CATARINA ISABEL COVA FERNANDES LUÍS

INHIBITED TEMPERAMENT AND SOCIAL ANXIETY IN CHILDHOOD

A Multimethod and Longitudinal Study

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DOUTORAMENTO EM PSICOLOGIA

Trabalho efetuado sob a orientação de:

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Declaração de autoria de trabalho

Declaro ser a autora deste trabalho, que é original e inédito. Autores e trabalhos consultados estão devidamente citados no texto e constam da listagem de referências incluída.

Catarina Isabel Cova Fernandes Luís

À minha Julinha

Perseverança é a força silenciosa que nos impulsiona a continuar a seguir os nossos sonhos, mesmo quando o caminho é incerto, lembrando-nos de que a única forma de falhar é desistir!

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Resumo

Crianças com temperamento inibido tendem a apresentar reações de inibição, vergonha, preocupação e retraimento perante pessoas ou situações desconhecidas, características estas que parecem demonstrar ser estáveis ao longo do tempo. Este tipo temperamento está frequentemente associado a um risco acrescido de desenvolver perturbações emocionais na adolescência e na idade adulta, como a ansiedade social, uma condição que pode ter consequências severas no dia-a-dia dos sujeitos. Dada a prevalência significativa na infância e o impacto potencial a longo prazo, a avaliação precoce do temperamento inibido revela-se essencial. Para o efeito, recorrem-se frequentemente a medidas de relato parental, relato de educadores e, de forma menos comum, a medidas de observação. A abordagem multimétodo é frequentemente privilegiada, uma vez que proporciona uma avaliação mais completa e descritiva do funcionamento da criança em diferentes contextos. Do nosso conhecimento, são escassas as medidas para avaliar o temperamento inibido na infância adaptadas à população portuguesa. Neste contexto, os nossos dois primeiros estudos (Capítulo 2) visaram validar duas medidas de temperamento inibido em crianças: uma medida de observação (Estudo 1) e uma medida de relato parental e de educadores (Estudo 2).

No primeiro estudo, aplicámos uma bateria de observação em conjunto com um questionário de relato parental a crianças entre os três e os nove anos. Os resultados demonstraram que a medida observacional tem uma convergência moderada com o instrumento de relato parental, revelando-se uma medida válida que pode ser integrada numa abordagem multimétodo para avaliar o temperamento inibido em crianças portuguesas.

No segundo estudo, foi aplicado um instrumento de relato parental e de educadores de temperamento inibido, a ser validado, juntamente com uma subescala de avaliação do temperamento inibido já existente e um instrumento de ansiedade social para o estudo da sua validade. Os resultados indicaram que a medida de relato (parental/educador) é válida e fiável para avaliar o temperamento inibido em crianças portuguesas, evidenciando uma boa concordância entre pais e educadores, uma robusta validade convergente e sensibilidade para discriminar os diversos contextos em que o temperamento inibido se manifesta.

Com duas medidas válidas e adequadas para avaliar o temperamento inibido em crianças, o nosso próximo objetivo foi investigar a trajetória do temperamento inibido e o seu papel na etiologia e manutenção da ansiedade social. Embora o temperamento inibido seja amplamente reconhecido como o principal fator predisponente para o desenvolvimento de ansiedade social, nem todas as crianças com temperamento inibido acabam por manifestar ansiedade. Além disso, nem todos os indivíduos que desenvolvem ansiedade social possuem ou apresentam histórico de temperamento inibido. Assim, compreender os fatores que influenciam a estabilidade e evolução do temperamento inibido, bem como a sua interação com variáveis cognitivas e emocionais, é crucial para desvendar o percurso patológico e intervir precocemente.

Entre os fatores que podem influenciar o desenvolvimento do temperamento inibido e, consequentemente, da ansiedade social durante a infância, destacam-se as características parentais, que podem exercer influência através de vias biológicas ou por modelagem comportamental. Destacam-se, neste contexto, a própria ansiedade social dos pais e os estilos parentais, como a superproteção. Desta forma, *no terceiro estudo* desta tese (Capítulo 3), investigámos como as características parentais e o temperamento inibido interagem para contribuir para a manifestação de sintomas de ansiedade social. Foram avaliados pais e mães de crianças em idade pré-escolar, que responderam a um conjunto de medidas de autorrelato destinadas a avaliar a superproteção, a ansiedade social dos pais, e o temperamento inibido e ansiedade social das crianças.

Os resultados revelaram uma associação direta, moderada e positiva, entre o temperamento inibido e a ansiedade social das crianças, independentemente do género da criança ou da influência parental. Relativamente às características parentais, verificámos que a ansiedade social das mães influenciava diretamente a ansiedade social das crianças, e que a superproteção atuava como mediadora do efeito da ansiedade social de ambos os pais sobre a ansiedade social das crianças. Contudo, o papel mediador da superproteção parece variar de acordo com o género dos pais e das crianças. Em suma, estes resultados destacam não apenas o papel central do temperamento inibido, mas também a influência das características dos progenitores — tanto pais como mães — como uma via alternativa e relevante na etiologia da ansiedade social nas crianças.

Para além das características parentais, a literatura tem destacado fatores individuais da criança como potenciais moderadores ou mediadores da relação entre o temperamento inibido e a ansiedade social. Entre esses fatores, incluem-se o viés atencional para a ameaça e a maturação cognitiva — refletida no controlo cognitivo e na flexibilidade cognitiva —, assim como a capacidade de regulação emocional. Estes processos desempenham um papel importante no desenvolvimento do temperamento inibido e podem hipoteticamente aumentar ou reduzir a vulnerabilidade à ansiedade.

Estudos anteriores indicam que crianças com temperamento inibido tendem a apresentar um viés atencional para a ameaça, o que pode aumentar a sua vulnerabilidade ao desenvolvimento de ansiedade. Adicionalmente, quando o temperamento inibido é combinado com um elevado controlo inibitório, poderá atuar como um fator de risco para o desenvolvimento de ansiedade social. Pelo contrário, a flexibilidade cognitiva e o recurso a estratégias ativas de regulação emocional têm sido apontadas como fatores de proteção. Contudo, a utilização de metodologias inadequadas para a faixa etária infantil e o foco em estudos transversais têm frequentemente resultado em conclusões inconsistentes e pouco consensuais na literatura.

Deste modo, o objetivo do último e *quarto estudo* (Capítulo 4) foi avaliar, através de uma metodologia longitudinal, o desenvolvimento do temperamento inibido e a relação deste com a ansiedade social ao longo de três anos, analisando o impacto de caraterísticas parentais, variáveis cognitivas e emocionais nesta trajetória. Para o efeito, crianças entre os três e os nove anos de idade foram avaliadas em três momentos distintos ao longo de três anos, com foco na ansiedade social e superproteção dos pais e no temperamento inibido, ansiedade social, controlo inibitório, flexibilidade cognitiva, viés atencional e regulação emocional das crianças, com recurso a medidas de relato parental, tarefas comportamentais e técnicas de rastreamento ocular. Os resultados indicaram que além dos fatores parentais como a ansiedade social e o temperamento inibido, as funções cognitivas e emocionais foram identificadas como essenciais na compreensão da trajetória do temperamento inibido. Melhores níveis de regulação emocional, bem como de controlo inibitório e flexibilidade cognitiva, e ainda um viés atencional direcionado para estímulos positivos demonstraram estar associados a uma diminuição do temperamento inibido ao longo do tempo, enquanto um viés atencional direcionado para estímulos não sociais parece estar associado a uma diminuição mais lenta do temperamento inibido.

A relação entre o temperamento inibido e a ansiedade social foi confirmada através de uma análise *cross-lagged*. O temperamento inibido demonstrou uma influência causal forte sobre a ansiedade social que foi particularmente acentuada em crianças com

um viés atencional para estímulos negativos e não-sociais, sugerindo que o viés atencional amplifica a conexão entre o temperamento inibido e a ansiedade social. As análises de moderação moderada mostraram que as funções executivas, especificamente o controlo inibitório e a flexibilidade cognitiva, moderaram a relação entre o temperamento inibido e a ansiedade social, particularmente na presença de viés atencional. As crianças com maior controlo inibitório e maior flexibilidade cognitiva apresentaram uma relação mais fraca entre o temperamento inibido e a ansiedade social, o que indica que estas funções executivas ajudam a mitigar o impacto do viés atencional no desenvolvimento da ansiedade social. Crianças com maior latência para fixar o olhar em rostos zangados e com menor controlo inibitório mostraram uma maior propensão para desenvolver ansiedade social. Por outro lado, as crianças com maior flexibilidade cognitiva mostraram uma relação mais fraca entre o temperamento inibido e a ansiedade social, mesmo na presença de vieses atencionais prejudiciais, sugerindo que a flexibilidade cognitiva pode ajudar a gerir os vieses atencionais de forma mais adaptativa. Estes resultados oferecem uma compreensão significativa da trajetória desenvolvimental do temperamento inibido e o seu papel na predisposição das crianças para a ansiedade social e enfatizam a importância de considerar múltiplos fatores na avaliação e intervenção no temperamento inibido e na ansiedade social.

Em suma, os estudos incluídos nesta tese apresentam evidências de que: *1)* a abordagem multimétodo parece ser a mais fiável na avaliação do temperamento inibido infantil; *2)* o BIQ e o Lab-TAB parecem ser medidas válidas e fiáveis para a avaliação do temperamento inibido em crianças portuguesas; *3)* a ansiedade social e a superproteção parental têm uma influência significativa sobre a ansiedade social das crianças que não depende do temperamento inibido, mas do género da criança e dos pais; e *4)* o viés atencional, o controlo inibitório e a flexibilidade cognitiva parecem intervir como moderadores e a regulação emocional como mediador cujo impacto parece ser significativo no desenvolvimento do temperamento inibido para ansiedade social.

Palavras-chave: Temperamento inibido, Ansiedade social, Avaliação Multimétodo, longitudinal, Infância

Abstract

Behavioral Inhibition (BI) is characterized by inhibition, shyness, worry, and withdrawal in unfamiliar situations. It shows moderate stability over time and is linked to an increased risk of emotional disorders, especially social anxiety (SA), impacting children's socioemotional development.

Given its prevalence and potential consequences, early assessment of BI is crucial, often involving parent reports, educator reports, and observational methods. However, there are few validated measures specifically adapted for the Portuguese population, highlighting the need for culturally appropriate assessment tools. Thus, the first two studies of this thesis aimed to validate two BI measures in Portuguese children: the first study found that the observational measure moderately correlated with parent reports, supporting its validity as part of a multi-method approach. The second study validated a parent/educator report measure of BI, confirming its reliability and ability to assess BI in various contexts.

Given these validated tools, the next objective was to explore BI's role in the development of SA. Although BI is a key predictor of SA, not all children with BI develop SA. Thus, understanding factors affecting BI's trajectory is critical. Results of the third study showed a moderate, direct link between BI and SA, and maternal SA directly influenced child SA, with overprotection acting as a mediator, varying based on the gender of parents and children. The final study used a longitudinal design to explore how cognitive and emotional variables influence the trajectories of BI and the manifestation of SA. Results indicated that attentional bias, emotional regulation, inhibitory control, and cognitive flexibility played critical roles in shaping BI's trajectory. BI strongly predicted SA, especially in children with attentional biases towards negative stimuli, highlighting the moderating role of executive functions and emotional regulation in mitigating the BI-SA relationship. The findings underscore the importance of considering multiple factors in assessing and intervening in BI and SA.

Keywords: behavioral inhibition, social anxiety, multimethod assessment, longitudinal, childhood

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LIST OF ABBREVIATIONS

AMBI – Adult Measure of Behavioral Inhibition

BIQ – Behavioral Inhibition Questionnaire

BI – Behavioral Inhibition

CBQ – Children's Behavior Questionnaire

ERC – Emotional Regulation Checklist

Lab-TAB – Laboratory Temperament Assessment Battery

PAS – Preschool Anxiety Scale

POM – Parental Overprotection Measure

SA – Social Anxiety

SIPAAS – Social Interaction and Performance Anxiety and Avoidance Scale

TABC-R - Temperament Assessment Battery for Children – Revised

CHAPTER ONE

GENERAL INTRODUCTION

Social Anxiety (SA) in children is characterized by a pronounced fear of social situations, such as meeting new people, engaging in conversations, speaking in front of the class, asking questions to teachers, performing before an audience, requesting assistance in shops or at school, and attending parties or social events (Beidel & Turner, 2007). In some cases, this SA can intensify and become chronic, leading to a diagnosis of Social Anxiety Disorder (SAD), a more severe and persistent form of SA.

