perceived stress and alexithymia was found to have significant associations with the follow-up symptoms, suggesting a moderating role of alexithymia in this path. The model accounted for 52% of variance in the change in the depressive symptoms [$R^2 = 0.52$, $F(8, 650) = 87.99$, $p < .001$], and 43% in the anxiety symptoms [$R^2 = 0.43$, $F(8, 650) = 61.56$, $p < .001$].

Table 6. Parameters for conditional process modeling.

	B	SE	95% CI LL	95% CI UL	p
			Outcome: perceived stress		
Constant	1.043	.488	.084	2.013	.033
Gender	-.092	.260	-.610	.412	.724
Economic satisfaction	-.249	.047	-.352	-.148	<.001
Negative life events	.514	.233	.050	.982	.028
Pandemic events	**.099**	**.038**	**.031**	**.172**	**.009**
			Outcome: follow-up depressive symptoms		
Constant	6.428	.631	5.152	7.689	<.001
Gender	-1.695	.323	-2.272	-1.094	<.001
Economic satisfaction	.038	.059	-.077	.156	.516
Negative life events	.573	.286	.008	1.166	.045
Depressive symptoms (T0)	.226	.031	.163	.291	<.001
Pandemic events	.153	.047	.061	.244	.001
Perceived stress (M)	.959	.050	.846	1.073	<.001
Alexithymia (W)	.026	.014	-.002	.052	.073
Interaction (M*W)	**.013**	**.005**	**.002**	**.024**	**.008**
			Outcome: follow-up anxiety symptoms		
Constant	5.002	.702	3.620	6.383	<.001
Gender	-1.852	.370	-2.500	-1.184	<.001
Economic satisfaction	-.062	.068	-.199	.073	.359
Negative life events	.020	.330	-.616	.662	.951
Anxiety symptoms (T0)	.327	.035	.245	.425	<.001
Pandemic events	.250	.055	.136	.364	<.001
Perceived stress (M)	.775	.056	.634	.918	<.001
Alexithymia (W)	.053	.016	.022	.084	.001
Interaction (M*W)	**.018**	**.006**	**.005**	**.032**	**.001**

95% CI based on bootstrapped sample size = 5,000; LL = Lower limit; UL = Upper limit. SE = Standard error. Gender: 1 = Women; 2 = Men. Negative Life events: 0 = Absence of experiences; 1 = Presence of experiences. The focal factors are written in bold.

Psychological impacts of perceived stress conditional on alexithymia

The simple slopes analysis revealed that, at both low and high levels of alexithymia, perceived stress had significant effects on depressive (B = .838 at low alexithymia, and B = 1.079 at high alexithymia, $p < .001$) and anxiety symptoms (B = .605 at low, and B = .946 at high alexithymia, $p < .001$). Notably, as indicated by steeper slopes, higher levels of alexithymia reflected stronger effects (**Figure 7**). At the low level of perceived stress, there were no significant differences in psychological symptoms between individuals with low and high levels of alexithymia ($p = .599$ for depressive symptoms, $p = .926$ for anxiety symptoms). However, at the high level of perceived stress, significant differences emerged ($p = .002$ for depressive symptoms, $p < .001$ for anxiety symptoms).

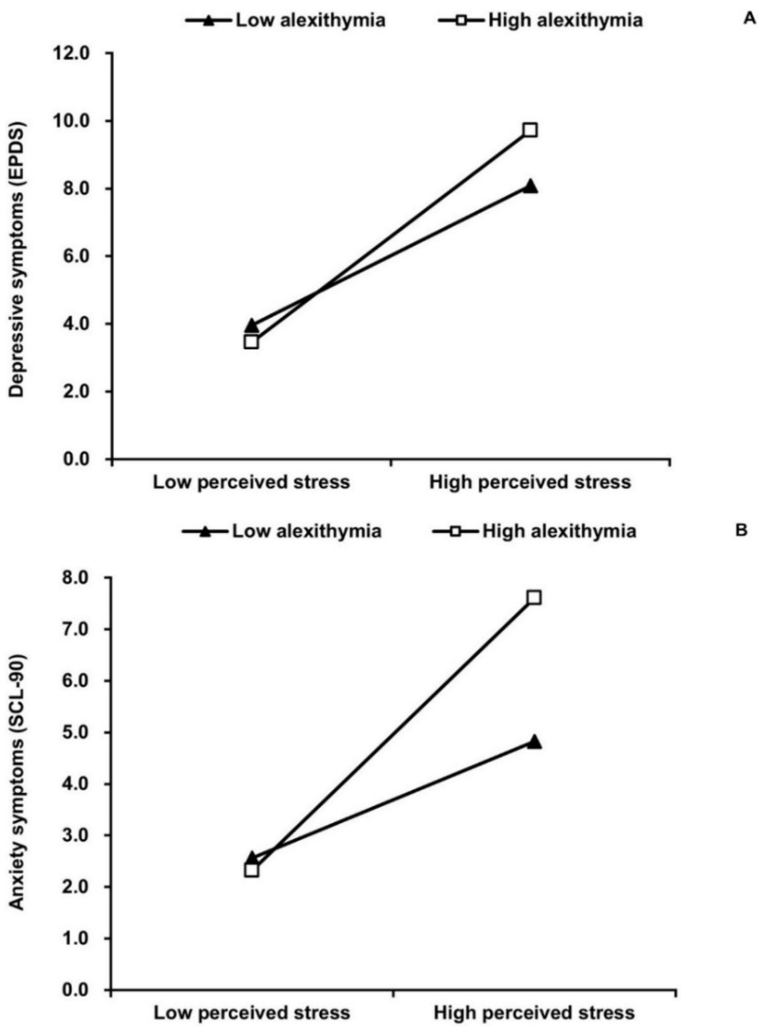

Figure 7. Alexithymia as a moderator in the relations between perceived stress and the follow-up depressive (A) and anxiety (B) symptoms, controlling for the baseline symptoms.

Mediation effect of perceived stress conditional on alexithymia

Effects of pandemic-related events on the changes in depressive and anxiety symptoms were mediated by perceived stress, regardless of low or high alexithymia levels. Nevertheless, this indirect effect was significant stronger at high levels of alexithymia compared to low levels, with a pairwise contrast of .024 for depressive symptoms (**Table 7**) and .034 for anxiety symptoms (**Table 8**). The indirect effects of pandemic events via perceived stress on the psychological symptom changes conditional on alexithymia are illustrated in **Figure 8**.

Table 7. Indirect effects of pandemic events via perceived stress on the change in depressive symptoms at low and high levels of alexithymia and its three dimensions.

Moderator level	Indirect effects of pandemic events			
	Effect	SE	Bootstrapped 95% CI	
			LL	UL
Alexithymia (TAS-20 total)				
Low	.083	.032	.025	.149
High	.107	.040	.032	.189
Contrast	.024	.014	.002	.055
DIF				
Low	.081	.032	.021	.147
High	.110	.042	.028	.197
Contrast	.028	.014	.005	.061
DDF				
Low	.086	.034	.024	.157
High	.106	.040	.029	.187
Contrast	.020	.012	.001	.047
EOT				
Low	.092	.037	.023	.168
High	.100	.039	.025	.178
Contrast	.008	.012	-.014	.034

95% CI based on bootstrapped sample size = 5,000. LL = Lower limit; UL = Upper limit. SE = Standard error. TAS-20 = 20-item Toronto Alexithymia Scale; DIF = Difficulty identifying feelings; DDF = Difficulty describing feelings; EOT = Externally oriented thinking.

Table 8. Indirect effects of pandemic events via perceived stress on the change in anxiety symptoms at low and high levels of alexithymia and its three dimensions.

Moderator level	Indirect effects of pandemic events			
	Effect	SE	Bootstrapped 95% CI	
			LL	UL
Alexithymia (TAS-20 total)				
Low	.060	.025	.014	.115
High	.094	.036	.026	.168
Contrast	.034	.017	.006	.072
DIF				
Low	.052	.023	.012	.102
High	.101	.039	.027	.181
Contrast	.050	.021	.013	.097
DDF				
Low	.065	.028	.015	.125
High	.091	.035	.024	.163
Contrast	.026	.016	-.002	.062
EOT				
Low	.077	.031	.019	.140
High	.081	.033	.020	.149
Contrast	.004	.013	-.023	.032

95% CI based on bootstrapped sample size = 5,000. LL = Lower limit; UL = Upper limit. SE = Standard error. TAS-20 = 20-item Toronto Alexithymia Scale; DIF = Difficulty identifying feelings; DDF = Difficulty describing feelings; EOT = Externally oriented thinking.

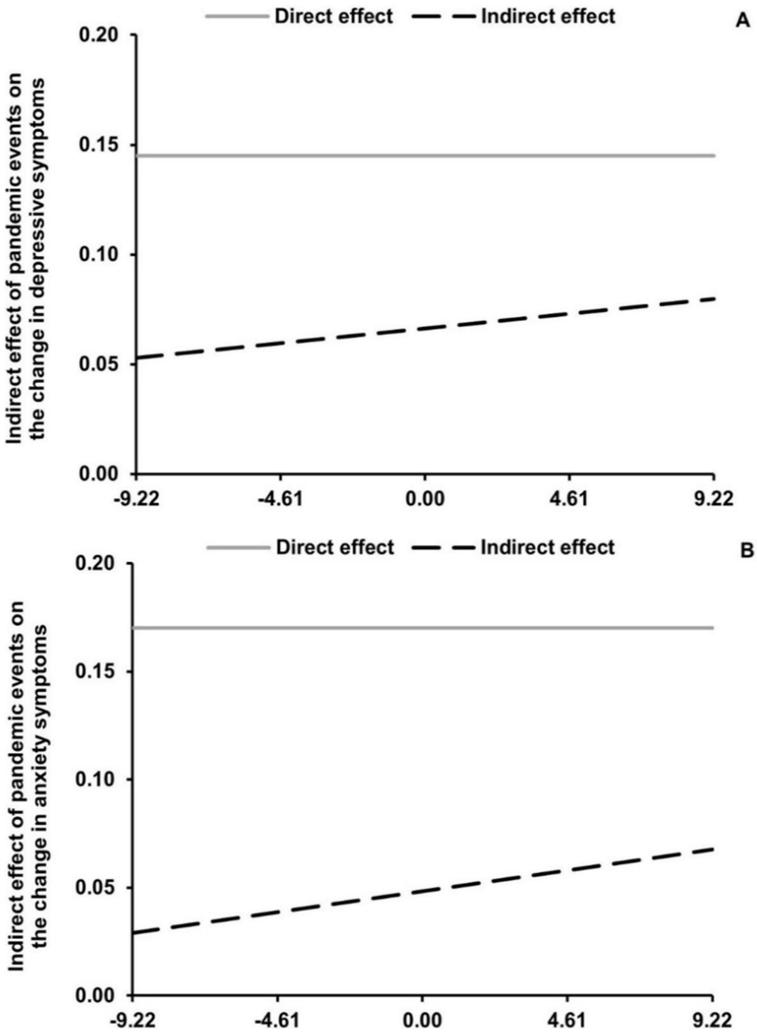

Figure 8. Indirect effects of pandemic events on the change in depressive (A) and anxiety (B) symptoms conditional on alexithymia levels.