Recent studies indicate that the prevalence of Social Anxiety Disorder (SAD) in children was estimated to be 4.7% in community samples. Among adolescents and youth, the prevalence is even higher, ranging between 8.3% and 17%, reflecting a progressive and an increased vulnerability to SAD during this developmental stage (Salari et al., 2024).

In clinical settings, the prevalence of SAD ranges from 29% to 40%, making it one of the most prevalent disorders among children and adolescents. This high prevalence underscores the significant impact of SAD on various life domains and its potential for long-term implications for social adjustment (Hofmann et al., 2012; Polanczyk et al., 2015). SAD manifests along a severity continuum, with many individuals experiencing high levels of symptoms without meeting the criteria for a clinical diagnosis (Spence & Rapee, 2016).

SAD often begins in early adolescence, around age 11 (Beesdo-Baum et al., 2012), with a median age of onset between 8 and 13 years (Solmi et al., 2022). However, recent research shows that SAD symptoms can emerge in younger children, sometimes as early as ages 3 to 7 (Milic et al., 2020). SAD is also more prevalent among females (American Psychiatric Association, 2013). During adolescence, the lifetime prevalence of SAD is estimated at 7% for boys and 11.2% for girls (Merikangas et al., 2010). In addition to the high incidence and the earliest age of onset compared to other major mental health disorders, if left untreated, SA persist into adulthood resulting in significant personal and social costs (Erskine et al., 2015). This underscores the importance of better understanding this disorder and intervening early.

SAD is comorbid with a significant number of mental health problems, particularly with additional anxiety disorder (e.g., generalized anxiety disorder, panic disorder), mood disorder (e.g., depression and dysthymia), behavior disorder (e.g. conduct disorder) and with substance use (Beesdo-Baum et al., 2012; Burstein et al., 2011). However, it remains uncertain whether SAD is a cause or a consequence of these comorbid issues, or if the observed patterns of comorbidity are indicative of underlying shared causal factors (Spence & Rapee, 2016).

Despite effective treatments for child anxiety (James et al., 2013), research into the underlying factors of its development is still limited. Although there is no single theory that fully explains SAD (Beidel et al., 2019), understanding risk factors, especially during preschool years before the typical age of onset, can provide valuable insights for preventing anxiety.

Updating their 2004 etiological model of SAD (Rapee & Spence, 2004), Spence and Rapee (2016) developed an evidence-based model to explain the aetiology of Social Anxiety Disorder. This model highlights both proximal and distal risk factors that contribute to the development of SAD. According to the model, there is an interaction between environmental factors and intrinsic elements (distal risk factors) that increase the risk of developing SAD. For instance, children with biological or genetic predisposition to SA or with behavioral inhibition (BI) temperament have higher risk to SA development if also experience environmental risk factors such an abusive family situation and negative peer or parental influence. These distal risk factors are suggested to influence the development of social skills, emotional regulation skills and interpersonal problem solving (proximal risk factors), leading to the development of maladaptive schema and beliefs. These maladaptive schemas relating to the self and others can result in various cognitive distortions and biases—such as biases in expectations, evaluations, attention, and interpretations—during and after challenging social situations.

In turn, these cognitive distortions lead to somatic, behavioral, and emotional responses to anxiety. For example, an attentional bias exacerbated for social situations and expectations that the social performance will be negatively assessed by others, contributes to an experience of anxiety. Even if a child’s social performance is less competent than peers, a tendency to self-assess even more negatively leads to higher levels of anxiety. In these cases, the tendency is to avoid social situations, a behavioral manifestation of anxiety, which in turn reduces the opportunities to acquire social skills and develop positive relationships with peers. In this way, a vicious cycle is established that contributes to increasing levels of SA. Finally, according to the authors, to consider a SAD, it is necessary to attend to the degree of impairment in life, considering variables such as life goals, age, gender, and culture (Spence & Rapee, 2016). However, some of the linkages proposed by authors are still speculative and longitudinal studies are needed to clarify strengths and weaknesses in the model.

One of the early-life predictors of Social Anxiety (SA), as outlined in the model by Spence and Rapee (2016), and widely recognized, is Behavioral Inhibition (BI) (Chan, 2010). BI is a temperament dimension strongly associated with the development of SA (Spence & Rapee, 2016). Kagan et al. (1987) and Rapee (2002) characterize BI as a tendency to withdraw, exhibit wariness, avoid unfamiliar individuals and situations, and display shyness. These behaviours are often accompanied by physiological responses such as elevated cortisol levels, pupil dilation, and increased heart rate (Hirshfeld-Becker et al., 2014). Children exhibiting high levels of BI typically show reduced eye contact, seek proximity to familiar caregivers, exhibit limited verbal communication, and avoid threatening stimuli (Kagan et al., 1984; Ollendick & Benoit, 2012; Rapee, 2002). These safety-seeking behaviours and deficits in social skills are frequently observed in children as young as two years old and appear to be crucial to the aetiology and/or maintenance of SA (Spence & Rapee, 2016).

Clauss and Blackford (2012) conducted a meta-analytic study to analyze the association between childhood BI and risk for developing SA. Considering the seven studies included in this meta-analysis, the authors found that BI was associated with a greater than sevenfold increase in risk for developing SA (OR = 7.59, $p < 0.001$). In addition, the authors verified that 15% to 20% of children born with extreme BI and almost half of these children will eventually develop SA, proposing that childhood BI is one of the largest risk factors for SA. In line with these results, recently Sandstrom et al. (2020) conducted a meta-analysis with 27 studies to understand the association between BI and all anxiety subtypes. The authors found that, although BI is associated with any anxiety, the effect sizes are greater in relation to SA (OR = 5.84, $p <0.001$) again proving the weight of BI on the etiology of SA.

Given the importance of BI, it is necessary to detect this type of temperament through an appropriate assessment. To assess BI in children, researchers used parents and teachers reports, observation methods or multimethod assessment. The multimethod assessment has been getting more prominence since it allows to reduce possible limitations of the methods, applied individually, and allows to obtain more information on the functioning of the child in different contexts, thereby producing a complete picture of BI. Furthermore, not only converging information is important, but also informant discrepancies may yield relevant knowledge on the behaviours of child (Muris, 2019). Besides that, some studies have showed positive associations between observational and report measures (e.g. Kagan et al., 1984; Reznick et al., 1986). However, there are no measures adapted for the Portuguese population that allow a multimethod approach. We did not find observational measures adapted to Portuguese population and regarding parental report, there are two scales to assess BI through parent report, however, are incomplete or have only a subscale to assess BI.

In this context, in the ***second chapter*** of this thesis we aimed to validate two instruments for assessing BI – an observational and a parent report— to enable a multimethod evaluation of BI. For this purpose, we will present the Portuguese adaptation of two BI measures: Laboratory Temperament Assessment Battery (Lab-TAB; Goldsmith et al., 1993) and the Behavioral Inhibition Scale (BIQ; Bishop et al., 2003). Lab-TAB was developed by Kagan et al. (1984, 2004) and Kochanska (1995) studies and have been employed in several investigations that involve laboratory assessment of different child temperamental dimensions, such as BI (e.g. Morales et al., 2015) (***STUDY 1***). Similarly, BIQ is an self-report instrument that are theoretically based on Kagan's theory and is considered one of the most efficient measure to assess BI in children (Bishop et al., 2003) (***STUDY 2***).

Although the relationship between BI and the development of SA is recognized, according to the meta-analysis of Clauss and Blackford (2012) only 43% of children developed SA, which means that a significant proportion of BI children did not subsequently develop SA. In this context, it is important to identify which factors influence the stability of the BI and its development for SA as well as to recognize the presence of other pathways to SA that may not involve BI (Chan, 2010), once some children who are not identified as BI, subsequently develop SA.

A considerable body of theorical models identify also familiar factors as an important key in origin and maintenance of SA in childhood (e.g. Degnan et al., 2008; Dodd et al., 2017). These factors include parental anxiety (Biederman et al., 2001) and parenting features such as: negativity, insecure attachment, criticism (Barrett et al., 2005) and overprotection (Hudson & Rapee, 2001). Recent research indicates that children of parents with SA are at increased risk of developing SA themselves (Poole et al., 2018).

This risk is not solely attributable to genetic factors but is significantly influenced by the modelling of anxious behaviours (L. Murray et al., 2008). Such parents may convey threat-related information (Field et al., 2008) or encourage avoidance responses to ambiguous situations (Barrett et al., 1996). Additionally, parents with SA often exhibit parenting styles that are less supportive, more restrictive, and overprotective (Lindhout et al., 2006).

Parental overprotection is also associated with high levels of SA in children. Parental overprotection seems to decrease a child's opportunity to explore the new social situations and develop new skills, resulting in poor social performance and higher SA (Brook & Schmidt, 2008). Overprotective parents may communicate to the child a sense that the world is dangerous, increasing avoidance and decreasing confidence in dealing with potential challenges. In this sense, overprotective behaviors are the parental dimension most associated with child anxiety (Clarke et al., 2013). In contrast, a meta-analysis reported that parental factors accounted for only 4% of the variance in child anxiety (McLeod et al., 2007). However, this study did not specify the type of anxiety. More recently, through a literature review about the etiology of social anxiety disorder, Norton and Abbott (2017) concluded that parental factors may play a larger role in SA development compared to other anxiety disorders, considering the early age of onset. What remains unclear is how the parental factors interact to lead to high levels of SA (Wong & Rapee, 2015).

Rather than serving as an alternative pathway to Behavioral Inhibition (BI) for the development of SA, parenting plays a crucial role in shaping the relationship between BI and the subsequent emergence of SA. Recent models emphasize that parental influence is pivotal not only in the early development of SA in children but also in maintaining or exacerbating a BI temperament (e.g., Ollendick et al., 2014; Ollendick & Benoit, 2012). For instance, theoretical frameworks suggest that a child's withdrawn behavior can trigger overprotective parenting, which subsequently predicts increased anxiety (e.g. Dadds & Roth, 2001; Kiel & Buss, 2011; Rubin et al., 2009). When parents excessively shield their inhibited children from fears or engage in overly protective or intrusive caregiving, the child's anxieties are likely to be reinforced and intensified (Degnan et al., 2010), thereby heightening the risk of developing SA.

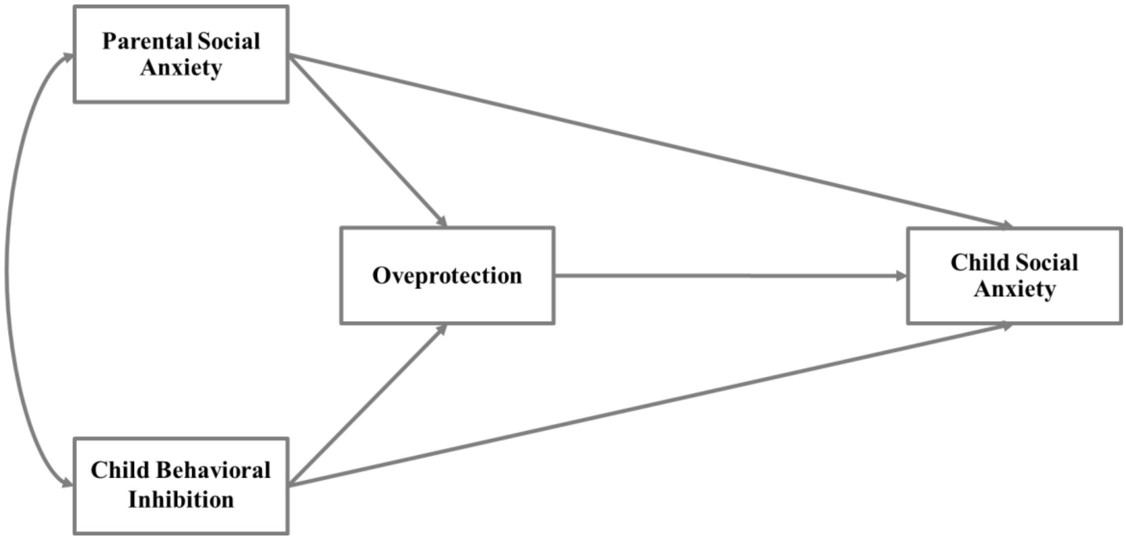
In some cases, this social anxiety can intensify and become chronic, leading to a diagnosis of Social Anxiety Disorder (SAD), a more severe and persistent form of SA.In some cases, this social anxiety can intensify and become chronic, leading to a diagnosis of Social Anxiety Disorder (SAD), a more severe and persistent form of SA.