Regarding alexithymia dimensions, DIF (B = .038, p < .001 for depressive symptoms; B = .058, p < .001 for anxiety symptoms) and DDF (B = .033, p = .003 for depressive symptoms; B = .028, p = .023 for anxiety symptoms), but not EOT (p = .402 for depressive symptoms; p = .736 for anxiety symptoms), may play a moderating role. The results, as shown in **Table 7** and **Table 8**, confirmed the absence of a moderating role of EOT in the indirect effects of pandemic events. The bootstrapped 95% CI, which did not include zero, further supported that the indirect link of the pandemic events to psychological symptoms was primarily conditional on the level of DIF.

5.3 Study III

5.3.1 Sample characteristics

Table 9 presents the descriptive statistics and missing data information at each time point. There were no significant differences in the background factors, temperament traits, and alexithymia among the respondents at T0, T1 and T2, suggesting similar characteristics of the sample across the time points.

Table 9. Descriptive statistics and the proportion of missing data for respondents (parents completing the symptom measurement) at each time point.

	T0 respondents (N = 706)		T1 respondents (N = 822)		T2 respondents (N = 532)	
	N (%) or mean (SD), range	**Missing**	**N (%) or mean (SD), range**	**Missing**	**N (%) or mean (SD), range**	**Missing**
Gender		-		-		-
Women	551 (78.0%)		645 (78.5%)		411 (77.8%)	
Men	155 (22.0%)		177 (21.5%)		118 (22.2%)	
Education		3.5%		4.1%		4.1%
Low	168 (24.7%)		204 (25.9%)		121 (23.7%)	
Mid	199 (29.2%)		235 (29.8%)		148 (29.0%)	
High	314 (46.1%)		349 (44.3%)		241 (47.3%)	
Age	32.0 (4.6), 18–50	-	31.7 (4.7), 18–50	0.1%	32.0 (4.6), 19–50	0.2%
ES	6.1 (2.3), 0–10	4.0%	6.1 (2.3), 0–10	4.6%	6.1 (2.3), 0–10	4.5%
Children at home		2.5%		2.2%		1.7%
1	125 (18.1%)		135 (16.8%)		90 (17.2%)	
2	387 (56.0%)		452 (56.2%)		289 (55.3%)	
≥ 3	179 (25.9%)		217 (27.0%)		144 (27.5%)	
Remote work		34.3%		36.3%		1.9%
< 50%	346 (74.6%)		393 (75.0%)		388 (74.3%)	
≥ 50%	118 (25.4%)		131 (25.0%)		134 (25.7%)	
PS	5.5 (2.6), 0–14	2.8%	5.5 (2.7), 0–15	1.8%	6.1 (2.4), 1–14	1.7%
NLE	0.4 (0.7), 0–5	3.1%	0.4 (0.7), 0–5	2.1%	0.4 (0.6), 0–3	1.7%
ATQ						
NA	3.9 (0.7), 1.8–6.1	11.6%	3.9 (0.7), 1.8–6.1	20.8%	3.9 (0.7), 1.8–5.9	15.8%
EC	4.7 (0.7), 2.6–6.6	11.6%	4.7 (0.7), 2.6–6.6	20.8%	4.7 (0.7), 2.6–6.6	15.8%
E/S	4.6 (0.7), 2.2–6.6	11.6%	4.7 (0.7), 2.2–6.6	20.8%	4.6 (0.7), 2.2–6.5	15.8%
OS	4.6 (0.8), 2.1–6.6	11.9%	4.5 (0.8), 2.1–6.6	21.0%	4.5 (0.8), 2.1–6.6	16.2%
TAS-20	40.3 (9.4), 22–72	10.2%	40.2 (9.4), 22–72	16.9%	40.5 (9.2), 22–72	12.2%
EPDS	4.9 (4.5), 0–27	-	6.7 (4.8), 0–24	-	6.8 (5.1), 0–23	-

SD = Standard deviation. ES = Economic satisfaction (0 = Low satisfaction, 10 = High satisfaction). PS = Pandemic stressors. NLE = Negative life events. ATQ: Adult Temperament Questionnaire; NA = Negative affect, EC = Effortful control, E/S = Extraversion/surgency, OS = Orienting sensitivity. TAS-20: 20-item Toronto Alexithymia Scale. EPDS: Edinburgh Postnatal Depression Scale.

5.3.2 Trajectories of depressive symptoms

Table 10 shows the indices regarding the model fit. According to the criteria for model evaluation (as described above in section **4.5.3**), the best-fitting model could not be identified based on the LL, AIC, and BIC indices, which improved up to the 5-class model, and B-LRT, which showed significant *p* values for all solutions. However, the VLMR-LRT index suggested no significant improvement for the 5-class model in comparison to the 4-class model. Therefore, the 4-class solution was adopted.

Table 10. Fit indices for latent growth mixture modeling.

Fit Indices	Number of latent groups				
	1	2	3	4	5
LL	-5678.026	-5608.277	-5572.625	-5561.546	-5554.526
AIC	11372.052	11238.554	11173.250	11157.093	11147.052
BIC	11409.814	11290.477	11239.333	11237.336	11236.736
Entropy		0.73	0.74	0.75	0.76
VLMR (*p*)		0.008	<.001	0.007	0.163
B-LRT (*p*)		<.001	<.001	<.001	<.001
Class Size (ALCP)					
Class 1	829	657 (.94)	61 (.93)	67 (.90)	75 (.86)
Class 2		172 (.85)	542 (.91)	515 (.90)	220 (.77)
Class 3			226 (.79)	19 (.72)	8 (.81)
Class 4				228 (.78)	498 (.88)
Class 5					28 (.71)

LL = Loglikelihood, AIC = Akaike information criterion, BIC = Bayesian information criterion, VLMR = Vuong-Lo-Mendell-Rubin likelihood ratio test, B-LRT = Bootstrapping likelihood ratio test, ALCP = Average latent class probabilities.

According to the patterns of the estimated trajectories (**Figure 9**), the four identified groups were named "*Consistently low symptoms*", "*Steeply increasing symptoms*", "*Subclinical stable symptoms*", and "*Decreasing symptoms*", respectively. The corresponding observed individual trajectories are illustrated in **Figure 9** (**a**, **b**, **c**, and **d**), reflecting the variation within each latent group. **Table 11** presents the estimated means, slopes, and random effect parameters of the modeling, showing distinct estimated starting points (T0) of the identified trajectories.

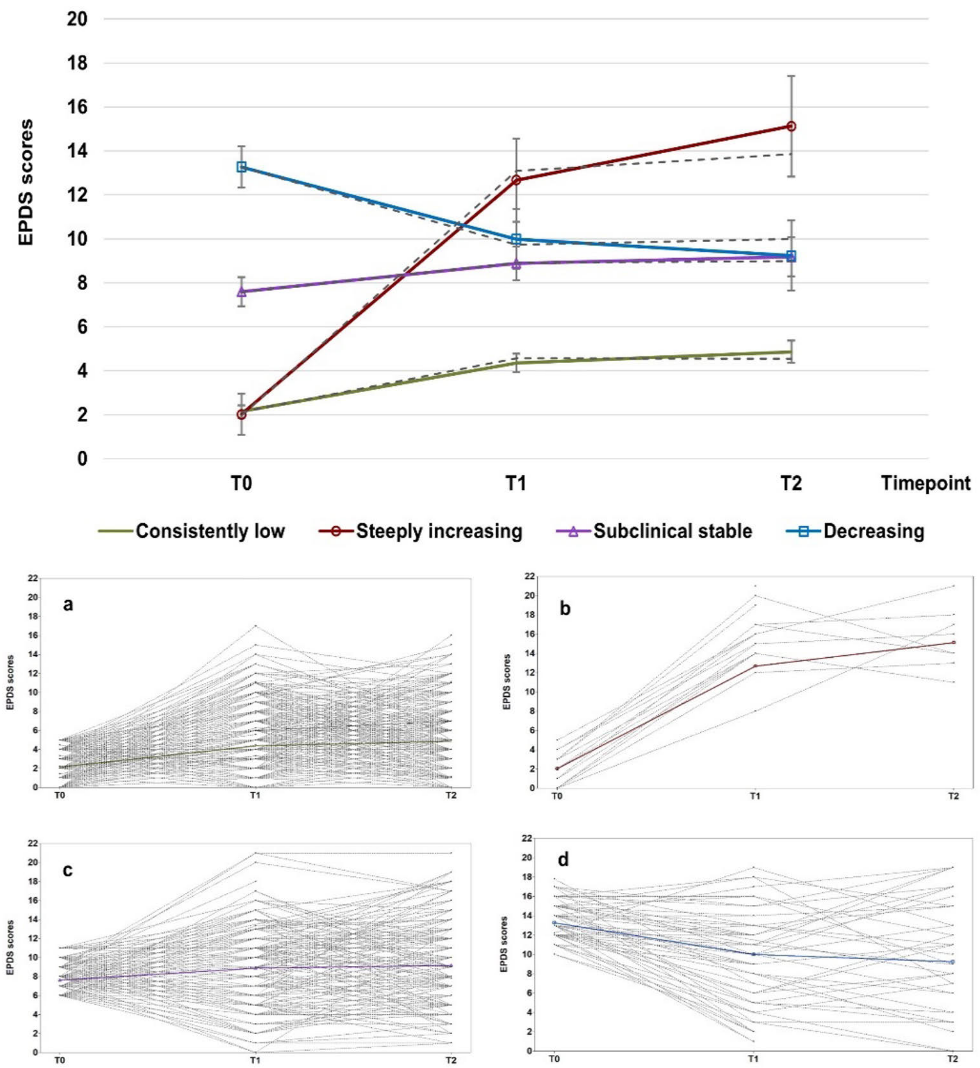

Figure 9. Estimated (solid line) and sample mean (dashed line) trajectories for the four-class solution and the observed individual trajectories for each latent group. EPDS: Edinburgh Postnatal Depression Scale. Error bars represent 95% confidence intervals.