In addition, previous findings highlight the importance of addressing the differential role of father and mother in this relation between parenting styles and SA in children. Historically, mothers have played a significantly more active role in children's daily lives, dedicating around 65% to 75% of the total daily time to direct caregiving, compared to fathers who typically spent only 20% to 30% (Craig, 2006). However, more recent studies suggest a growing trend of increased paternal involvement. Milkie et al. (2015) confirmed this disparity in total caregiving time but noted that in dual-earner households, the gap between mothers and fathers is narrowing, with some fathers now taking on up to 40% of the direct interaction time. Actually, both parents play an important role in the development of SA in children, and it has been suggested that paternal overprotection may have a higher influence than maternal overprotection on child SA (Bögels & Perotti, 2011). A father that encourages independence, curiosity and competition can reduce the risk of SA in children while mothers' challenging behavior, appears to predict more observed SA, potentially conflicting with their traditional caring and supportive role (Majdandžić et al., 2014). However, recently, Möller et al. (2016) in a meta-analysis with the objective of study the differential associations between maternal and parental behavior and anxiety and its precursors in children found that both mothers and fathers overprotection is significantly associated with anxiety in early childhood. The authors justify these findings as the possibility that the results were underestimated for parental overprotection and overestimated for maternal overprotection, requiring further studies to study the effects of parental overprotection on the child's anxiety. Besides that, studies focusing on parenting styles failed to consider the differential role of mothers and fathers since the literature has focused more on maternal role (Parke & Cookston, 2019).

In this context, in the ***third chapter*** of this thesis we aimed to understand how variables of parental influence (i.e. SA and overprotection) and child variables (BI) are related to SA levels of the child, considering the gender of parents and children. In this sense, we proposed a model (Figure 1.1) that tries to understand the relationships between parental features and child variables to explain SA in childhood.

Figure 1.1.

Hypothesized structural model



For that purpose, we employed four parent-report instruments. To assess the child's behavioral inhibition, we utilized the Portuguese version of the Behavioral Inhibition Questionnaire, as detailed in the second chapter (***STUDY 2***). For evaluating SA in children, we applied the Portuguese adaptation of the Preschool Anxiety Scale (PAS), originally developed by Spence et al., (2001) and subsequently translated by Almeida and Viana (2013). To measure both SA and parental overprotection, we incorporated the Social Interaction and Performance Anxiety and Avoidance Scale (SIPAAS; Pinto-Gouveia et al., 2003) and the Parental Overprotection Measure (POM; Edwards et al., 2008). Since the POM scale had not been validated for the Portuguese population, we undertook its adaptation and validation specifically for this context (Fernandes et al., n.d.-b).

The combination of an inhibited temperament and environmental factors, such as parental anxiety and overprotection, can lead to a tendency to perceive the social world in a threatening way, with high attention to threat cues and interpreting social cues as indicators of threat (Rapee & Spence, 2004), increasing the likelihood of developing SA. A fearful style of reacting when confronted with novelty and the communication of the world as a threat by overprotective parents can lead the child to develop cognitive bias in the processing of emotionally congruent information such as, automatically, and selectively attend and interpret social situations like socially threatening. In this sense, the child's ability to engage cognitive processes involved in the successful regulation of emotions, behaviors, and thoughts in children can be another possible mechanism influencing the developmental trajectories of BI (White et al., 2011) or helping to explain alternative pathways to the development of SA.

Attentional bias to threat has been mentioned as a determinant cognitive factor that may moderate the stability of BI, as well as the association between BI and SA (Thai et al., 2016). For example, Pérez-Edgar et al. (2010, 2011) found that children with BI at 2-3 years exhibited social withdrawal later only when they displayed a threat bias.

White et al. (2017) suggested that BI assessed during toddlerhood was most strongly linked to anxiety in children who exhibited a concurrent threat bias at age 7. Interestingly, they found no significant relationship between attentional bias at age 5 and anxiety at age 7.

Similarly, Nozadi et al. (2016) found that threat-related attentional biases moderated the relationship between BI and anxiety. However, in contrast, their findings showed that BI and anxiety were not associated in children who either displayed no attentional bias or had an attentional bias away from threat. Together, these studies underscore the importance of attentional biases in shaping the trajectory from BI to anxiety, highlighting that the presence of a threat bias may be a key factor in whether BI leads to anxiety. In other hand, recent studies failed to find a moderation of this relation by attentional bias, suggesting that the relation between early BI and later SA do not depend of attentional bias (Van Bockstaele et al., 2021).

Taken together, these inconsistencies reveal that the way attentional bias influences BI stability and SA development remains unclear and may be influenced by several other factors. However, regardless of how they interact and influence SA, this maladaptive cognitive process appears to have a significant theoretical influence in the SA development. According to one of the early models, proposed by Rapee and Heimberg (1997), individuals predisposed to SA often construct a self-representation based on their perception of how others view them in social situations. Typically, these individuals assume that others have unrealistically high standards and tend to underestimate the quality of their own performance. As a result, they anticipate negative outcomes, which contributes to the development of cognitive, behavioral, and somatic symptoms of SA (Liu et al., 2017; Spence & Rapee, 2016). In general, there seems to be a tendency to preferentially allocate attentional resources to social threats, including signs of disapproval by others. However, although most SA models agree that there is an initially facilitated attention to socially threatening stimuli, there still seems to be no consensus regarding subsequent attentional processes (Wermes et al., 2018). While some models assume that SA individuals avoid the social threat to focus on a detailed monitoring of themselves (*vigilance-avoidance hypothesis*; e.g. Mogg et al., 2004), other authors claim that SA individuals have an enhanced attention towards social threatening, leading to a delayed disengagement after an initially facilitated attention (*maintenance hypothesis*; e.g. Heimberg et al., 2010).

These mixed results may stem from several factors. One potential explanation relates to the characteristics of sample selection, specifically the distinction between state and trait SA. Research by Clark (2001) and Eysenck et al. (2007) indicates that individuals experiencing state SA exhibit heightened attention towards threats and show delays in disengagement, whereas those with trait SA demonstrate a pattern of attentional vigilance combined with avoidance. The impact of these differences on attentional bias patterns in children remains poorly understood (Dudeney et al., 2015).

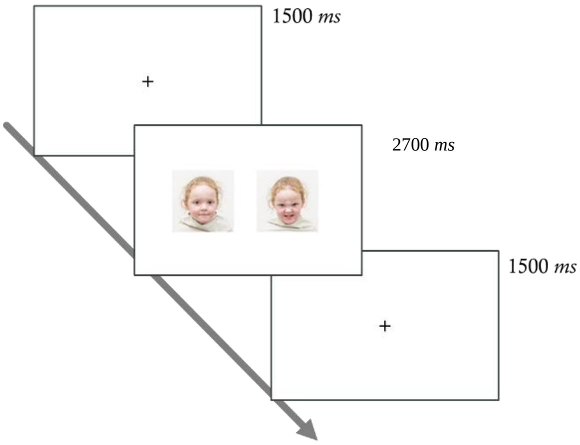
Another factor is the variability in experimental paradigms used to measure attentional bias. According to a meta-analysis by Dudeney et al. (2015), attentional bias in children has been assessed using a variety of paradigms, including Stroop tasks, dot-probe tasks, visual search, and eye tracking. Many of these paradigms rely on motor response times as a proxy for attentional bias, which may fluctuate with developmental stages. Consequently, attentional bias patterns in children with SA may be influenced by multiple factors, resulting in less clear-cut patterns compared to adults (Shechner et al., 2013). For instance, in the dot-probe task—a motor-dependent paradigm—participants are presented with two facial expressions simultaneously, followed by a probe that replaces one of the faces and requires a motor response. While SA adults typically show faster reaction times to threat stimuli, indicating an attentional bias towards threats (Bar-Haim et al., 2007), findings with children are more variable. Some studies reveal a bias towards threat, while others show a bias away from it (Shechner et al., 2013). Dudeney et al. (2015), meta-analyzing 38 studies, found that, although both anxious and non-anxious children had a bias towards the threat, anxious children had a more exacerbated bias. However, although the data was clear in the Stroop task, the data for the dot-probe task was mixed and inconsistent. The authors concluded that these reaction-time measures may not be sensitive enough to detect a bias in children and execution of the motor response can vary between individuals, especially in children (Armstrong et al., 2012). Second, once attention is measured at only one time point (latency time) and have short stimulus presentation (normally 500 *ms*), is not possible analyze the time course of attention and study the complex models of temporal dynamics of attention on SA (Cisler & Koster, 2010), like vigilance-avoidance hypothesis. Finally, these measures do not allow to depict precise spatiotemporal attention allocation (Wermes et al., 2018).

Eye tracking paradigms seek to overcome this limitation. This paradigm enables the measurement of both initial and subsequent viewing behavior (Weierich et al., 2008), allowing the analyze of shifts of attention, locations onto which attention is focused, and time course of visual attention. In this way is possible test the assumptions underlying the hypothesis of vigilance-avoidance and difficulty disengaging attention, which is not true for reaction time measurements (Schofield et al., 2012).

Considering these assumptions, in this thesis was used eye movement monitoring to study attentional bias in children. To extend previous findings we employed an experimental paradigm similar to that of Schmidtendorf et al. (2018). The paradigm used was similar to a dot-probe task but rather than using button-press speed to index attention, subjects just had to free-view the stimulus while visual fixation patterns across stimulus presentation were assessed (Figure 1.2). The free-viewing tasks reflect a more ecologically valid assessment of attention, and it seems to be more suitable for children and adolescents, since it does not depend on the performance of the task (Lisk et al., 2020). The stimuli were pairs of pictures, including angry, positive, and neutral facial expressions. Besides that, we also examined orienting responses to nonsocial *vs*. social cues including pictures of baskets paired with neutral faces to examine if the attentional bias is specific to emotional content or if it elicited by social cues per se (Chen et al., 2002).

Figure 1.2.

A representation of the free-viewing task using eye movement monitoring



In this task, participants must observe the pictures freely. In the paradigm pairs of pictures with faces of children and adults appeared randomly during 2700 *ms*. Pairs of pictures were then replaced by a cross during which participants could blink and then again pairs of pictures.

In addition to attentional bias, other cognitive variables such as inhibitory control and attentional shifting/cognitive flexibility can play crucial roles in the development of BI and subsequently SA. For instance, White et al. (2011) and Buzzell et al. (2021) identified that the ability to effectively engage cognitive processes, such as cognitive flexibility and inhibitory control, may explain the variability in the development of BI. Their findings indicate that high levels of cognitive flexibility can mitigate the risk of SA symptoms in children with high BI, whereas elevated inhibitory control may exacerbate the risk.

Cognitive flexibility is described as the ability to flexibly reallocate attention in an internal/external environment to maintain goal-directed attention or meet task demands (Pérez-Edgar & Fox, 2005). In this sense, low cognitive flexibility levels are expected to be associated with a high risk of SA. Research by White et al. (2011) indicates that high levels of cognitive flexibility can serve as a protective factor against anxiety symptoms in behaviorally inhibited children. Cognitive flexibility refers to the ability to divert attention from negative thoughts or threatening stimuli and redirect it towards more positive and adaptive information. This process can help reduce a child's level of fear or negative affect, thereby facilitating the regulation of emotions.

As previously mentioned, children with high BI often exhibit a heightened attention bias towards threat. The ability to shift attention away from these sources of threat and towards less negative stimuli is crucial in mitigating anxiety (White et al., 2011). This capacity for flexible attention shifting helps decrease the frequency of anxiety experienced by behaviorally inhibited children.

Inhibitory control, typically conceptualized as the general ability to inhibit dominant responses and behaviors in favor of more appropriate or subdominant responses and behaviors (Rothbart et al., 2003), has been conceptualized as a risk factor that moderates the relationship between BI and SA. Although inhibitory control is generally seen as beneficial for social and emotional development, White et al. (2011) suggest that for children with high BI, high levels of inhibitory control might actually increase the risk of anxiety. This is because these children may develop an excessive level of control and inflexibility due to the combination of an active fear system and strong inhibitory control mechanisms.