Table 11. Estimated mean levels and slopes (SE: Standard error), as well as random effect parameters of modeling.

			Estimate	SE
Means	Latent classes			
	Consistently low	Level	2.15	0.14
		Slope	2.20	0.20
	Steeply increasing	Level	2.01	0.48
		Slope	10.66	0.98
	Subclinical stable	Level	7.60	0.34
		Slope	1.28	0.37
	Decreasing	Level	13.27	0.48
		Slope	-3.28	0.66
Random effect parameters	Variances	Level	0.87	2.27
		Slope	4.55	2.12
	Residual variances	T0	2.40	2.34
		T1	7.36	0.77
		T2	7.68	0.98

5.3.3 Background factors in relation to depressive symptoms and symptom trajectories

Table 12 indicates the Spearman's correlation matrix for continuous variables. Follow-up depressive symptoms at T1 and T2 were correlated with economic satisfaction, COVID-stressors, and negative life events. **Table 13** demonstrates the background information stratified by the identified latent groups. Men and individuals with high education levels, high economic satisfaction, having only one child at home, and engaging less remote work were found more likely to be classified into the *Consistently low symptoms* group. Compared to the other groups, the parents in the *Consistently low symptoms* group reported less experience of COVID-19 stressors, while those in the *Steeply increasing symptoms* group reported more experience of negative life events. There were no significant differences in terms of age among the four trajectory groups. Accordingly, gender, education, economic satisfaction, number of children at home, remote work, COVID-stressors, and negative life events were included as confounders in the subsequent regression analyses (**Table 13**).

Table 12. Spearman's correlation matrix for continuous variables.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. EPDS (T0)																		
2. EPDS (T1)	.49**																	
3. EPDS (T2)	.48**	.68**																
Temperament (ATQ)																		
4. Negative affect	.27**	.27**	.29**															
5. Effortful control	-.29**	-.22**	-.24**	-.38**														
6. Extraversion/surgency	-.14**	-.02	-.03	-.22**	.16**													
7. Orienting sensitivity	.14**	.19**	.16**	.19**	.00	.15**												
Coping factors																		
8. Emotion-diverting	.22**	.34**	.28**	.25**	-.10**	-.02	.14**											
9. Avoidant	.14**	.19**	.16**	.03	-.13**	-.05	-.05	-.04										
10. Constructive	-.08*	-.16**	-.10*	-.09*	.07	.13**	.04	-.03	.03									
11. Religion	.04	.12**	.07	.07	.00	.05	.12**	.00	-.11**	-.06								
12. Alexithymia (TAS-20)	.20**	.11**	.18**	.13**	-.27**	-.25**	-.11**	.01	.14**	-.10**	-.10**							
13. DIF	.31**	.23**	.30**	.29**	-.32**	-.17**	.03	.12**	.13**	-.03	.01	.59**						
14. DDF	.18**	.08*	.11*	.09*	-.21**	-.27**	-.07	.00	.13**	-.04	-.07	.67**	.45**					
15. EOT	.01	-.04	.02	-.07	-.09*	-.14**	-.21**	-.10**	.09*	-.10**	-.15**	.58**	.11**	.31**				
16. PS	.10**	.22**	.24**	.12**	-.07	.04	.08	.18**	.04	.02	.12**	-.04	.03	-.05	-.08*			
17. NLE	.08*	.21**	.26**	.08	-.08*	-.03	.08*	.07*	.02	-.01	.09*	.06	.07	.07	.00	.16**		
18. ES	-.19**	-.13**	-.14**	-.09*	.16**	.02	-.07	-.03	-.09**	.05	-.01	-.06	-.04	-.06	-.04	-.03	-.10**	
19. Age	.00	-.04	-.02	-.10*	.09*	-.06	-.02	-.07	-.01	.02	.01	-.02	-.10*	.00	.05	-.01	.02	.04

EPDS: Edinburgh Postnatal Depression Scale. ATQ: Adult Temperament Questionnaire. TAS-20: 20-item Toronto Alexithymia Scale. DIF = Difficulty identifying feelings; DDF = Difficulty describing feelings; EOT = Externally oriented thinking. PS = Pandemic stressors. NLE = Negative life events. ES = Economic satisfaction. $^{*}p < .05$, $^{**}p < .01$. The pooled values after multiple imputation are presented.

Table 13. Group comparisons for all the variables among identified latent groups.

	Consistently low (N = 515)	Steeply increasing (N = 26)	Subclinical stable (N = 229)	Decreasing (N = 74)	*p*
Gender					.051
Women	391[a]	24	190	57	
Men	124[b]	2	39	17	
Education					.030
Low	119[a]	12	63	27	
Mid	157[ab]	5	67	23	
High	239[b]	9	99	24	
Children at home					.015
1	73[a]	5	43	22[a]	
2	298[b]	13	132	33[b]	
≥ 3	144[b]	8	54	19[b]	
Remote work					.138
< 50%	396[a]	18	164	56	
≥ 50%	119[b]	8	65	18	
Age	31.7 (4.6)	31.7 (4.3)	31.5 (4.6)	32.3 (5.1)	.519
Economic satisfaction	6.4 (2.2)[a]	6.4 (2.1)[a]	5.7 (2.3)	5.2 (2.7)	<.001
Pandemic stressors	5.1 (2.6)[a]	6.4 (3.1)	6.0 (2.7)	6.3 (3.0)	<.001
Negative life events	0.4 (0.6)	1.0 (1.1)[a]	0.5 (0.8)	0.6 (0.7)[a]	<.001
Temperament					
Negative affect	3.74[a]	4.10	4.17	4.08	<.001
Effortful control	4.82[a]	4.55	4.49	4.36	<.001
Extraversion/surgency	4.71	4.75	4.56	4.52	.031
Orienting sensitivity	4.5	4.78	4.69	4.83	<.001
Coping Factors					
Emotion-diverting	-.15[a]	.27	.21	.26	<.001
Avoidant	-.11	.16	.17	.17	<.001
Constructive	.07[a]	-.41[b]	-.10[ab]	-.06[ab]	.014
Religion	-.04	.15	-.01	.24	.080
Alexithymia (TAS-20)	39.15	40.78	42.24	41.84	.001
DIF	10.65[a]	11.73[a]	12.72	13.31	<.001
DDF	9.56	9.95	10.60	10.75	.004
EOT	17.79	18.92	18.94	19.10	.247

TAS-20: 20-item Toronto Alexithymia Scale. DIF = Difficulty identifying feelings; DDF = Difficulty describing feelings; EOT = Externally oriented thinking. Chi-square analyses, Kruskal-Wallis tests or One-way ANOVA were used according to the types of data. Harmonic mean based on the group size was used for continuous variables. Sharing the same superscript indicates no significant differences.

5.3.4 Temperament traits and coping factors in relation to symptom trajectories

As shown in **Table 12**, most of the temperament traits and all the coping factors were correlated with follow-up depressive symptoms. At T2, no correlations were observed between symptoms and extraversion/surgency or the religion coping factor. The results from the group comparisons in **Table 13** indicated significant differences between the symptom trajectories in terms of all these study variables, except for the religion factor.

Figure 10 depicts the forest plot showing the odds ratios of the main study variables in predicting the symptom trajectories, with the *Consistently low symptoms* group as the reference. The individuals with higher negative affect were more likely to be in the *Subclinical stable symptoms* group. Those with a lower level of effortful control or applying more emotion-diverting coping or avoidant coping were more likely to be in the *Subclinical stable symptoms* and *Decreasing symptoms* group. The group of *Decreasing symptoms* also showed a higher level of orienting sensitivity. Notably, the individuals using less constructive coping tended to be in the groups of *Steeply increasing symptoms* and *Subclinical stable symptoms* (**Figure 10**). No significant predictors were observed when comparing the groups of *Steeply increasing symptoms*, *Subclinical stable symptoms* and *Decreasing symptoms*.

Predictors	Latent groups	OR (95% CI)	*p*
Temperament (ATQ)			
Negative affect	2	1.30 (.59–2.86)	.518
	3	**1.53 (1.07–2.19)**	**.021**
	4	1.14 (.67–1.96)	.633
Effortful control	2	.73 (.36–1.50)	.397
	3	**.72 (.53–.98)**	**.039**
	4	**.52 (.31–.88)**	**.015**
Extraversion/Surgency	2	1.13 (.53–2.42)	.758
	3	.83 (.63–1.10)	.203
	4	.71 (.44–1.14)	.152
Orienting sensitivity	2	1.26 (.63–2.52)	.512
	3	1.21 (.94–1.56)	.129
	4	**1.58 (1.04–2.40)**	**.031**
Coping Factors			
Emotion-diverting	2	1.52 (.93–2.50)	.094
	3	**1.47 (1.22–1.78)**	**< .001**
	4	**1.61 (1.21–2.16)**	**.001**
Avoidant	2	1.39 (.95–2.04)	.085
	3	**1.38 (1.16–1.64)**	**< .001**
	4	**1.37 (1.07–1.75)**	**.014**
Constructive	2	**.56 (.36–.87)**	**.010**
	3	**.82 (.69–.98)**	**.026**
	4	.84 (.64–1.11)	.220
Religion	2	1.12 (.72–1.76)	.609
	3	1.01 (.83–1.22)	.947
	4	1.28 (1.00–1.66)	.053
Alexithymia (TAS-20)	2	1.02 (.97–1.07)	.500
	3	**1.03 (1.01–1.05)**	**< .001**
	4	1.03 (1.00–1.06)	.054
DIF	2	1.03 (.91–1.16)	.647
	3	**1.08 (1.03–1.13)**	**.002**
	4	**1.12 (1.05–1.19)**	**.001**
DDF	2	1.01 (.86–1.18)	.939
	3	1.03 (.97–1.10)	.338
	4	1.03 (.95–1.12)	.430
EOT	2	1.02 (.91–1.15)	.708
	3	1.00 (.95–1.05)	.896
	4	**.92 (.86–.99)**	**.021**