Studies have shown that behaviorally inhibited children with high inhibitory control may exhibit more SA and less social competence (Thorell et al., 2004). This overcontrol could lead to heightened anxiety because these children might be overly concerned with their performance and excessively monitor their behavior, resulting in rigid and inflexible responses.

The interaction between cognitive flexibility and inhibitory control also plays a significant role. While cognitive flexibility can protect against anxiety by helping children divert their attention from threats, inhibitory control might contribute to anxiety if it results in excessive self-regulation and behavioral monitoring (Fox et al., 2021; White et al., 2011). Understanding these dynamics is essential for developing targeted interventions that address these cognitive processes to mitigate the risk of SA in behaviorally inhibited children.

Finally, another possible predictor mentioned in literature is emotional regulation. Research suggests that emotional regulation may be a key mechanism through which early BI confers risk for later SA symptoms and behaviors (Suarez et al., 2021). Emotion regulation involves the processes by which individuals influence their emotions, how they experience them, and how they express them. Children with an inhibited or shy temperament tend to use less active and more passive emotional regulation strategies. For example, shy children often seek comfort from their mothers and engage less in active regulatory strategies during fear-eliciting tasks (Root et al., 2015). These children also react more intensely in emotionally charged situations, which can hinder their ability to employ active emotional regulation strategies (Hane et al., 2008).

Research has shown that emotional regulation strategies mediate the relationship between early BI and later socioemotional functioning. For instance, shy children who use more active emotional regulation strategies tend to have better social adjustment, while those who rely on passive strategies are more likely to experience social difficulties (Hipson et al., 2019). Furthermore, emotional regulation strategies measured in early childhood can predict social competence in later years, indicating their importance in the developmental pathways linking early temperamental risk to social outcomes (Penela et al., 2015).

While the role of emotional regulation strategies in linking early BI to social competence has been well documented, their impact on SA outcomes remains less explored. Understanding how adaptive emotional regulation strategies can mitigate the risk of SA is crucial, as social competence alone does not fully capture the anxious feelings and symptoms that manifest later in childhood or early adolescence (Suarez et al., 2021).

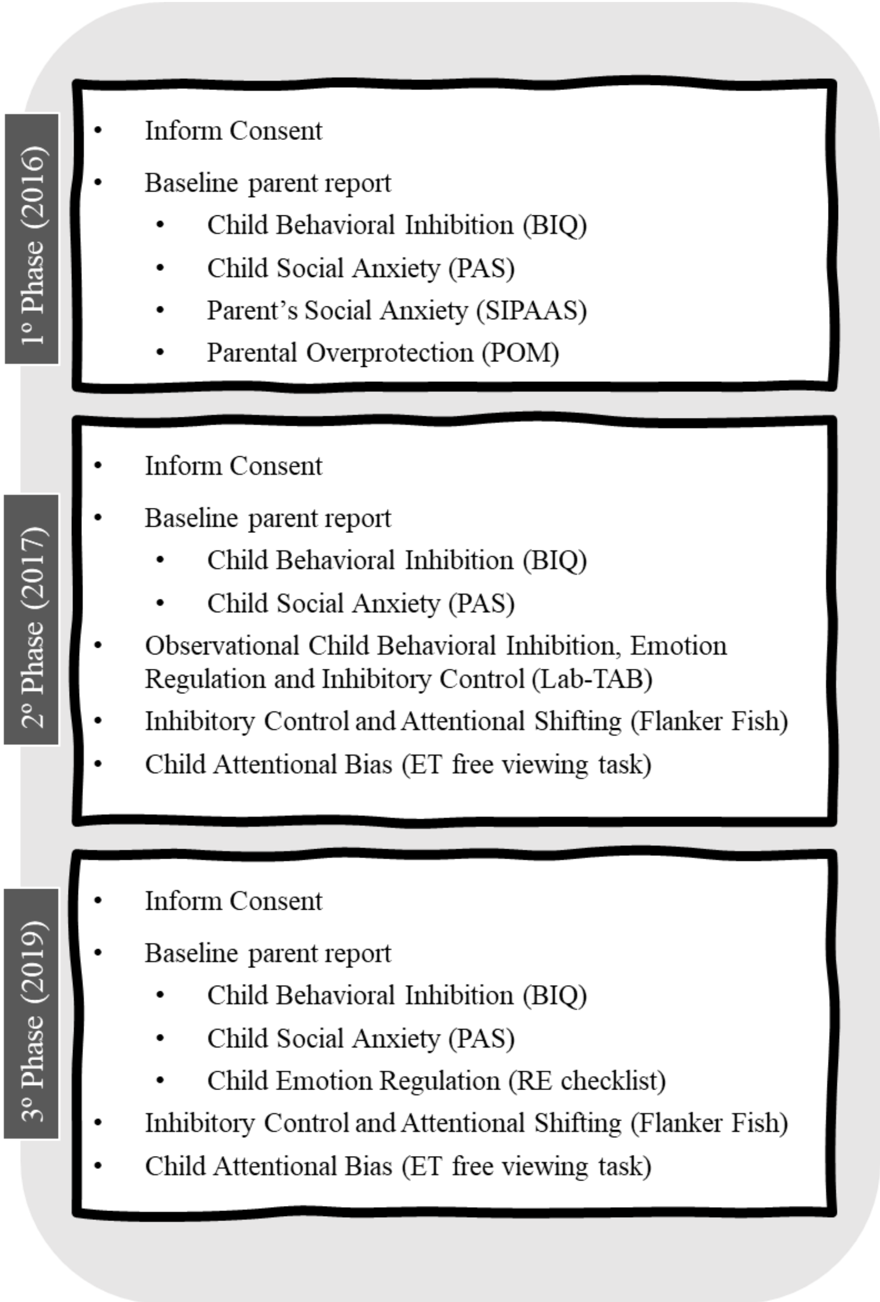
In conclusion, the ability to engage in adaptive emotional regulation strategies may be one of the developmental pathways through which early temperamental risk leads to SA. However, many studies investigating these relationships utilize cross-sectional and correlational designs, which limit the ability to establish causal connections between variables—something that longitudinal studies are better suited to address. Additionally, much of the existing literature focuses on individuals with established high levels of SA, complicating the determination of whether these factors merely reflect existing SA or contribute to its development.

Most research has focused on factors that sustain SA rather than those contributing to its initial onset (Rapee & Heimberg, 1997; Spence & Rapee, 2016). Given the critical need to understand how factors such as BI, attentional bias, cognitive processes, and emotional regulation interact to influence SA development, the fourth chapter of this thesis employs a longitudinal design to explore these relationships.

In *Chapter 4*, we investigated the developmental interplay between BI, attentional bias, emotional regulation, and executive functions—specifically inhibitory control and cognitive flexibility – in explaining SA in children. This longitudinal study, illustrated in Figure 1.3, followed children through three phases to examine the long-term impact of these factors on the trajectory of SA symptoms.

Figure 1.3.

Data Collection Steps



Note. In the first stage, the collection was made with the preschools of the municipality of Faro. In the second and third stages, participants were invited to the university to perform the tasks.

To measure attentional bias, we utilized the eye-tracking task detailed earlier. Emotional regulation was assessed using two episodes from the Lab-TAB and the Emotional Regulation Checklist (ERC; Shields & Cicchetti, 1995; Portuguese version: Melo, 2005). Executive functions were evaluated through an additional Lab-TAB episode, the Children's Behavior Questionnaire (CBQ; Rothbart et al., 2001; Portuguese version: Franklin et al., 2003), and the Fish Flanker Task (Diamond et al., 2007). Behavioral Inhibition and social anxiety in children were measured using scales described in previous chapters.

In the *first phase* (2016), we collected data on child BI and SA, as well as parental variables (BI, overprotection, and SA) through parental reports. During the *second phase* (2017), families visited our group laboratory in university, where child BI and SA data were updated via parental reports, and behavioral assessments were introduced to measure BI, attentional bias, inhibitory control, cognitive flexibility and emotional regulation. The final and *third phase* (2019) involved repeating the parental questionnaires on BI and SA, adding additional assessments for emotional regulation and inhibitory control, and repeating the flanker task and the eye-tracking task for attentional bias.

In summary, this thesis aims to enhance the understanding of the development and stability of BI and their impact on the aetiology and maintenance of SA in children. Addressing the methodological limitations identified in the existing literature, we conducted a three-year prospective study to investigate the long-term effects of BI, and to explore how cognitive maturation and emotional regulation influence the trajectory of SA symptoms. This prospective design is crucial for examining the causal relationships between these variables and SA. Additionally, the longitudinal approach with a narrowly defined age range allows for the assessment of stability and change in individual differences over time, minimizing the confounding effects of age.

To achieve the study's objectives, specific aims were outlined. Initially, we focused on adapting assessment procedures for the Portuguese population, including measures of Behavioral Inhibition (BIQ and Lab-TAB) (Chapter 2). Our *first objective* was to develop reliable and validated measures for both the Portuguese population and the study's age group.

The *second objective* was to investigate the relationship between BI and other proximal variables, namely parental factors, including the differential roles of mothers and fathers, on a child's SA (Chapter 3). We anticipated finding a direct relationship between BI and the child's SA, independent of gender. Additionally, we aimed to identify potential differential impacts of maternal and paternal roles on the child's SA, although the specific nature of these relationships remained uncertain due to inconsistencies in the literature.

The *third objective* was to examine the evolution of BI over time through a longitudinal study, and to determine whether the attentional bias, the development of executive functions (i.e., inhibitory control and cognitive flexibility) and emotional regulation skills have a long-term impact in the link between BI and SA. We hypothesized that children with higher levels of SA would exhibit a consistent attentional bias towards threats over time compared to their lower SA counterparts. We also expected that executive functions and emotional regulation variables act as mediators or moderators, influencing the persistence or reduction of BI and thereby affecting the development of SA. Specifically, we hypothesized that BI present from the first assessment would contribute to an attentional bias towards socially threatening stimuli (e.g., angry faces), and that cognitive skills such as inhibitory control, cognitive flexibility, and emotional regulation would influence the maintenance or diminution of BI, subsequently impacting SA levels.

This thesis aims to contribute to the understanding of SA disorder in children by providing insights into potential causal and maintenance factors. Through its longitudinal design, it aims to address and refine the speculative relationships proposed in the model by Spence and Rapee (2016). The findings may offer useful clinical insights for early identification, differential diagnosis, and prevention strategies for this age group. Additionally, a better understanding of the risk factors associated with SA in preschool-aged children could help inform the development of more targeted interventions. Insights into BI development and its role in SA might contribute to refining current treatment approaches.

CHAPTER TWO

STUDY ONE: Behavioral Inhibition in Childhood: European Portuguese Adaptation of an Observational Measure (Lab-TAB)

ABSTRACT

The assessment of behaviorally inhibited children is typically based on parent or teacher reports, but this approach has received criticisms, mainly for being prone to bias. Several researchers proposed the additional use of observational methods because they provide a direct and more objective description of the child's functioning in different contexts. The lack of a laboratory assessment of temperament for Portuguese children justifies the adaptation of some episodes of the Laboratory Temperament Assessment Battery (Lab-TAB) as an observational measure for behavioral inhibition. In our study, we included 124 children aged between 3 and 9 years and their parents. The evaluation of child behavioral inhibition was made by parent report (Behavioral Inhibition Questionnaire) and through Lab-TAB episodes. Parental variables with potential influence on parents' reports were also collected using the Social Interaction and Performance Anxiety and Avoidance Scale (SIPAAS) and the Parental Overprotection Measure (POM). The psychometric analyses provided evidence that Lab-TAB is a reliable instrument and can be incorporated in a multi-method approach to assess behavioral inhibition in studies involving Portuguese-speaking children. Moderate convergence between observational and parent report measures of behavioral inhibition was obtained. Mothers' characteristics, as well as child age, seem to significantly affect differences between measures, being potential sources of bias in the assessment of child temperament.

Keywords: behavioral inhibition; child temperament; Lab-TAB; observational data; psychometrics; assessment bias

INTRODUCTION

Behavioral inhibition (BI) is a specific aspect of human temperament, originally described by Kagan et al. (1984) and reliably identified in infancy and early childhood. It is characterized by high sensitivity to novel stimuli and fear and avoidance of unfamiliar situations or people, with great physiological activation adjacent to these reactions (Fox et al., 2005). Approximately 15% of toddlers react with marked inhibition to novel situations, remaining vigilant and rarely approaching novel objects or unfamiliar people (Kagan et al., 1984). Early inter-individual differences in BI are gradually, continuously distributed and show moderate stability over childhood (Degnan et al., 2011; Kagan et al., 1988; Wang et al., 2003) and adolescence (Kagan et al., 2007).

BI has been one of the most studied antecedents of Social Anxiety Disorder (Buss, 2011; Lahat et al., 2011; Ronald M Rapee & Spence, 2004), and meta-analytic results suggest that behaviorally inhibited children have a seven-fold increase in risk for the later emergence of social anxiety symptoms (Clauss & Blackford, 2012). BI has also gained relevance as one of the factors involved in the manifestation of other dis-orders, such as depression in young adulthood (Caspi et al., 1996; Jaffee et al., 2002), schizophrenia (Brandee Feola et al., 2019), selective mutism (Gensthaler et al., 2016; Peter Muris et al., 2015), autism spectrum disorders (Schiltz et al., 2018), general substance abuse (Lahat et al., 2012) and psychopathic-like personality (Glenn et al., 2007). Recently, its importance as a transdiagnostic factor across mood and psychotic disorders has been evidenced (Feola et al., 2019).

Research on the early temperamental precursors of late psychological problems requires the assessment of child temperament, which is rarely based on self-reported information given the children's young age and their limitations when reflecting on or describing their own behaviors. Thus, BI is usually assessed through parents' or teachers' reports. However, concerns about the validity of parent reports have been raised in the literature for at least 40 years (Vaughn et al., 1981). In fact, although adult report questionnaires may provide information about children's responses across a large variety of situations and over a long period (Rothbart & Bates, 2006), the report of child characteristics by parents or educators corresponds only to their limited perception of children's temperament (Zentner & Shiner, 2012), it is mostly based on how the child behaves within the context of the parent-child relationship, and it is likely biased by adults' characteristics (Kagan & Fox, 2006).

Therefore, the use of direct observation measures for assessing child temperament has been defended by several authors (Durbin et al., 2007; Gagne et al., 2011; Rothbart & Goldsmith, 1985; Seifer et al., 1994). Even though these measures are more costly and time-consuming than questionnaires (Bishop et al., 2003), they are considered a reliable alternative method to study human behavior, especially in children, by providing a direct description of the individual's functioning in different contexts (Wysocki, 2015).

Despite their well-known advantages, only a few observational instruments are available to assess temperament in children. Kagan et al. (1984, 2004) and Kochanska (1995) were the first researchers who used standardized tasks to study temperament in observational settings where children were exposed to unknown persons and objects. Inspired by those earlier studies, Hill Goldsmith et al. (Buss & Goldsmith, 2000; Durbin et al., 2007; Goldsmith et al., 2010; Goldsmith & Rothbart, 1996a, 1996b) developed the Laboratory Temperament Assessment Battery (Lab-TAB). This instrument aims to assess temperament using standardized tasks simulating everyday situations (episodes), with adaptations for specific age groups, namely the pre-locomotor, the locomotor, the toddler, the preschool, and the middle childhood versions. Each Lab-TAB version is made up of several 3–5 min episodes (for instance, the locomotor version comprises 20 episodes, while the preschool and the middle childhood versions comprise 32 and 14 episodes, respectively), specifically designed to observe children's reactions to stimuli which elicit emotional or behavioral reactivity across a broad range of infant temperament dimensions (fearfulness, anger proneness, shyness, sadness, positive expression, persistence, approach, active engagement, and inhibitory control (Gagne et al., 2011; Goldsmith et al., 1993, 2010)).

Lab-TAB episodes have been employed in several investigations that involve laboratory assessment of child BI. Although it is not explicitly stated by the Lab-TAB manuals which episodes should be selected to assess BI, authors interested in this temperament dimension have preferably relied on episodes taken from the "fear set" ("Stranger Approach", "Risk Room", "Exploring New Objects", "Scary Mask" or "Jumping Spider"; (Buss, 2011; Dyson et al., 2011; Fang & Gagne, 2018; Johnson et al., 2016; Kim et al., 2011; Laptook et al., 2010; Morales et al., 2015; Mumper et al., 2020; Olino et al., 2010; Pfeifer et al., 2002; Stumper et al., 2017; Volbrecht & Goldsmith, 2010). The Lab-TAB manuals provide a detailed guide to code children's reactions in each episode, but researchers are encouraged to develop their temperament composite indexes, depending on the purposes of their research projects (Planalp et al., 2017). Despite its potential, this practice has resulted in the proliferation of observation-al measures that are only partially comparable (Provenzi et al., 2017).

Like any other psychological measures, observational assessments should obey psychometric principles to ensure reliability and foster validity. However, only a pair of studies was specifically dedicated to the Lab-TAB psychometric properties (Gagne et al., 2011; Planalp et al., 2017). Results show satisfactory internal consistency for the different composite scores based on Lab-TAB episodes (0.50 ≤ Cronbach's alpha ≤ 0.94, for the home version of the preschool Lab-TAB, presented in Gagne et al.'s study (Gagne et al., 2011); 0.64 ≤ alpha ≤ 0.94, for the pre-locomotor and locomotor versions presented in the study of Planalp et al. (2017)). Although these studies did not compute a specific BI measure, fear composites (based on the "stranger approach", "masks", "spider" episodes) showed alphas ranging from 0.70 (the pre-locomotor sample of Planalp et al., (2017)) to 0.90 (the preschool sample of Gagne et al. (2011)). Further reliability information has been reported in non-psychometric studies where a BI measure was computed based on Lab-TAB pre-school and middle childhood versions; these findings also express acceptable internal consistency levels, with alpha coefficients ranging from 0.56 to 0.84, most of them above 0.70 ([7,37,43]; reliability indexes reported in several other studies were all based on the same sample used by Laptook et al., which came from the Stony Brook Temperament Study: (Johnson et al., 2016; Kim et al., 2011; Mumper et al., 2020; Olino et al., 2010; Stumper et al., 2017)). Overall, these psychometric results suggest that Lab-TAB can be considered a reliable tool for assessing BI in children. However, the available information concerning validity is not so straightforward. Some studies have reported the association between parent ratings and Lab-TAB measures of children's BI (Dyson et al., 2011; Fang & Gagne, 2018; Gagne et al., 2011; Kim et al., 2011; Laptook et al., 2010; Stumper et al., 2017) and the results show small to moderate correlations between these measures (correlations ranged from 0.15 to 0.44, depending on the Lab-TAB composite score used, child's age and parents' questionnaire applied; median r = 0.25). These findings should not be surprising: considering the differences between questionnaire and observational assessments, a strong convergence would not be expected, making parent report measures an inappropriate criterion to validate laboratory observational assessments.

Several reasons have been invoked to explain the lack of agreement between par-ents and laboratory observers in child temperament research. Disagreements may result from fundamental differences in the features of temperament captured by these two methodological approaches (Gagne et al., 2011). The lack of agreement might also result from specificities and flaws in one or both methodologies. While parent reports reflect the view of their children across a variety of situations, laboratory assessments only pro-vide a snapshot of the child's temperament (Stifter et al., 2008). The novelty and the artificiality of the laboratory tasks, as well as the potential dissimilarity with real daily life situations in terms of the intensity of stimuli used to elicit behavior (Rothbart & Bates, 2006), may also justify the lack of correspondence between these approaches to temperament assessment.

On the other hand, parent ratings of child temperament seem to be particularly susceptible to parents' characteristics such as educational level (Forman et al., 2003), personality traits (Vaughn et al., 1987), parents' own early childhood experiences (Leerkes & Crockenberg, 2003), anxiety (Mebert, 1991), depression (Forman et al., 2003; Gartstein & Marmion, 2008), and maternal anxiety and stress (Giuseppone & Brumariu, 2017; Niditch & Varela, 2011). Such characteristics may interfere with parents' ability to accurately identify and report their child's behaviors and emotional responses, potentially affecting the degree of concordance between parent reports and observational measures of infant temperament. Parent ratings may also echo stable conceptualizations about their children (Pérez-Edgar & Guyer, 2014) or be influenced by social desirability (Stifter et al., 2008). Similarly, child characteristics or child–parent interaction quality may affect parent reports. For instance, a child–gender bias, probably driven by gender-dependent cultural expectations, has been found to influence parents' tendency to over-rate sadness and stress and under-rate hostility and anger in their daughters due to social stereotypes for emotions (Bayly & Gartstein, 2013). In addition, Parade and Leerkes (2008) observed a stronger congruence for the temperament of girls when mothers are the reporting parent. Notably, no studies have specifically explored the possible effects of such factors on the parental assessment of BI.

Overall, these results highlight the partial overlap between the two methods and reinforce the relevance of adopting a multimethod approach while studying child temperament (Hwang & Rothbart, 2003). In Portugal, the absence of laboratory-based temperament assessment protocols hinders adopting such a multimethod approach and fully justifies the adaptation of the Lab-TAB for research purposes.

For this reason, one aim of this study is the adaptation of episodes from the pre-school and middle childhood versions of Lab-TAB (Goldsmith et al., 1993, 2010), to provide an observational tool to assess BI in Portuguese children. The measures provided by Lab-TAB will be analyzed psychometrically as well as their convergence with parent report measures of children's BI. We expect that Lab-TAB will demonstrate psychometric characteristics that allow it to be considered as a reliable instrument for the observational assessment of the BI temperament of Portuguese children. We also anticipate that the agreement between parent and laboratory measures will be comparable to the typical levels re-ported in the literature.

Due to the aforementioned debate about the extent to which observational and reported measures of temperament concur, and considering the inexistence of studies specifically addressing this question for the case of BI assessment, a second aim is to examine whether parental variables—such as age, educational level, anxiety, avoidance and overprotection—and child variables—such as gender, age, birth order and the number of siblings—could be influencing the differences found between the two methods of assessing children's BI.

METHODS

PARTICIPANTS

One hundred and twenty-four children aged between three and nine years (65 girls and 59 boys, mean age = 5.40 years, SD = 1.12) participated in this study. All children spoke European Portuguese and their education level ranged from pre-school to the 4th grade. The parents of the assessed children also participated: 92 mothers (mean age = 39.07 years, SD = 4.59) and 32 fathers (mean age = 38.6 years, SD = 4.53). Regarding education, mothers had an average of 15.6 schooling years (SD = 2.91) and fathers 15.1 (SD = 3.53), which in both cases correspond to a college degree. This was a convenience sample selected from the general population (we targeted schools and kindergartens in Algarve, Portugal). Exclusion criteria comprised the existence of neurodevelopmental disorders or serious organic diseases. This was the first-time children participated in a laboratory task. Two different Lab-TAB versions were used to cover the age span of the children in the study (Preschool and Middle Childhood), and the sample was split into two groups, accordingly. Table 2.1.1. shows the composition of the sample, considering the age group associated with each version of the Lab-TAB.

Table 2.1.1.

Participants' distribution according to the Laboratory Temperament Assessment Battery (Lab-TAB) version: gender and age

***Lab-TAB* Version.**	**Girls (*n* = 65)**	**Boys (*n* = 59)**	**Total (*n* = 124)**
Preschool (3 to 5 years)	*n* = 32 (48.5%) (M_{Age} = 4.47; *SD* = 0.62)	*n* = 34 (51.5%) (M_{Age} = 4.59; *SD* = 0.61)	*n* = 66 (M_{Age} = 4.53; *SD* = 0.61)
Middle Childhood (6 to 9 years)	*n* = 33 (56.9%) (M_{Age} = 6.55; *SD* = 0.71)	*n* = 25 (43.1%) (M_{Age} = 6.20; *SD* = 0.41)	*n* = 58 (M_{Age} = 6.40; *SD* = 0.62)

Note. M_{Age} = mean age (in years); SD = standard-deviation

MEASURES

Sociodemographic questionnaire

A questionnaire was used to collect sociodemographic information about each child and his/her family, including parents' and children's clinical history and school situation.