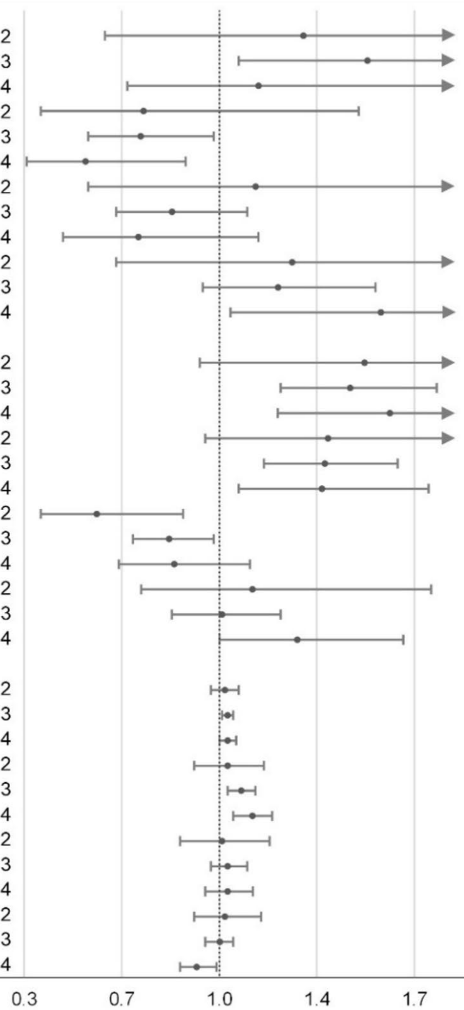

Figure 10. Odds ratios (OR) for temperament traits, coping factors, and alexithymic traits predicting trajectories of depressive symptoms. ATQ: Adult Temperament Questionnaire. TAS-20: 20-item Toronto Alexithymia Scale. DIF = Difficulty identifying feelings; DDF = Difficulty describing feelings; EOT = Externally oriented thinking. Latent groups: 2 = Steeply increasing symptoms; 3 = Subclinical stable symptoms; 4 = Decreasing symptoms. Reference latent group: Consistently low symptoms. Statistically significant results are bolded; the pooled values after multiple imputation are presented.

5.3.5 Alexithymic traits in relation to symptoms trajectories

As displayed in **Table 12**, the TAS-20 total score and its subscales DIF and DDF were positively correlated with depressive symptoms at all three time points. Alexithymia had significant correlations with all the temperament traits.

Alexithymia, as well as its three dimensions DIF, DDF, and EOT, were found to be negatively related to extraversion/surgency and orienting sensitivity. Among the coping factors, the most evident and positive association with alexithymia was observed in avoidant coping, while emotion-diverting coping was positively correlated to DIF but negatively to EOT. As presented in **Table 13**, the group comparisons suggested significant differences in overall alexithymia, and DIF and DDF dimensions between the latent groups. The *Consistently low symptoms* and *Steeply increasing symptoms* groups tended to show a relatively low level of DIF.

As presented in the forest plot (**Figure 10**), when controlling for the covariates, a higher level of alexithymia was found to be related to increased odds of being in the group of *Subclinical stable symptoms* (OR = 1.03, 95% CI = 1.01–1.05) compared to the *Consistently low symptoms* group. This association was apparently accounted for by the role of DIF (OR = 1.08, 95% CI = 1.03–1.13). The higher levels of alexithymia showed a trend towards being linked to the *Decreasing symptoms* group, which was also partly attributed to the effect of DIF (OR = 1.12, 95% CI = 1.05–1.19). However, the higher level of EOT was observed to be associated with lower odds of being classified into the *Decreasing symptoms* group (OR = .92, 95% CI = .86–.99).

5.4 Study IV

5.4.1 Preliminary analysis

The descriptive statistics for all variables and the percentage of missing data at each time point are presented in **Table 14**. Compared to T1, the respondents at T3 showed lower values of the AUDIT (mean rank: 512.7 vs. 571.0, p = .002), specifically in domain 1 (mean rank: 502.8 vs. 589.6, p < .001), and the EPDS score (mean rank: 565.8 vs. 637.2, p < .001). Using a cut-off point of 8, no significant differences in the prevalence of hazardous drinking between T1 (7.7%) and T3 (7.4%) were observed. There were no significant differences in all the background variables and alexithymia between the two time points.

Table 14. Descriptive statistics for all variables and percentage of missing data at each time point.

	T1 respondents (N = 716)		T3 respondents (N = 529)	
	N (%) or mean (SD), range	Missing	N (%) or mean (SD), range	Missing
Gender		-		-
Women	568 (79.3%)		417 (78.8%)	
Men	148 (20.7%)		112 (21.2%)	
Education		0.1%		0.2%
Low	156 (21.8%)		110 (20.8%)	
Mid	214 (29.8%)		154 (29.3%)	
High	346 (48.4%)		264 (49.9%)	
Age	31.74 (4.58), 18–50	-	31.98 (4.66), 18–50	-
Pandemic stressors	4.42 (2.76), 0–15	0.1%	4.34 (2.62), 0–15	0.4%
EPDS (pre)	4.81 (4.48), 0–26	0.1%	4.72 (4.32), 0–23	0.2%
SCL-90 (pre)	3.96 (4.75), 0–28	0.3%	3.87 (4.69), 0–28	0.2%
TAS-20 total	39.82 (9.66), 20–79	-	39.82 (9.67), 20–75	-
DIF	11.69 (4.71), 7–33	-	11.69 (4.70), 7–32	-
DDF	9.78 (3.68), 5–23	-	9.80 (3.67), 5–23	-
EOT	18.34 (4.43), 8–30	-	18.33 (4.45) , 8–30	-
AUDIT	3.54 (2.91), 0–32	11.5%	3.21 (2.77), 0–26	13.4%
Hazardous drinking	49 (7.7%)		34 (7.4%)	
Domain 1	1.77 (0.80), 0–3	10.8%	1.55 (0.82), 0–3	11.9%
Domain 2	0.10 (0.40), 0–3	3.1%	0.07 (0.30), 0–3	5.7%
Domain 3	0.38 (0.78), 0–4	3.4%	0.33 (0.72), 0–4	4.9%
EPDS (T1/T3)	6.71 (4.83), 0–24	4.7%	5.82 (4.78), 0–22	-
SCL-90 (T1/T3)	4.76 (5.08), 0–29	5.0%	4.35 (4.95), 0–33	0.8%

SD = Standard deviation. EPDS = Edinburgh Postnatal Depression Scale; SCL-90 = Symptom Checklist-90 (anxiety subscale). Pre = pre-pandemic symptoms. TAS-20 = 20-item Toronto Alexithymia Scale; DIF = Difficulty identifying feelings; DDF = Difficulty describing feelings; EOT = Externally oriented thinking. AUDIT = Alcohol Use Disorder Identification Test; Domain 1: Alcohol consumption; Domain 2: Alcohol dependence; Domain 3: Alcohol-related harm. Hazardous drinking: scores of 8 or more on the AUDIT.

5.4.2 Latent transition analyses (LTA)

LTA modeling without covariates

After conducting latent profile analyses for each time point, 3-profile models were selected for both T1 and T3, based on the model evaluation indices presented in **Table 15**. The likelihood-ratio test (df = 15, χ^2diff = 24.65, p = .055) suggested that no significant differences between the full invariant model (in which all measurement parameters were constrained across T1 and T2) and the baseline model (where all parameters were freely estimated). Despite minor variations in item levels across T1 and T3, the relative levels of items within profiles at each time point remained largely similar (**Table 16**, upper part), thus reasonably supporting the assumption of the full measurement invariance. The consistent general interpretation of the profiles over time ensures a clear and comprehensible understanding of the subsequent LTA modeling.

Table 15. Indices for latent profile model evaluation at two time points.

		Number of profiles				
		1	**2**	**3**	**4**	**5**
T1	LL	-3980.56	-3608.00	-3434.71	-3430.28	-3417.752
	AIC	7981.12	7248.01	6913.42	6916.55	6903.505
	BIC	8026.86	7321.19	7014.04	7044.62	7059.010
	LMR (*p*)	-	< .001	< .001	.263	.661
	Entropy	-	0.95	0.89	0.76	0.70
	ALCP	1	.98/.99	.98/.95/.92	.79/.82/.92/.97	.68/.76./.74.88.97
T3	LL	-3098.68	-2757.31	-2652.21	-2632.99	-2624.285
	AIC	6217.35	5546.61	5348.41	5321.99	5316.569
	BIC	6260.06	5614.95	5442.37	5441.58	5461.783
	LMR (*p*)	-	.003	< .001	.109	.462
	Entropy	-	0.95	0.89	0.84	0.80
	ALCP	1	.99/.98	.96/.98/.88	.79/.89/.97/.93	.87/.79/.97/.87/.89

LL = Log-likelihood, AIC = Akaike information criterion, BIC = Bayesian information criterion, LMR = Adjusted Lo-Mendell-Rubin likelihood ratio test, ALCP = Average latent class probabilities.

The parameters of the full invariant LTA model are presented in **Table 16** (lower part), and the 3-profile model with the full measurement invariance is depicted in **Figure 11**. The first profile, characterized by a relatively higher level of alcohol use-related problems and low psychological symptom levels, was named "*Risky Drinking*". The second profile, characterized by low levels of alcohol use problems but high levels of psychological symptoms, was named "*Distressed Non-Risky Drinking*". The third profile in which all the indicator variables were low was named "*Non-Distressed, Non-Risky Drinking*".

The transition probabilities are shown in **Table 17**, reflecting the dynamics and shifts of the identified profiles over time. Most of the individuals remained stable in their initial profile, while the individuals who experienced profile changes in the groups of *Risky Drinking* and *Distressed Non-Risky Drinking* at T1 tended to transition into *Non-Distressed, Non-Risky Drinking* at T3.

Table 16. Modelling parameters for the latent transition analyses (LTA).

	Risky Drinking	Distressed Non-Risky Drinking	Non-Distressed, Non-Risky Drinking
Baseline model			
Membership probabilities			
T1	21.75%	17.72%	60.54%
T3	21.08%	15.86%	63.06%
Z-score		*T1/T2*	
Alcohol consumption	0.61/0.76	-0.29/-0.44	-0.15/-0.16
Alcohol dependence	0.16/0.51	-0.16/-0.23	-0.21/-0.21
Alcohol-related harm	1.19/1.27	-0.46/-0.46	-0.48/-0.46
Depressive symptoms	0.07/0.09	1.13/1.24	-0.44/-0.44
Anxiety symptoms	-0.07/0.23	1.27/0.97	-0.49/-0.48
Full invariant model			
Membership probabilities			
T1	22.30%	18.14%	59.55%
T3	21.06%	15.99%	62.95%
Z-score			
Alcohol consumption	0.67	-0.34	-0.16
Alcohol dependence	0.26	-0.17	-0.21
Alcohol-related harm	1.22	-0.46	-0.47
Depressive symptoms	0.08	1.20	-0.43
Anxiety symptoms	0.05	1.17	-0.48

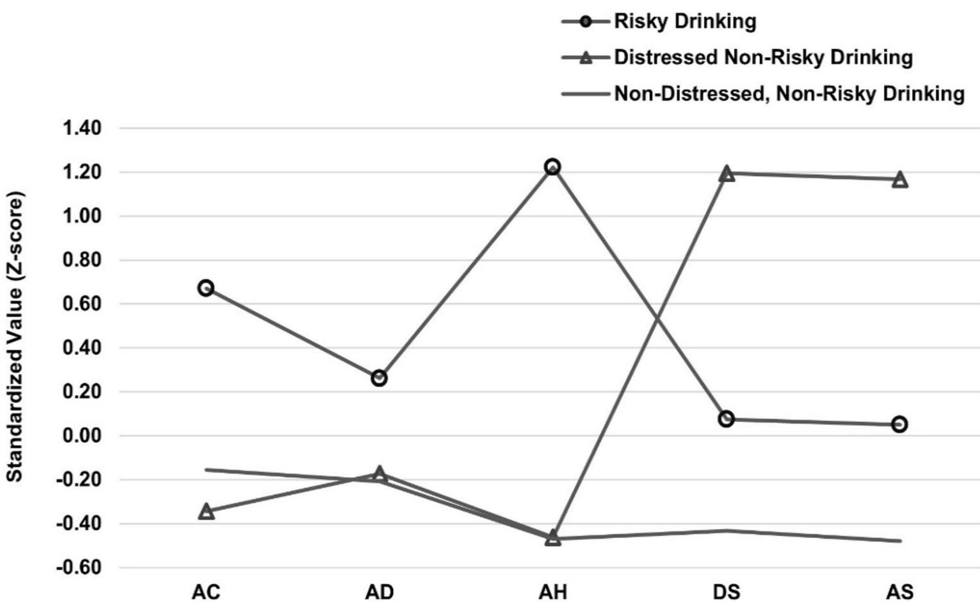

Figure 11. Identified three profiles of alcohol use and psychological symptoms during the pandemic (full measurement invariant model). AC = Alcohol consumption; AD = Alcohol dependence; AH: Alcohol-related harm; DS = Depressive symptoms; AS = Anxiety symptoms.

Table 17. Transition probabilities of latent profiles.

	Risky Drinking	Distressed Non-Risky Drinking	Non-Distressed, Non-Risky Drinking
		T1 (rows) by T3 (columns)	
Risky Drinking	66.8%	7.3%	25.9%
Distressed Non-Risky Drinking	14.4%	64.7%	20.9%
Non-Distressed, Non-Risky Drinking	5.9%	4.4%	89.6%

LTA modeling with background factors as covariates

Table 18 presents the direct effects of covariates on the profiles. Compared to *Non-Distressed, Non-Risky Drinking*, *Risky Drinking* at T1 was found to be more related to men, and lower education level. More experience of pandemic stressors and pre-pandemic psychological symptoms was observed in the profiles of *Risky Drinking* and *Distressed Non-Risky Drinking*. T3 profiles were associated with pre-pandemic depressive symptoms but not anxiety symptoms. Given the strong collinearity between the two symptoms, subsequent modeling included only depressive symptoms as a control variable.

Additionally, regarding the group-specific effects (with transitioning to Non-Distressed, Non-Risky Drinking as the reference), younger parents who were initially in the *Distressed Non-Risky Drinking* group at T1 were more likely to remain consistently over time (OR: 0.799, 95% CI: 0.725–0.881, $p < .001$). Pre-pandemic depressive symptoms increased the risk of transitioning to *Distressed Non-Risky Drinking* from *Non-Distressed, Non-Risky Drinking* (OR: 1.261, 95% CI: 1.142–1.393, $p < .001$) and *Risky Drinking* (OR: 1.186, 95% CI: 1.040–1.354, $p = .033$).

Table 18. Direct effects of covariates on the profiles at T1 and T3.

	Risky Drinking	Distressed Non-Risky Drinking	Non-Distressed, Non-Risky Drinking
		On T1 Profiles, OR (95% CI)	
Gender	2.389 (1.599–3.571)*	0.719 (0.357–1.448)	1
Education	0.664 (0.537–0.823)**	0.981 (0.738–1.303)	1
Age	0.974 (0.940–1.009)	0.960 (0.912–1.010)	1
Pandemic Stressors	1.120 (1.052–1.192)*	1.150 (1.067–1.239)*	
EPDS (Pre)	1.095 (1.034–1.158)*	1.190 (1.103–1.283)*	
SCL-90 (Pre)	1.115 (1.040–1.195)*	1.203 (1.103–1.312)*	
Alexithymia (TAS-20)	1.018 (1.000–1.036)	1.027 (1.006–1.049)*	1
DIF	1.097 (1.055–1.140)**	1.151 (1.101–1.203)**	1
DDF	1.036 (0.990–1.084)	1.071 (1.018–1.128)*	1
EOT	0.976 (0.938–1.015)	0.929 (0.894–0.966)*	1
		On T2 Profiles, OR (95% CI)	
Gender	1.928 (0.991–3.750)	0.563 (0.103–3.066)	1
Education	0.763 (0.544–1.071)	0.854 (0.465–1.567)	1
Age	1.096 (1.038–1.157)*	1.018 (0.917–1.130)	1
Pandemic Stressors	1.008 (0.911–1.116)	1.069 (0.889–1.285)	1
EPDS (Pre)	1.072 (0.986–1.166)	1.234 (1.101–1.382)*	
SCL-90 (Pre)	1.111 (1.012–1.220)	1.124 (0.966–1.309)	
Alexithymia (TAS-20)	1.070 (1.018–1.126)*	1.134 (1.031–1.081)*	1
DIF	1.066 (0.962–1.182)	1.151 (1.068–1.241)*	1
DDF	1.181 (1.046–1.334)*	1.193 (1.064–1.338)*	1
EOT	1.090 (0.998–1.191)	1.054 (0.951–1.168)	1

Gender: 1 = Women, 2 = Men; Education: 1 = Low, 2 = Mid, 3 = High. EPDS = Edinburgh Postnatal Depression Scale; SCL-90 = Symptom Checklist-90 (anxiety subscale). Pre = pre-pandemic. TAS-20: 20-item Toronto Alexithymia Scale. DIF = Difficulty identifying feelings; DDF = Difficulty describing feelings; EOT = Externally oriented thinking. OR = Odds ratios. $^{*}p < .05$, $^{**}p < .001$.

LTA modeling with alexithymic traits as covariates

After controlling for the abovementioned background factors, higher levels of alexithymia, specifically the dimensions DIF and DDF, consistently showed direct associations with both *Risky Drinking* and *Distressed Non-Risky Drinking* at both T1 and T2. Additionally, a lower level of EOT was linked to *Distressed Non-Risky Drinking* at T1 (**Table 18**).

Figure 12 displays the group-specific effects of alexithymia on the profile transition (with the transition to *Non-Distressed, Non-Risky Drinking* as the reference). A higher level of overall alexithymia increased the risk for *Risky Drinking* at T1 remaining consistently or transitioning into *Distressed Non-Risky Drinking* at T2. Although the *p* values did not reach statistical significance, the 95% CI exceeding one suggested a potential role of alexithymia in the transition from *Non-Distressed, Non-Risky Drinking* to *Distressed Non-Risky Drinking* to some extent.