Behavioral Inhibition Questionnaire (BIQ) – Parents version

The BIQ was created by Bishop et al. (2003) to assess the frequency of BI of children in six contexts, subdivided into two domains: social novelty (relative to unknown adults, peers, and performance in front of others) and situational novelty (relative to unknown situations, separation, and physical challenges). The BIQ has 30 items to be rated on a seven-point scale (between "1—Almost Never" and "7—Almost Always"), with higher scores indicating greater BI. This instrument is being adapted for the Portuguese population by Fernandes et al. (2023), and shows excellent internal consistency (Total score: McDonald's omega (McDonald, 1999), ω = 0.96; omega hierarchical, ω_h = 0.79; Social score: ω = 0.92; Situational score: ω = 0.94). In our sample, internal consistency was also highly satisfactory (alpha was 0.93 for the total scale; 0.82 and 0.88 for the Social and Situational composites, respectively). Only one of the parents filled out the BIQ, usually the mother (74.2%).

Social Interaction and Performance Anxiety and Avoidance Scale (SIPAAS)

The SIPAAS (Liebowitz, 1987) is a self-report questionnaire used to evaluate the level of anxiety and avoidance of adults in situations of social interaction. The scale includes 58 items, which are rated on a four-point scale. The Portuguese version of this instrument demonstrated good internal consistency, with Cronbach's alphas of 0.95 for the anxiety subscale and 0.94 for the avoidance subscale (Pinto-Gouveia et al., 2003). In the current study, internal consistency for both anxiety and avoidance subscales was high (alpha > 0.93, both for mother and father responses).

Parental Overprotection Measure (POM)

The POM aims to assess parental overprotecting behaviors in situations where the children are exposed to a possible perceived threat (with items such as: "I protect my child from conflict") (Susan L Edwards, Rapee, Kennedy, et al., 2010). The scale comprises 19 items, evaluated on a five-point rating scale, ranging from "Never" (0) to "Almost Always" (4); a high total score is indicative of high levels of parental protection. The Portuguese adaptation of this measure is being conducted by Fernandes et al. (Fernandes et al., n.d.-b) and presents excellent reliability ($\omega = 0.90$). In the current study, Cronbach's alpha was 0.91, both for mother and father responses.

Laboratory Temperament Assessment Battery (Lab-TAB)

Lab-TAB (Goldsmith et al., 1993, 2010) is a standardized instrument developed for the observational assessment of temperament. This battery consists of several episodes lasting between three and five minutes specifically designed to elicit different temperament responses, in which the child is exposed to situations that resemble possible contexts of everyday life. Following previous studies that use Lab-TAB to assess BI, the episodes used in the current study were taken from the preschool version (the four Fear episodes) and the middle childhood version (the Fear episode and the Social Inhibition and Shyness episode).

The Lab-TAB episodes used to assess preschool children (3–5 years) were: Risk Room (phase 1: the child is left alone to explore various unfamiliar objects; phase 2: after five minutes, the experimenter returns and asks the child to play with each object), Stranger Approach (in the experimenter's absence, an unfamiliar adult enters the room, speaks to the child and gradually approaches him or her), Jumping Spider (phase 1: the experimenter asks the child to touch an unknown, hidden object, a jumping spider; phase 2: then, after explaining that the spider is a toy, the experimenter asks the children to play with it), and Scary Mask (phase 1: in the experimenter absence, an unfamiliar adult enters the room and speaks friendly to the child; phase 2: the stranger puts a scary wolf mask and stares silently at the child; then, she takes the mask off and invites the child to touch it). Concerning school children (6–9 years), the assessment was based on two episodes: Scary Mask (phase 1: in the experimenter absence, an un-familiar adult enters the room wearing a scary mask and interacts briefly with the child; phase 2: then, the stranger takes the mask off and invites the child to touch it and to put it on) and Storytelling (the child is asked to describe what he/she did the previous day in front of the experimenter and the camera operator). Three of these episodes (Risk Room, Jumping Spider, and both Scary Mask episodes) comprise two phases, where situational and social factors have a differential impact.

The Portuguese version of these six Lab-TAB episodes was developed through a forward-backward translation procedure, according to Hambleton's (Hambleton & Li, 2005) recommendations. The translated materials include the manual for the researcher (administration guidelines and coding) and the instructions to participants and families. Two experts in Psychology, native speakers of Portuguese and fluent in English, translated the original materials into Portuguese. Both translated versions were then discussed in a first consensus panel. This preliminary version was then back back-translated into English by one independent bi-lingual expert, who was blinded to the original version. All inconsistencies between the resulting English version and the original were examined and resolved by a second consensus panel to attain a comprehensible instrument, conceptually consistent with the original. This preliminary Portuguese version was administered to a pilot sample (three children) to identify and solve any potential problems in translation.

PROCEDURE

Families that had previously voluntarily collaborated in a study carried out at the University campus were contacted by e-mail or telephone to schedule the laboratory assessment sessions, where children participated in the situational task (Lab-TAB) and parents were asked to complete the parental report measure (BIQ). The questionnaires used for other parental variables were completed in the previous phase of the investigation. Prior knowledge about the content of the tasks to be performed was given and parents completed an informed consent to ensure ethical issues. During the Lab-TAB tasks, if the child was visibly disturbed, the experimenter was instructed to interrupt the task and the parent could intervene and calm his/her child.

Lab-TAB coding procedures

All the Lab-TAB episodes required an experimenter, who was in direct contact with the child to perform the tasks, and two trained observers, who were in the control room, along with the parent who accompanied the child. Episodes were coded by the two independent observers, following the recommendations specified in the Lab-TAB manuals (Goldsmith et al., 1993, 2010); all episodes were videotaped for later confirmation of the on-line observational records.

For each Lab-TAB episode, multiple response items were scored, such as the latency of the first response (speed parameter), the peak intensity of each response (in-tensity parameter), and their frequency within each scoring interval (occurrence level parameter). Z-score transformations were applied to all items since scoring procedures involve aggregating measures expressed in different metrics (Gagne et al., 2011; Pfeifer et al., 2002); whenever necessary, items were reversed to guarantee that level, intensity, and speed parameters variation has the same meaning. Next, the transformed items were averaged to create an overall episode score, reflecting the child's overall reactivity in that episode, ideally aggregating speed, intensity, and response level parameters. For this purpose, inter-correlations among items, principal component analysis, and reliability statistics were used to determine which items show higher consistency and should be combined into the composite score representing the episode. Thus, not every recorded item was used in the composite score. Finally, because our interest was the behavioral inhibition dimension, which transcends any specific episode or situation, in the next step two high-er-level composites were computed across episodes, reflecting children's inhibition in social and situational contexts. These composites aggregate items coming from specific episodes, based on earlier Lab-TAB results (Dyson et al., 2012), were used to form the social and situational inhibition score. For example, preschool social inhibition items were taken from the fear episodes (Risk Room—Phase 2, Stranger Approach, and Scary Mask—Phase 1) and averaged to form the Preschool Social Inhibition score. Differentiating between Social Inhibition and Situational Inhibition allows studying the correspondence between Lab-TAB episodes and the parent-report measure (BIQ).

Coders agreement was evaluated through inter-rater reliability analyses both at the item and at the composite level. Measures of the inter-rater agreement at the item level are presented in Table 2.1.2 and were based on 24% of the sample (30 participants). The six composite scores computed from the Lab-TAB items showed a moderate to an excellent inter-rater agreement (intraclass correlation coefficient, ICC, ranging be-tween

0.66 and 0.94); only the Social Inhibition and the Total Inhibition scores from the Middle Childhood Lab-TAB version did not reach good levels of agreement between the two raters, respectively (ICC = 0.66 and ICC = 0.73). Whenever an item or composite score showed a lower inter-rater agreement (below 0.75), the video records for each child were re-screened, allowing for the two raters to form a consensual score to be used in the final data analysis.

Data Analysis

The data analysis was carried out using IBM SPSS (version 25.0). Inter-coder reliability was analyzed through the intraclass correlation coefficient (ICC), an adequate agreement index for quantitative variables (the two-way random, absolute agreement inter-rater ICC was used); Cohen's kappa (*k*) was used for chance-corrected inter-rater agreement in dichotomous variables. Before analysis, data were screened for missing values. Missing data occurred mainly in parent questionnaires (three participants missed one or two items in the sociodemographic questionnaire; one participant did not complete some BIQ items; four participants did not fill the POM questionnaire; two participants did not complete some SIPAAS items). Considering the relatively small amount of missing data, values were imputed using the SPSS Missing Value Analysis Expectation-Maximization algorithm whenever necessary for the analysis.

RESULTS

The subsets of the items used in each episode to compute the episode-level as well as the dimension-level composite scores are presented in Table 2.1.2. Inter-rater agreement indexes for each item (ICC) were always above 0.50, and most of them (84%) may be considered good or excellent (ICC > 0.75; Liljequist et al., 2019). Item-to-total corrected correlations for each episode suggest adequate item discrimination (mean r > 0.50, except for the Storytelling where mean r = 0.46).

Table 2.1.2.

Lab-TAB Behavioral Inhibition composite scores: structure and internal consistency

Dimensions	Episodes (and items)	Episodes score internal consistency (alpha)	Corrected item-total *r* (mean)
	Lab-TAB Preschool version		
Total Inhibition (alpha = 0.83)	Average of all the Social and Situational Inhibition items		
Social Inhibition (alpha = 0.81)	Risk Room (four items): Reference experimenter* (ICC = 0.81); Reference the parent (ICC = 0.76); Distress vocalizations (ICC = 0.80); Wary/fearful facial affect (ICC = 0.96) (all items recorded during the interaction with the experimenter—phase 2)	0.68	0.50
	Stranger Approach (four items): Peak intensity of fear expression (ICC = 0.88); Intensity of decrease in activity (ICC = 0.89); Peak intensity of avoidance behaviors (ICC = 0.99); Intensity of gaze aversion (ICC = 0.81)	0.78	0.59
	Scary Mask (six items): Intensity of facial fear expression (ICC = 0.89); Intensity of body fear expression (ICC = 0.98); Avoidance behavior (ICC = 0.96); Gaze aversion (ICC = 1.0); Fidgeting (ICC = 0.60); Approach* (ICC = 0.98) (all items recorded before presenting the scary mask—phase 1)	0.82	0.60
Situational Inhibition (alpha = 0.85)	Risk Room (seven items): Wary/fearful facial affect (ICC = 0.93); Wary/fearful facial affect—minute 1 (ICC = 0.88); Latency to intentionally touch the first object (ICC = 1.0); Total amount of time playing with objects* (ICC = 1.0); Total number of objects touched* (ICC = 1.0); Tentativeness of play (ICC = 0.95); Tentativeness of play—minute 1 (ICC = 0.92) (all items recorded before interaction with the experimenter —phase 1)	0.76	0.52
	Scary Mask (six items): Intensity of facial fear expression (ICC = 0.86); Intensity of body fear expression (ICC = 0.93); Intensity of vocal distress (ICC = 1.0); Avoidance behavior (ICC = 0.96); Approach* (ICC = 0.95); Fidgeting (ICC = 0.91) (all items recorded during and after the presentation of the mask—phase 2)	0.90	0.73
	Jumping Spider (seven items): Approach* (ICC = 0.98); Intensity of withdrawal (ICC = 0.96); Intensity of vocal distress (ICC = 0.60) (items recorded before knowing that the spider was a toy—phase 1); Approach* (ICC = 0.85); Intensity of withdrawal (ICC = 0.88); Intensity of vocal distress (ICC = 0.64); Plays with spider* (*k* = 1.0) (items recorded after knowing that the spider was a toy—phase 2)	0.81	0.55

	Lab-TAB Middle Childhood		
Total Inhibition (alpha = 0.91)	Average of all the Social and Situational Inhibition items		
Social Inhibition (alpha = 0.85)	Storytelling (nine items): Percent time speaking (ICC = 1.0); Intensity of facial fear (ICC = 0.79); Intensity of bodily fear (ICC = 0.62); Number of disfluencies/hesitations (ICC = 0.67); Intensity of avoidance behavior (ICC = 0.77); Presence of negativity (ICC = 0.89); Latency to first fear response* (ICC = 1.0); Presence of smiling* (ICC = 0.86); Latency to first fidgeting* (ICC = 1.0)	0.77	0.46
	Scary Mask (six items): Intensity of fear expression (ICC = 0.78); Intensity of vocal distress (ICC = 1.0); Intensity of bodily fear (ICC = 0.84); Intensity of avoidance (ICC = 0.98); Presence of negativity (ICC = 0.60); Cooperation or refusal* (ICC = 0.98) (all items recorded after removing the scary mask—phase 2)	0.93	0.79
Situational Inhibition (alpha = 0.89)	Scary Mask (eight items): Intensity of fear expression (ICC = 0.88); Intensity of vocal distress (ICC = 0.94); Intensity of bodily fear (ICC = 0.82); Intensity of avoidance (ICC = 0.57); Presence of negativity (ICC = 0.72); Latency to first clear fear response (ICC = 1.0); Intensity of approach* (ICC = 1.0); Intensity of fidgeting (ICC = 0.65) (items recorded while the stranger has the mask on—phase 1)	0.89	0.66

* Reversed scoring. For each episode, constituent items are listed, followed by ICC for inter-rater agreement; internal consistency for the episode score (Cronbach’s alpha) and item discrimination information (mean of the corrected item-to-total correlations) are also displayed.