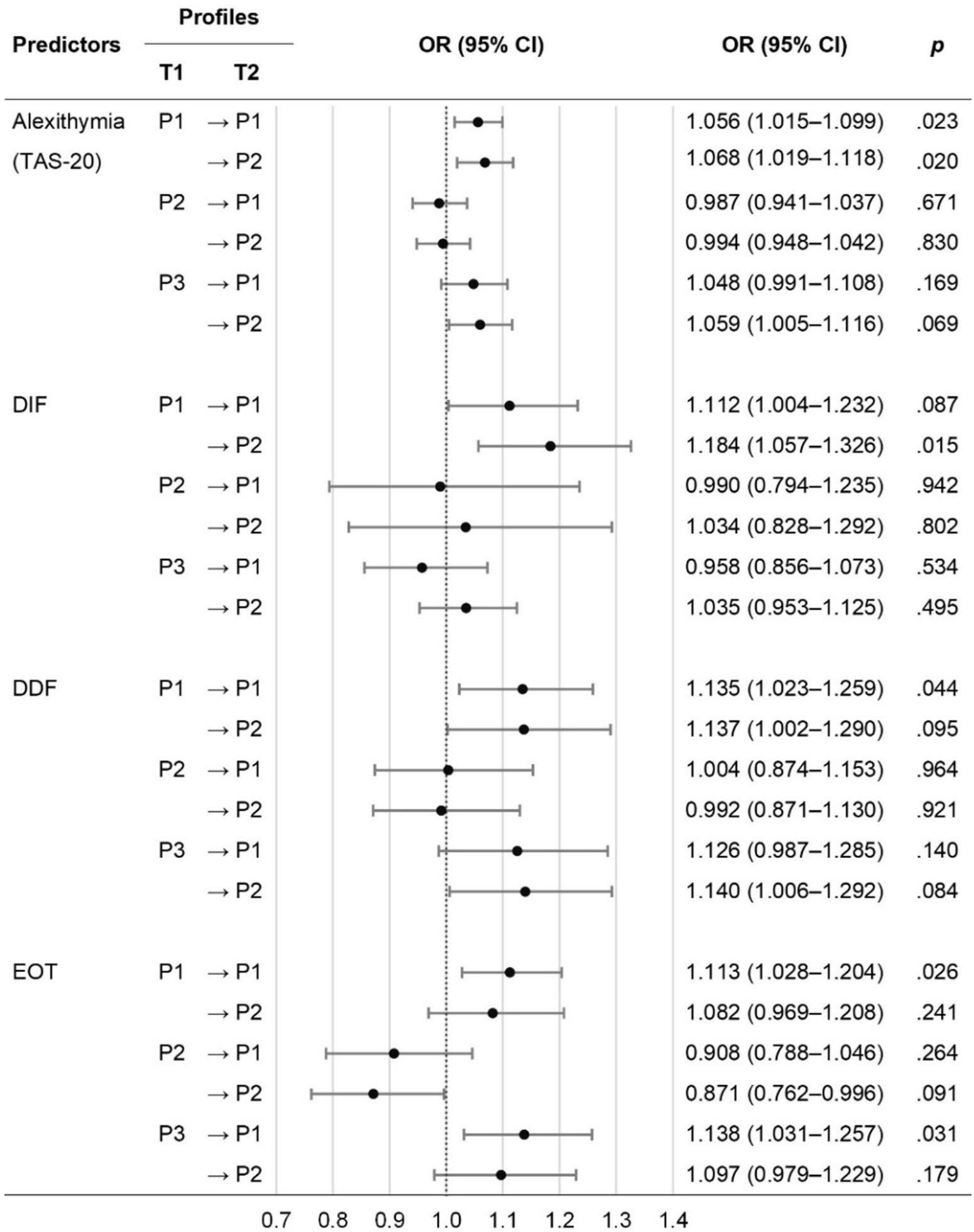

Figure 12. Odds ratios (OR) for alexithymic traits predicting the transitions in the profiles from T1 to T2. P1 = Risky Drinking; P2 = Distressed Non-Risky Drinking; P3 = Non-Distressed, Non-Risky Drinking. TAS-20 = 20-item Toronto Alexithymia Scale; DIF = Difficulty identifying feelings; DDF = Difficulty describing feelings; EOT = Externally oriented thinking. Reference: transition to P3 (Non-Distressed, Non-Risky Drinking) at T2.

In terms of the dimensions of alexithymic traits, higher DIF levels increased the risk for the transition from *Risky Drinking* at T1 into *Distressed Non-Risky Drinking* at T2. A higher level of DDF was significantly linked to the persistence of *Risky Drinking* in the same profile over time. Higher DDF also showed a trend of *Non-Distressed, Non-Risky Drinking* transitioning into *Distressed Non-Risky Drinking*. A higher level of EOT increased the risk for the persistence of *Risky Drinking* across T1 and T2. Moreover, *Non-Distressed, Non-Risky Drinking* individuals with higher EOT were more likely to transition into *Risky Drinking*. Again, a lower level of EOT exhibited a trend to be associated with sustained presence of *Distressed Non-Risky Drinking* over time (**Figure 12**).

6 Discussion

6.1 Main Findings

6.1.1 Sex-specific role of alexithymia in relationships between parental bonding and psychological symptoms (Study I)

Study I aimed to explore the relationships among childhood parental bonding, alexithymia, mental health, and potential sex differences. Using a moderated mediation model, alexithymia was found to mediate the indirect relationships between perceived dysfunctional parental bonding and depression/anxiety symptoms. Moreover, the association between alexithymia and dysfunctional paternal bonding (DysPB), but not dysfunctional maternal bonding (DysMB), was moderated by sex, which in turn moderated the indirect effects of dysfunctional paternal bonding on psychological symptoms via alexithymia. These findings highlight the sex-specific role of alexithymia in the relationship between dysfunctional paternal bonding and mental health.

While maternal bonding is often emphasized in previous studies (Abbaspour et al., 2021; Eun et al., 2018), our results, with both maternal and paternal bonding showing similar effects, highlight the importance of dysfunctional parenting styles from fathers as significant risk factors for mental illnesses. Similarly, there is evidence from large population samples showing that the quality of parenting received from both mothers and fathers during childhood is equally influential in shaping adult mental health (Kendler et al., 2000; Otowa et al., 2013).

Additionally, the study indicated an indirect effect of perceived dysfunctional parental bonding on later mental health, which may be mediated by alexithymia. For the first path of this indirect link, although previous research suggests that maternal bonding may have stronger impacts on alexithymia in non-clinical samples (Fukunishi et al., 1997, 1999; Karukivi et al., 2011), the current study revealed largely similar associations of DysMB and DysPB with alexithymia. For the second path, the significant association of alexithymia with depressive/anxiety symptoms was observed, consistent with previous research that has linked alexithymia to psychological symptoms (Honkalampi et al., 2000a; Marchesi et al., 2005). This finding supports a mechanism behind the mental health impacts of parental bonding, highlighting the role of insecure parent-child attachment perceived in childhood, decreased emotion identification and regulation (Brumariu et al., 2012; Colle & Del Giudice, 2011; Steele et al., 2008), and the difficulties among alexithymic individuals in linking affective states to specific memories or situations (Berking & Wupperman, 2012). Ultimately, these factors are likely to contribute to increased negative emotions and inadequate coping strategies, thus leading to mental health problems (Berking & Wupperman, 2012; Rieffe et al., 2010; Taylor et al., 1997b).

Furthermore, sex was found to moderate the relations between DysPB and alexithymia, in turn moderating the alexithymia-mediated relations between DysPB and psychological symptoms. Some previous studies have shown that perceived paternal bonding emerges as a stronger predictor for depression than maternal bonding in males (Howard, 1981; Shibata et al., 2016), and males with depression and anxiety disorders report higher levels of DysPB (Enns et al., 2002). In our study, similarly, despite females having more symptoms overall, DysPB had stronger indirect effects on psychological symptoms in males. There are potential explanations for this finding. On one hand, father-child attachment or interactions may involve greater emotional arousal (Brand & Klimes-Dougan, 2010; Brumariu, 2015; Deckert et al., 2020), supporting the link between paternal bonding and difficulties in identifying and expressing emotions. On the other hand, research indicated that males who have experienced early insecure attachment often employ avoidant coping strategies (Brumariu, 2015; Del Giudice, 2009), and alexithymia can be regarded as reflecting an avoidance-oriented coping style to some degree (Parker et al., 1998).

More specifically, paternal overprotection (PO) was the dominant factor contributing to the effects of paternal bonding on alexithymia, which, in turn, affected mental health. This finding is partly supported by previous research suggesting a relation between PO and alexithymia in males (Karukivi et al., 2011), as well as a study showing that males with a higher level of mental health problems reported more perceptions of PO (Shibata et al., 2016). Parental overprotection, characterized by harsh and hostile discipline, can inhibit children’s expression of feelings and ideas and impede their self-regulation capacity, potentially contributing to the development of alexithymia (Grolnick & Ryan, 1989; Joussemet et al., 2008). However, no significant associations of paternal overprotection with alexithymia or psychological symptoms were found in females. The reasons behind the differential effects in males and females are not fully understood. There is evidence showing a stronger impact of harsh parenting from fathers on sons compared to daughters (Chang et al., 2003), implying that males may be more vulnerable to the influence of paternal parenting styles.

6.1.2 Alexithymic traits in psychological responses to COVID-19 pandemic (Study II)

Inasmuch as alexithymic traits as a potential psychological predisposition for mental health problems in general populations in the context of the COVID-19 pandemic remain largely understudied, Study II investigated the role of alexithymia in the changes in depressive and anxiety symptoms related to the COVID-19 pandemic. The findings revealed that the impacts of pandemic events on psychological symptoms were mediated by perceived stress, with the mediation effect being conditional on the level of alexithymia.

Our study supported previous findings showing that unpredictable environmental factors can induce psychological stress levels (Han et al., 2021; Pickering, 2001; Yu et al., 2005). In turn, consistent with prior evidence (Dong et al., 2013; Spada et al., 2008), perceived stress was observed to contribute to the change in depressive and anxiety symptoms. Perceived stress is a measure of global stress levels that reflects an individual's personal evaluation of nonspecific stressful events or situations. Its impact on health-related outcomes can be more significant than the objective count of stressors experienced (Cohen et al., 1983; Lee, 2012), supporting the mediating role of perceived stress in the link between the pandemic events and psychological symptom changes. This result also aligns with the stress-vulnerability model, which posits that individuals may develop mental illnesses when stress surpasses their threshold (Zubin & Spring, 1977).

Although the presence of the relationship between pandemic events, perceived stress, and psychological responses was found to be independent of alexithymia, it was evident that the strength of this relationship was conditional on the level of alexithymia. When perceiving more stress, individuals with higher levels of alexithymia experience a greater increase in depressive and anxiety symptoms related to the COVID-19 pandemic. Given that alexithymia did not directly moderate the relationship between pandemic events and psychological symptoms but played a role in the indirect mental health effects of the pandemic events by interacting with perceived stress, it apparently had a closer relation to the appraisal of subjective feelings rather than objective stressors. This also echoes the stress-alexithymia hypothesis, suggesting that alexithymia hinders emotion regulation and coping, leading to prolonged stress responses (Martin & Pihl, 1985). According to existing empirical evidence, the association of alexithymia with stress-related disorders, including depression, anxiety, and cardiovascular disease, indeed underscores its role in cumulative stress over time (Honkalampi et al., 2000a; Marchesi et al., 2005; Tolmunen et al., 2010; Šago et al., 2020).

In terms of the dimensions of alexithymic traits, DIF and DDF played a dominant role in the moderation effect, supporting the attention-appraisal model that associates DIF and DDF with difficulties in emotion appraisal and suggests

EOT to be a lack of attention to emotions (Preece et al., 2017). Consistent with prior evidence, psychiatric symptoms are primarily associated with DIF and DDF, but not EOT (Grabe et al., 2004; Kajanoja et al., 2017a). However, EOT may have conflicting effects, possibly acting as a protective factor against psychological distress (Alkan Härtwig et al., 2014) but predisposing individuals to regulate emotions through problem behaviors such as substance use (Davydov et al., 2013; Kajanoja et al., 2018). The inconsistent effects between DIF/DDF and EOT are particularly relevant to the development of mental health problems in response to stressors. Therefore, for a more comprehensive understanding, future research could benefit from exploring the differential role of these dimensions in pandemic-related issues such as alcohol use and longitudinal symptom courses.

6.1.3 Alexithymic traits in longitudinal trajectories of depressive symptoms during the pandemic (Study III)

In Study III, we investigated the trajectories of depressive symptoms from the pre-pandemic to the pandemic period and identified four distinct latent groups of the symptom trajectories: "*Consistently low symptoms*", "*Steeply increasing symptoms*", "*Subclinical stable symptoms*", and "*Decreasing symptoms*". The majority of the participants (61.4%) experienced consistently low symptoms, in line with previous evidence showing that most individuals exhibited good mental health (Joshi et al., 2021; Pierce et al., 2021). Subsequently, we explored potential factors that may predispose the heterogeneity of depressive symptoms during the pandemic.

This study revealed that individuals with higher levels of alexithymic traits were more prone to experience subclinical levels of depressive symptoms rather than low levels during the pandemic. The finding is consistent with numerous existing studies that have reported associations between alexithymia and mental health problems (Frewen et al., 2008; Honkalampi et al., 2000a; Marchesi et al., 2005; Tolmunen et al., 2010; Šago et al., 2020). A previous study suggested that alexithymia may mediate the relations between the exposure to the pandemic and depression (Tang et al., 2020). However, we found that the individuals with high levels of alexithymia did not exhibit significant emotional responses to the pandemic. As suggested by Study II, it is plausible that alexithymia per se did not directly contribute to the pandemic-related depressive symptoms. Instead, it appears to be associated with increased symptom levels by interacting with additional factors, such as perceived stress.

Regarding the dimensions of alexithymia, DIF served as the dominant factor contributing to the relations between alexithymia and subclinical depressive symptoms. However, the individuals with a high level of DIF may also show decreasing symptoms. This phenomenon can be partially explained by the tendency observed in alexithymic individuals to display reduced attention to negative emotions (Alkan Härtwig et al., 2014). Nevertheless, the participants with a higher level of EOT were more likely to experience consistently low depressive symptoms compared to decreasing symptoms, suggesting that individuals with high symptom levels prior to the pandemic may experience an improvement in their symptoms if they have lower EOT levels.

To enrich the understanding of various factors in relation to the symptom trajectories, we additionally extended our research focus to include temperament and coping strategies. In terms of temperament traits, negative affect was related to subclinical depressive symptoms over time, while effortful control was associated with consistently low levels of depressive symptoms, supporting the protective nature of effortful control (Gulley et al., 2016; Hoffmann et al., 2019). Orienting sensitivity, albeit involving automatic attention to sensory events and perceptual sensitivity to slight intensity stimulation (Evans & Rothbart, 2007, 2008), was not identified as a risk factor for depression during the pandemic. This could be attributed to the reduced external and social stimulation caused by the pandemic, resulting in fewer stress-inducing situations. Constructive coping was identified as the sole factor associated with a reduced risk of increasing depressive symptoms during the pandemic, highlighting its protective role in maintaining mental health. This finding underscores the importance of incorporating techniques like positive reframing and acceptance, which have clinical evidence supporting their salient effectiveness in treating and preventing depression (Hayes et al., 2004; Vittengl et al., 2007; Williams et al., 2008).

The study revealed a significant association between overall alexithymia levels and avoidant coping, reflecting an avoidance mechanism (Panayiotou et al., 2015; Parker et al., 1998), rather than emotion-diverting coping that represents a more active style. The EOT dimension, positively correlating with avoidant coping and negatively correlating with emotion-diverting coping, played a dominant role in this nature. It is noteworthy that DIF was positively linked to emotion-diverting coping, suggesting a contrasting role in behavioral preferences when processing emotions compared to EOT. Notwithstanding these relations, no significant interactions were observed between alexithymia and other predictors including temperament and coping factors. In addition, there were no sex differences in the relationship between alexithymia and the trajectories of depressive symptoms. In this study, depressive symptoms were measured until December 2020, which does not capture the ongoing and evolving impacts of the pandemic. Moreover, the effects of specific personality traits and coping styles may vary depending on the stressor and the adaptability of each factor. For example, in some situations where immediate resolution or change is not possible, avoidance may be effective for managing short-term uncontrollable stressors (Taylor & Stanton, 2007). Individuals with alexithymia may somewhat experience benefits, potentially due to their limited capacity to attend to psychological distress (Alkan Härtwig et al., 2014; Davydov, 2017; Wiebe et al., 2017). Hence, further longitudinal research is needed to enhance the understanding of the long-term mental health development and relevant factors in the context of the pandemic.

6.1.4 Alexithymic traits in longitudinal transitions in patterns of alcohol use and psychological symptoms during pandemic (Study IV)

In Study IV, we identified three distinct profiles of alcohol use and psychological symptoms, namely *Risky Drinking*, *Distressed Non-Risky Drinking*, and *Non-Distressed, Non-Risky Drinking*, at two time points and their transitions across 10 months during the pandemic. The finding highlights interesting cross-sectional patterns regarding the relationship between alcohol use and psychological symptoms and their dynamic nature in the context of the pandemic. Furthermore, this study revealed the differential role of alexithymia and its dimensions in contributing to the development of these profiles.

At cross-sectional level, we did not observe the co-occurrence of problematic drinking and high levels of psychological symptoms, which is contrary to some previous research findings (Brière et al., 2014; Falk et al., 2008). This result may be attributed to the characteristics of our study sample, which primarily consisted of highly educated parents with minor mental health problems. It is worth noting that high prevalence of alcohol use does not necessarily coincide with the presence of depressive or anxiety symptoms (de Sousa et al., 2017; Piwoński et al., 2010; Puddephatt et al., 2022, 2021). Longitudinally, a small proportion of transitions from *Non-Distressed, Non-Risky Drinking* to other profiles over time may also be explained by the sample characteristics. The two-way transitions between *Risky Drinking* and *Distressed Non-Risky Drinking* were observed. Pre-pandemic depressive symptoms were associated with the transition from *Risky Drinking* to *Distressed Non-Risky Drinking*. On the one hand, psychological distress may serve as a motivator for individuals to reduce or cease alcohol consumption (Sarich et al., 2019). On the other hand, abstainers may even experience more psychological symptoms (Alati et al., 2004; Rodgers et al., 2000; Skogen et al., 2011). Additionally, mentally distressed individuals may turn to alcohol to alleviate their symptoms (Khantzian, 1997; Rolland et al., 2020), resulting in 14.4% *Distressed Non-Risky Drinking* transitioning to *Risky Drinking* in our study.

In line with many existing studies (Devine et al., 1999; Honkalampi et al., 2000a; Thorberg et al., 2009), the current study indicated significant associations of alexithymia with *Risky Drinking* and *Distressed Non-Risky Drinking* at both two time points. Underlying mechanisms may involve HPA axis dysfunction (Alkan Härtwig et al., 2013). While the impact of alexithymia on mental health development among healthy populations was relatively weak, alexithymia emerged as a significant predictor for the persistence of risky alcohol consumption or the development of psychological problems even after abstaining from alcohol. The finding highlights the role of alexithymia, particularly among individuals with existing alcohol-related problems, in the ongoing presence of alcohol use and the subsequent psychological symptoms. This is similar to our observation in Study II, which suggested that alexithymia contributed to the change in mental health through its interaction with perceived stress, rather than through direct effects on its own.

Supporting previous findings that specific dimensions of alexithymic traits played distinct roles in the development of mental health problems and alcohol use (Alkan Härtwig et al., 2014; Kajanoja et al., 2017a, 2018), our study indicated that in individuals with *Risky Drinking*, DIF and DDF were predisposing factors for experiencing psychological distress or persisting with alcohol use. DIF and DDF are proposed as representing the emotional component of alexithymia and have been linked to maladaptive defense style and social interaction difficulties (Taurino et al., 2021; Vanheule et al., 2007). However, the absence of the association between EOT and transitions to *Distressed Non-Risky Drinking* from other profiles suggested that EOT did not contribute to the deterioration of psychological symptoms.

In contrast, EOT was observed to act as a risk factor for increased alcohol use among individuals with *Non-Distressed, Non-Risky Drinking*, while also contributing to the persistence of risky alcohol use. EOT reflects a cognitive style characterized by pragmatic thinking and a lack of subjective significance of inner feelings (Müller et al., 2003), and it has been linked to field dependence, which refers to a tendency to rely on information from the outer world, as well as a lack of social self-confidence in individuals with alcohol-related problems (Brion et al., 2017; Riadh et al., 2019). Moreover, impaired executive functions may contribute to the role of EOT in problematic alcohol use (Brion et al., 2017; Riadh et al., 2019). Interestingly, individuals with *Distressed Non-Risky Drinking* displayed lower levels of EOT compared to those with *Non-Distressed, Non-Risky Drinking* at T1. The findings echo the notion that EOT may have protective effects on emotions but lead individuals to poor coping skills, such as resorting to substance use as a means of managing stress (Alkan Härtwig et al., 2014; Davydov, 2017; Wiebe et al., 2017). Except for the role of EOT showing a trend, alexithymic traits had minor influence on the change in *Distressed Non-Risky Drinking*. This may be attributed to the individuals with *Distressed Non-Risky Drinking* at T1 already having high levels of alexithymia, where even with a relatively lower level of alexithymia within this profile group, it can be still high, resulting in a limited impact on reducing psychological symptoms.

6.2 Strengths, and Limitations

Study I benefits from a relatively large cohort sample drawn from a general population of parents, providing a good opportunity to gather sound evidence about the effect of alexithymia on mental health outcomes related to parenting factors, with a particular focus on examining sex differences. Additionally, the major strength of Studies II–IV was the employment of longitudinal methodology, which allowed for a prospective follow-up of mental health issues including depressive and anxiety symptoms, as well as alcohol use during the COVID-19 pandemic. The inclusion of multiple time points in the assessment and the use of different modeling techniques enable us to gain comprehensive insights from several perspectives into the actual role of alexithymic traits in the development of mental health problems among parents in a general population, specifically in the context of the pandemic.