RELIABILITY ANALYSIS

Cronbach's alpha was used to assess the internal consistency of the Lab-TAB composite scores (Table 2.1.2.). In the preschool version, all dimensions—Total Inhibition, Social Inhibition, Situational Inhibition—have good internal consistency (alpha ≥ 0.81). Although the Risk Room episode presents a slightly lower alpha (0.68), it does not re-duce the internal consistency of the final composites. In the middle childhood version, again all measures showed good internal consistency indexes, both at episode (alpha ≥ 0.77) or at dimension levels (alpha ≥ 0.85). Overall, results indicate very satisfactory levels of internal consistency for the computed BI composite scores in this sample of Portuguese children.

GENDER EFFECTS

To examine possible gender effects on the Lab-TAB episodes, we analyzed the mean differences between boys and girls (Table 2.1.3.). Results indicate the absence of significant gender effects both in the preschool and the middle childhood versions ($p > 0.5$); effects sizes ranged from small (Social Inhibition in older children, $d = -0.18$) to negligible (Total inhibition in older children, $d = 0.02$).

Table 2.1.3.

Gender effect on Lab-TAB Inhibition scores (t-test and effect sizes)

Lab-TAB Preschool version	**Girls (*n* = 32) M (SD)**	**Boys (*n* = 34) M (SD)**	***t***	***p***	**Cohen's d (95% CI)**
Total Inhibition	0.01 (0.43)	−0.05 (0.38)	0.58	0.563	0.15 (−0.34; 0.63)
Social Inhibition	0.01 (0.64)	−0.03 (0.37)	0.33	0.743	0.08 (−0.41; 0.56)
Situational Inhibition	0.00 (0.46)	−0.06 (0.52)	0.49	0.624	0.12 (−0.36; 0.60)
Lab-TAB Middle Childhood	**Girls (*n* = 33) M (SD)**	**Boys (*n* = 25) M (SD)**	***t***	***p***	**Cohen's d**
Total Inhibition	0.01 (0.62)	−0.00 (0.51)	0.05	0.960	0.02 (−0.46; 0.50)
Social Inhibition	0.04 (0.65)	−0.05 (0.55)	0.50	0.617	0.15 (−0.33; 0.63)
Situational Inhibition	−0.04 (0.81)	0.09 (0.61)	−0.28	0.519	−0.18 (−0.63; 0.30)

CONVERGENCE WITH BI PARENT REPORTS

The correlations between the BI dimensions based on the Lab-TAB and the BIQ scores are shown in Table 2.1.4.

Concerning the preschool version, the Lab-TAB Social Inhibition composite shows a positive moderate correlation with the BIQ Social Inhibition score (r = 0.31, p = 0.012) and with the subscales from this domain (exception for the Inhibition to Unfamiliar Peers). Lab-TAB Social Inhibition also correlates positively with the BIQ Situational Inhibition score (r = 0.22, p = 0.073) and with its subscales (except for Physical Challenges), although coefficients were smaller and marginally significant. The Lab-TAB Situational Inhibition composite is positively associated with the BIQ Situational Inhibition (r = 0.26, p = 0.034) and with the subscales from this domain (except for the Separation/Preschool subscale). Finally, the Lab-TAB Total Inhibition composite for the preschool version shows a positive moderate correlation with the BIQ Total Inhibition score (r = 0.33, p = 0.006) and with almost all BIQ partial scores.

Regarding the Lab-TAB composites for the middle childhood version, the pattern of correlations is like that observed with the younger group. Thus, the Lab-TAB Social Inhibition composite correlates significantly with the BIQ Social Inhibition (r = 0.35, p = 0.008) and all its subscales. The Lab-TAB Social Inhibition score also correlates with BIQ Situational Inhibition (r = 0.34, p = 0.010) and its subscales (again except for the Physical Challenges). The Lab-TAB Situational Inhibition score correlates preferably with the BIQ Situational Inhibition (r = 0.24, p = 0.071) and the Unfamiliar Situations subscale, although correlations are only marginally significant. The Lab-TAB Total Inhibition composite for the middle childhood version shows a positive moderate correlation with the BIQ Total Inhibition score (r = 0.32, p = 0.014), and with both BIQ Social and Situational scores.

Table 2.1.4.

Pearson correlation coefficients between Lab-TAB and Behavioral Inhibition Questionnaire (BIQ) inhibition scores

	Lab-TAB Preschool Version (*n* = 66)			**Lab-TAB Middle Childhood Version (*n* = 59)**		
	Social Inhibition	**Situational Inhibition**	**Total Inhibition**	**Social Inhibition**	**Situational Inhibition**	**Total Inhibition**
BIQ Social Inhibition	0.31*	0.16	0.30*	0.35**	0.09	0.28*
Unfamiliar Adults	0.33**	0.13	0.29*	0.23º	0.08	0.20
Unfamiliar Peers	0.17	0.11	0.18	0.27*	0.02	0.20
Performance	0.31*	0.16	0.30*	0.36**	0.14	0.31*
BIQ Situational Inhibition	0.22º	0.26*	0.33**	0.34**	0.24º	0.34**
Separation/Preschool	0.21º	0.14	0.23º	0.27*	0.17	0.26*
Unfamiliar Situations	0.26*	0.25*	0.34**	0.35**	0.22º	0.34**
Physical Challenges	0.02	0.26*	0.21º	0.16	0.20	0.20
BIQ Total Behavioral Inhibition	0.26*	0.25*	0.33**	0.36**	0.17	0.32*

º $p < 0.1$; * $p < 0.05$; ** $p < 0.01$.

Overall, significant positive moderate correlation coefficients ($r \sim 0.3$) were observed between the same constructs measured by BIQ and by Lab-TAB, although correlations were weaker for the situational domain. The cross-correlations between Lab-TAB Social Inhibition and BIQ Situational Inhibition, observed in both versions of the Lab-TAB, suggest a limited discriminant validity between these measures of the inhibition subdimensions. In fact, although Social and Situational scores correlate positively (reflecting the existence of a latent generic BI dimension), correlations are far stronger for BIQ measures ($r = 0.80$, $p < 0.001$ and $r = 0.77$, $p < 0.001$, respectively, for the preschool and the middle childhood group) than for Lab-TAB measures ($r = 0.23$, $p = 0.069$ and $r = 0.53$, $p < 0.001$, respectively, for the preschool and the middle childhood group).

DO PARENTAL VARIABLES EXPLAIN THE REDUCED CONVERGENCE BETWEEN BI MEASURES?

Hierarchical regression analyses were performed, estimating the contribution of parental variables (measures of anxiety and avoidance in social situations, parental overprotection, as well as age and educational level of the parent) and offspring in-formation (age and gender of the assessed child, number of siblings and birth order) in explaining the additional variability shown by the parental report of BI after controlling for the observational measures provided by Lab-TAB episodes. Due to the small number of fathers who completed the BIQ (only 32), we confined this analysis to those children whose BIQ was filled out by their mothers (Preschool sample: $n = 48$; Middle Childhood sample; $n = 44$).

In the regression analysis corresponding to the preschool children, the Lab-TAB Total Inhibition score was entered in the first step to explain the BIQ Total Inhibition score and, as expected, contributed positively to its variance ($R^2 = 0.091$; $\beta = 0.31$, $p = 0.038$). The parental and family variables entered in the second step and their contribution to BIQ was evaluated through a stepwise approach. Only birth order emerged with a significant negative contribution ($\Delta R^2 = 0.115$; $\beta = -0.45$, $p = 0.014$), indicating that when the preschooler being assessed is a first child mothers may overestimate more his/her BI (compared to BI observational measures), while such overestimation will be smaller for a second or a third child. From the remaining variables that did not enter the regression model, only child's age showed a marginally significant contribution ($\beta = 0.26$, $p = 0.076$) to BIQ after Lab-TAB being partialed-out, suggesting that mothers may tend to overestimate the BI of their older children when compared to the BI observational measures.

Regarding the middle childhood subsample, Lab-TAB Total Inhibition explained only a marginally significant amount of mother's BIQ Total inhibition scores variance ($R^2 = 0.072$; $\beta = 0.27$, $p = 0.078$). In the second step, mothers' avoidance ($\beta = 0.44$, p = 0.001), mother's age ($\beta = -0.45$, $p = 0.001$) and children's age ($\beta = 0.29$, $p = 0.023$) contributed significantly to the differences between Lab-TAB and BIQ measures of BI ($\Delta R^2 = 0.383$, $\Delta p < 0.001$).

DISCUSSION

Behavioral Inhibition is one of the temperament dimensions most commonly studied in childhood, being recognized as an important risk factor for the development of Social Anxiety and other psychological disorders (Feola et al., 2019). The most widely used approach to assess early temperament is based on parental or teachers' reports. However, relying exclusively on adult-ratings for studying child temperament has well-known limitations, as several biases can affect the assessment of young children (Durbin et al., 2007; Zentner & Shiner, 2012). For that reason, many investigators include in their studies some form of observational assessments, such as the Laboratory Temperament Assessment Battery (Lab-TAB). Unfortunately, there is a lack of observational temperament measures available for non-English speaking countries, including Portugal.

Therefore, the main objective of this paper was the adaptation of six Lab-TAB episodes to provide an observational measure of Behavioral Inhibition for Portuguese-speaking children. The adaptation involved a careful translation of the original manuals and scoring grids to the European Portuguese, as well as the instructions to be given to children in each episode.

Considering the observational nature of the data collected with Lab-TAB episodes, two observers were used to record and code data in this adaptation study. The obtained degree of agreement between these two independent observers was strong, both at the item and the composite scores level, indicating that Lab-TAB observation and scoring procedures ensure consistent scores, even when the application involves only a single coder. Similar levels of agreement between raters have been observed in studies using Lab-TAB to evaluate temperament dimensions (Pfeifer et al., 2002; Planalp et al., 2017).

In this study, we propose two BI composites obtained through the aggregation of the items obtained in six Lab-TAB episodes. Although these episodes are part of the Fear and the Social Inhibition sets, some of them take place in two phases, each phase imposing a different degree of social and situational pressure on the child. For this reason, and unlike other authors who used the same episodes to obtain similar measures, the BI composite scores proposed here were not always based on the entire episode but on their different meaningful phases. Thus, for the preschool-aged children (3–5 years), the measure for BI in situational contexts was based on behavioral and emotional indicators recorded during the first phase of the Risk Room episode (when the child is left alone to explore various unfamiliar objects), the second phase of the Scary Mask episode (when the adult takes off the scary mask and invites the child to touch it), and the Jumping Spider episode (where the child is invited to touch a jumping spider, only to find out that it was a toy). The measure for BI in social contexts was based on different epochs of the same episodes, namely the second phase of the Risk Room episode (when the unfamiliar experimenter invites the child to explore the al-ready known objects in the room), the first phase of the Scary Mask episode (when a friendly but unfamiliar adult enters the room where the child has left alone and speaks to him/her) and the Stranger Approach episode (when the child is approached by an unfamiliar adult). For the older children (6–9 years), the measure for BI in situational contexts was based exclusively on the first phase of the Scary Mask episode (when an adult enters the room wearing a scary mask but does not interact with the child). The measure for social contexts was based on the Storytelling episode (the child is asked to describe what he/she did the previous day in front of the experimenter and the camera operator) and on the second phase of the Scary Mask episode (when the strange adult takes off the mask and interacts with the child).