Nevertheless, there are several limitations that should be acknowledged. Firstly, the participants exhibited a relatively low level of alexithymia compared to prior research involving general populations (Franz et al., 2008; Mattila et al., 2009). This may be ascribed to selection bias, as individuals participating in the birth cohort study are apparently engaged in intimate relationships and experience fewer interpersonal problems. Moreover, the predominance of female participants, who typically show less alexithymia compared to males, may contribute to the observed low alexithymia levels in this study. Secondly, as a related point, another limitation is the relatively high levels of education and socioeconomic status in the participants. In our study, withdrawals from follow-ups were more common among males and those with lower education levels, consistent with attrition analyses reported in the initial cohort study (Karlsson et al., 2018). This apparently limits the generalizability of the findings, warranting caution in interpretation. However, to ensure effective and ethical use of the cohort data while maintaining statistical power and analytical parsimony, we chose not to divide the samples based on their characteristics. Additionally, the remarkable role of alexithymia observed in a "low-risk" and healthy population plausibly implies its applicability to "higher-risk" populations. Thirdly, a potential limitation to be acknowledged is the reliance on self-report questionnaires for measuring alexithymia (e.g., discussion in section **2.2**). It is reasonable to speculate that individuals with difficulties in verbal and emotional capacity may struggle to accurately perceive and articulate their experiences, potentially resulting in less precise self-reports (Lane et al., 1997).

Nonetheless, the TAS-20 has consistently shown high psychometric quality across diverse populations and cultures, establishing it as the most widely used instrument for assessing alexithymic traits (Bagby et al., 1994b; Joukamaa et al., 2001; Taylor et al., 2003). Research comparing the TAS-20 with observer-rated measures of alexithymia suggests that in most research situation, using the TAS-20 alone can be sufficient for evaluating alexithymia (Taylor et al., 2000). In addition, while some research argues for an overlap between alexithymia measured by the TAS-20 and current psychological distress (Preece et al., 2020b), there is evidence supporting their separate and independent nature (Marchesi et al., 2000; Parker et al., 1991).

Regarding Study I, an additional limitation is the potential bias in the retrospective assessment of parental bonding. However, evidence has indicated the stability of PBI over a span of 20 years, remaining unaffected by mood fluctuations (Murphy et al., 2010). In addition, some researchers raise concerns about the validity of establishing actual mediation effects solely based on cross-sectional data (Hayes & Rockwood, 2017; Maxwell & Cole, 2007; Nguyen et al., 2020). Nevertheless, given the foundations rooted in personality–psychopathology theories (Gramstad et al., 2013; Jorm et al., 2000; Kotov et al., 2010, 2007) and the well-documented nature of alexithymia as a personality trait (Hiirola et al., 2017; Karukivi et al., 2014a; Tolmunen et al., 2011), the model-based findings in our study provide valuable insights into the potential sex-specific effect of alexithymia on the psychological outcomes related to perceived parental bonding during childhood. Regardless, longitudinal research to clarify the sex-specific role of alexithymia in causal processes is strongly recommended. Similarly, in Study II, although psychological symptoms were measured at two time points, the mediation effect was not fully longitudinal due to the concurrent measurement of perceived stress and follow-up symptoms. This suggests the possibility that psychological distress may also influence perceived stress levels, which should be taken into consideration while interpreting the findings. However, this direction was not moderated by alexithymia, supporting our theoretical hypothesis of moderated mediation.

With regard to Studies II–IV, the interval between the measurement of alexithymia and the indicators for modeling differed across individuals. However, this is not a major issue given the high stability of alexithymia even over 11 years in adult general population (Hiirola et al., 2017; Karukivi et al., 2014a; Tolmunen et al., 2011). In Studies II and III, the evaluation of negative life events did not encompass the full duration between the pre-pandemic measurement (T0) and the first follow-up time point during the pandemic (T1). Therefore, we need to keep in mind that there can be factors other than pandemic events potentially interacting with mental health changes during this period. Additionally, due to varying timeframes of psychological symptom assessment between 2014 and 2019, the interval between the T0 and T1 varied across individuals. Nonetheless, no significant associations were observed between this discrepancy and the levels or changes in psychological symptoms. Therefore, in Study III, an average interval was used for modeling trajectories. Related to this, the use of LGMM assumes continuous development over time, which may not fully capture nonlinear trajectories. However, it was justified by similar trajectory patterns and better model fit compared to alternative models (as described in section **4.5.3**). Regardless, it is recommended to compare alternative models in future research to obtain a more comprehensive understanding of symptom development and the potential predictors involved. An additional limitation in Study III is that the sample size of the latent group "*Steeply increasing symptoms*", which reflected the most clinically meaningful symptom changes, was relatively small. This may be due to the participant drop-outs, within-group heterogeneity, and the study's focus on the sample composed of a relatively healthy general population. In terms of Study IV, the measurement timeframes for measuring alcohol use (past year), depressive symptoms (past week), and anxiety symptoms (past month) lack consistency. Nonetheless, the consistent patterns identified over time point to the fact that this would not significantly impact the findings. In addition, these observed profiles and transitions may not be generalizable to other situations, as they were largely influenced by social factors such as restrictive policies impacting alcohol availability, which can differ over time during the pandemic.

7 Conclusions

7.1 General Remarks

The mediating role of alexithymia observed in Study I highlights the importance of both perceived dysfunctional parental bonding during childhood and alexithymia for depressive and anxiety symptoms. Additionally, the study revealed sex differences, with males showing a stronger effect of dysfunctional paternal bonding on alexithymia and psychological symptoms, which is somewhat unexpected, as females are typically associated with higher levels of psychological distress. Integrating our findings from Studies II–IV that explored mental health problems in the context of the COVID-19 pandemic, the majority of participants did not exhibit significant mental health responses to the pandemic, in line with most prior research with the general population. The significance of alexithymia as a prominent standalone predictor appears to be limited, especially concerning the changes in mental health related to the pandemic. Nonetheless, the effect of alexithymia becomes notably more pronounced under some specific situations, such as perceiving a high level of stress (Study II) and engaging in potentially risky alcohol use (Study IV). Although our finding suggests sex differences in the link between parental bonding and alexithymia, sex was not found to play a role in the relationship between alexithymia and mental health problems, both before and during the pandemic.

While considering the dimensions of alexithymic traits, we observed that difficulty identifying (DIF) and describing feelings (DDF) were more likely to be associated with the development of psychological distress, and externally oriented thinking (EOT) tended to predispose alcohol use. Somewhat unexpectedly, Study IV revealed that high levels of alcohol consumption did not co-occur with psychological distress during the pandemic. This can partially account for the result of Study III that demonstrated a high level of EOT in the consistently low symptom group. Even in Study IV, the negative relation between EOT and psychological distress appeared to imply a protective nature of EOT from psychological symptoms. However, Study III indicated that individuals with pre-existing psychological distress may benefit from a lower level of EOT. These are not paradoxical, as in Study III, the participants who experienced a decrease in depressive symptoms remained at higher symptom levels compared to the average and were still likely to be identified as psychologically distressed individuals in Study IV.

7.2 Implications

This study sheds light on the nature of alexithymia, which remains not fully understood. On one hand, the observed finding provides evidence for the theory about the development of alexithymia in relation to parenting factors. On the other hand, along with illuminating the main point of whether and how alexithymia plays a role in mental health issues, we also attempt to dissect the findings and provide new insights into the meaning of its multidimensional features.

Specifically, Study I suggests an explanation for how perceived parental bonding during childhood influences mental health, enhancing the limited understanding of sex-specific role of alexithymia in mental health problems related to parental bonding, especially paternal bonding, which has been less-explored thus far. In addition, as part of this finding, although parental bonding often reflects an individual's subject interpretation of childhood experiences with their parents, the significant association between alexithymia and perceived parental bonding to some extent supports the notion that the parent-child relationship is a contributing factor to the etiology of alexithymia. As indicated in Study II, even among the participants in the study who represent a relatively healthy population with limited mental health problems, individuals with alexithymic traits may be subjected to prolonged stressors, leading to a steady exacerbation of negative psychological outcomes. According to Study III, despite individuals with a high level of alexithymia displaying stable mental status during the pandemic, alexithymia was evidently associated with the overall high levels of psychological symptoms from the pre-pandemic to pandemic period. It is therefore plausible to speculate that alexithymia indeed predisposes individuals to mental health problems, likely over the long term. Additionally, as discussed in section 6.1.3, the differential links between coping factors and alexithymia, especially regarding its dimensions, provide an insight into the underlying nature of alexithymia. By integrating these understandings with Study IV, we propose that people with high DIF levels may somehow actively engage in diverse distractive approaches to unload psychological distress; however, on one hand, those with a higher level of EOT are more passive and tend to avoid directly dealing with stressors, and on the other hand, instead, they seek to experience euphoria through more facile and extreme means, such as substance use.

Consequently, this study underscores the significance of taking alexithymic traits into account when providing mental health advice and services for the general population. The findings hold relevant implications for identifying vulnerable individuals under stressful situations like exposure to a pandemic. For example, individuals exhibiting specific characteristics, such as elevated stress perception and present or pre-existing alcohol use problems, should be mindful of their alexithymic traits and consider their potential implications. Moreover, the studies using longitudinal data showed that mental health could potentially improve with a reduction in any of the dimensions of alexithymia, particularly emphasizing DIF, which is more relevant to emotional challenges, and EOT, which deserves attention when addressing problems related to cognitive or behavioral styles. Therefore, our findings also suggest clinical implications for tailoring preventive and psychotherapeutic interventions.

Based on current knowledge and the limitations inherent in this study, there are several potential directions for further studies. For instance, investigating alexithymia in relation to environmental factors with longitudinal settings spanning a broader range of period, from childhood to adulthood, may provide valuable insights into its developmental trajectory over time and its interaction with life events. Examining the relationship between alexithymia and various mental and physical health issues while considering additional contributors could enhance our understanding of its contributing role. In addition, evidence from genetic, epigenetic, and neurobiological research can provide essential clues about the biological mechanisms driving alexithymic traits. Furthermore, conducting cross-cultural research can be beneficial in uncovering cultural variations and contextual factors that influence the experience and manifestation of alexithymia, developing more profound knowledge of its nature.

Overall, our study contributes to the growing body of research on the impact of emotional processing difficulties on mental health outcomes, specifically related to early perceptions of dysfunctional parental bonding and recent experiences of the COVID-19 pandemic, suggesting the significance of alexithymia in individuals' responses to challenging and stressful circumstances. Given the complex interplays of factors influencing mental health, more research with rigorous designs and comprehensive methodologies is clearly warranted in the future to delve deeper into the multifaceted and intricate nature, causes, and effects of alexithymia, thus developing promising interventions and ultimately aiming to support individuals' well-being.

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