The psychometric reliability analysis of the Lab-TAB BI composite scores (Social Inhibition, Situational Inhibition, and Total Inhibition) demonstrated high values of internal consistency in our sample for the two versions under study (0.81 ≤ Cronbach's alpha ≤ 0.91), although slightly higher for the Middle Childhood version. These findings converge with those published in the literature (ranging from 0.56 to 0.90, in Gagne et al., (2011) and support the use of these composites as reliable measures for children's BI in social and situational contexts. Internal consistency at the episode level was also satisfactory: all episodes showed good to excellent alpha coefficients (0.76 ≤ alpha ≤ 0.93), except for the Risk Room episode (alpha = 0.68). However, we decided to keep this episode in the preschool Social Inhibition composite score due to its moderate correlation with the Social Inhibition measure taken from parental reports ($r = 0.39$, $p = 0.001$).

Regarding convergence with BI parental reports, Lab-TAB inhibition scores showed weak to moderate correlations with the corresponding BIQ measures ($0.24 \leq r \leq 0.36$), with somewhat stronger coefficients for social (when compared to situational) contexts. These findings are comparable to the published results mentioned in the Introduction, where the median correlation between observational and parent-report measures was only $r = 0.25$. According to the authors of these previous studies e.g., (Gagne et al., 2011; White et al., 2011), weak associations are expected, considering the lack of specific correspondence between adult-report and observational approaches to temperament assessment.

A more detailed analysis of the correlations between BIQ and Lab-TAB measures revealed that, while Lab-TAB Situational Inhibition correlates exclusively with BIQ Situational Inhibition, Lab-TAB Social Inhibition correlates both with BIQ Social Inhibition and BIQ Situational Inhibition scores. These results are open to several interpretations, but the strong correlation between BIQ dimensions ($r \sim 0.8$) suggests that cross-correlations between assessment domains (social vs. situational) may partly arise from parents' reduced ability to accurately discriminate aspects of social and situational nature in their children's inhibited behavior.

Despite its putative sensitivity to social and situational contexts, Lab-TAB Situational Inhibition and Social Inhibition composites are positively correlated (Preschool version: $r = 0.23$, $p = 0.069$; Middle Childhood version: $r = 0.53$, $p < 0.001$), so the limited discriminant validity between these BI composites cannot be discarded. This result di-verges from a previous study (Dyson et al., 2011) that obtained a null correlation between Lab-TAB indices of social and non-social BI ($r = 0.07$, $p = 0.08$), suggesting that such scores were tapping distinct constructs. However, the episodes used to compute the BI score were not the same in both studies (only Risk Room and Strange Approach episodes were shared). Also, the sample in Dyson's study was younger (mean age = 42 months) than the Preschool group in the present study (mean age = 54 months). Further studies should explore the shared variance between social and non-social inhibition measures to clarify if these observational measures are targeting different constructs.

Gender differences were also analyzed for the BI composites of the two Lab-TAB versions. Although girls tended to obtain slightly higher scores than boys, differences were small or negligible and non-significant (Cohen's $d < 0.18$), confirming a recent meta-analysis of gender differences in temperament (Else-Quest et al., 2006) that reported a small, but significant effect favoring girls in shyness and fear ($d = 0.10$ and $d = 0.12$, respectively; $p < 0.05$). Most studies of gender differences in child temperament have relied on parent report measures of temperament (Olino et al., 2013), so the present result suggests that the Lab-TAB BI composites may not introduce biases that systematically favor one gender.

Given the weak association found between BI observational measures and parent reports, the second goal of this study sought to determine if parental sociodemographic and family variables could explain the differences found. In the preschool group, results suggested that discrepancies between mother reported and observational measures of behavioral inhibition may be negatively associated with birth order of the child: when assessing their first child, mothers' report tends to overestimate behavioral inhibition (compared to laboratory observations). This result reinforces the hypothesis that sometimes typical traits of development, such as shyness and inhibition, can be misinterpreted by less "expert" mothers, who have not had enough experience to accurately judge the behavior of their first child (Kagan et al., 2002). A marginally significant result also suggests that mothers tend to score their preschool child as more inhibited than observational measures when the child is older.

In middle childhood, the differences between observational measures and parental reporting seem to be associated with mother anxious symptomatology (avoidance), suggesting that more avoidant mothers perceived their children as more inhibited. These findings are similar to previous studies showing that anxious parents are more reclusive and focused and tend to evaluate their children as more inhibited and vulnerable (Schrock & Woodruff-Borden, 2010; Turner & Barrett, 2003). The overestimation of BI by avoidant mothers may also reflect disorder-relevant biases (Chronis-Tuscano et al., 2009); such biases can also make part of the implicit plan in a strained mother–child relationship that may later originate Social Anxiety in the child or exacerbate symptoms for both (Svihra & Katzman, 2004). The negative contribution of mothers' age in the middle childhood sample also indicates that younger mothers tend to report higher BI for their children when compared to BI levels captured through direct observation. Again, this result may reflect the effect of less maternal experience on the assessment of the child's traits. Finally, and like observed in the Preschool sample, mothers of school children have a greater propensity to overestimate the characteristics of BI in their children when they are older. This effect may arise from mothers' ratings being influenced by their expectations about age-appropriate behavior rather than their own child's behavior (for in-stance, "He is not that young anymore to be so shy").

Overall, the present investigation allowed us to verify one of the major disadvantages of parental reporting: that it may be biased by parent expectations or by pa-rental personal characteristics (Lahat et al., 2011; Yap & Jorm, 2015), serving as a projection of their personality (Karp et al., 2004). However, the effects observed in regression analysis are small (especially for the Pre-school sample), indicating that other relevant variables not considered here could be influencing the parental report. Furthermore, the weak correlations between parent reports and laboratory measures suggesting that the variance of the BIQ scores not explained by the Lab-TAB composites may reflect the unique privileged perspective the parents have on the inhibited temperament of their children. As Bates and Bayles (1984) suggested, parent reports on infant temperament contain both an objective com-ponent (i.e., a description of the actual child behavior) and a subjective component (i.e., reflecting characteristics of the informant). This objective component may not overlap with the component targeted by the observational approaches since parents have a better knowledge of child traits and behaviors expressed at a low base rate that cannot be reliably captured in a single visit to the laboratory.

Therefore, a multi-method measurement approach, incorporating unique perspectives from parents and laboratory observation, would potentially provide a more comprehensive assessment of child BI and clarify the existing differences between approaches (Hwang & Rothbart, 2003). However, the question as to whether using different informants captures the contextual variations in BI manifestations or instead just reflects different perceptions or beliefs will require further empirical evidence. The incremental validity (Hunsley & Meyer, 2003) of Lab-TAB measures, when compared to parental or educators reports about BI, also needs additional empirical support. Inferences about the incremental validity of a new measure are conditional and depend on the criterion measures that are being explained (for instance, anxiety or externalized symptoms) or on the contexts and populations that are being assessed (Izquierdo-Sotorrío et al., 2016). Incremental validity is particularly relevant for observational measures, considering their cost-effectiveness in relation to more readily obtainable measures (Haynes & Lench, 2003). So, it is essential to assess if the amount of BI variability provided by Lab-TAB measures and not overlapping with parental reports is conveying important information to explain and predict children's specific behaviors or symptoms.

The Lab-TAB adaptation and the composite measures developed in this study to assess BI showed good psychometric quality and are appropriate to Portuguese-speaking samples, both in clinical and research contexts. Regardless of these encouraging results, this study does have some limitations. The sample size is relatively modest, which may have contributed to a lack of statistical power (namely, only moderate to large correlations – $r > 0.3$ – could be detected as statistically significant). The study of the validity of the BI measures provided by Lab-TAB was restricted to the analysis of the convergence with parental reports, which is very limited in scope. Although temporal stability of the temperament measures is particularly relevant here, test-retest reliability analysis using the same laboratory tasks is not appropriate. The loss of the intended effect associated with the novelty of some Lab-TAB episodes would make it difficult to know if any observed behavioral changes observed would be due to the habituation of the child to the context or due to the inconsistency of the measurements. It should also be noted that it would have been ideal to adapt the more Lab-TAB episodes for preschool and middle childhood. However, given the arduous nature of this undertaking, i.e., the difficulty of using laboratory-based temperament-eliciting episodes in a controlled setting, we restricted this European Portuguese version to the relevant episodes for the present investigation.

Future directions include conducting a longitudinal study using a multi-method approach to examine the developmental trajectories of BI in order to obtain a deeper understanding of the role of variables such as effortful control (Carrasco et al., 2015; White et al., 2011) in the stability and change of BI across childhood. Such a longitudinal design would also allow to explore the temporal stability of the measures and to explore variables that may ex-plain the differences between observational measures of BI and measures obtained by parental reporting. Both Lab-TAB and parent-rated assessments can be used to examine BI dimensions in preschool to middle childhood and be used to predict related child health and educational outcomes such as behavioral maladjustment and school readiness.

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STUDY TWO: Portuguese adaptation of the Behavioral Inhibition Questionnaire (BIQ)

ABSTRACT

Behavioral inhibition (BI) is a temperamental trait characterized by a consistent pattern of behavioral and emotional responses to unfamiliar people and novel situations. BI exhibits moderate stability across development and is considered a risk factor for the emergence of emotional disorders in adolescence and adulthood, making early assessment crucial for understanding this behavioral pattern. In the Portuguese context, there is a paucity of measures specifically designed to assess BI in childhood. To address this gap, we aimed to adapt and examine the psychometric properties of the Behavioral Inhibition Questionnaire (BIQ) in Portuguese children. We obtained BIQ ratings from both parents and teachers of 435 children (average age = 57.1 months; *SD* = 13.8). Confirmatory factor analysis supported a six-factor measurement model, each factor loading onto a higher-order BI factor. Additionally, we included a method factor to account for reversed items. Full scalar measurement invariance across gender and age groups was supported. Parents and teachers showed good agreement in their ratings of BIQ scores. Comparisons with other instruments revealed good convergent validity. The BIQ scores showed acceptable reliability, although the subscales exhibited limited sensitivity in discriminating between different contexts where BI may manifest. This study suggests that the BIQ is a reliable and valid tool for assessing BI in Portuguese children.

Keywords: behavioral inhibition; temperament; BIQ; children; Portuguese sample; psychometric properties

INTRODUCTION

Behavioral inhibition (BI) is a temperamental predisposition that manifests as heightened sensitivity to new stimuli and a tendency to avoid unfamiliar people, situations, and objects (Kagan et al., 1984). Approximately 15% of children exhibit BI, characterized by reduced approach, caution, and withdrawal in response to unfamiliarity (Kim et al., 2011). BI can be observed across various social and non-social contexts, including interactions with unfamiliar adults or peers, encounters with novel objects and participation in low-risk physical activities (G. Kochanska & Radke-Yarrow, 1992; Reznick et al., 1986).

BI is recognized as a significant risk factor for anxiety disorders, particularly social anxiety disorder, in later childhood and adolescence (Chronis-Tuscano et al., 2009; Clauss & Blackford, 2012). Additionally, BI seems to be involved in the manifestation of other psychological disorders, including selective mutism (Peter Muris et al., 2015), autism spectrum disorders (Schiltz et al., 2018), schizophrenia (Brandee Feola et al., 2019), general substance abuse (Lahat et al., 2012), psychopathic-like personality (Glenn et al., 2007; Salekin, 2017), and depression in young adulthood (Caspi et al., 1996; Jaffee et al., 2002). Due to its transdiagnostic nature, it is crucial to develop and validate reliable remeasures for assessing BI (Brandee Feola et al., 2019).

While the relevance of BI manifestations during childhood is well-established, to our knowledge there are a limited number of report measures specifically tailored to assess BI in preschool years. This measures include the Preschool Behavioral Inhibition Scale (P-BIS; Ballespí et al., 2012), the Behavioral inhibition/Behavioral activation scales (BIS/BAS; Carver & White, 1994), the Temperament Assessment Battery for Children – Revised (TABC-R; Presley & Martin, 1994) and the Behavioral Inhibition Questionnaire (BIQ; Bishop et al., 2003). However, P-BIS and BIS/BAS scales focus solely on BI in social situations, while TABC includes only one subscale dedicated to BI. In our opinion, the BIQ stands out as the most comprehensive tool for assessing BI in preschool children. as it utilizes parent and teacher reports to capture BI across a diverse range of novelty contexts (Bishop et al., 2003). Drawing upon Kagan's theory, the BIQ comprises 30 items (28 items for the teacher version) organized into six contexts reflecting three broad domains: social novelty (unfamiliar adults, unfamiliar peers, performance situations), situational novelty (separation/preschool, unfamiliar situations) and physical challenge.

The validation of the original Australian BIQ version (Bishop et al., 2003) was based on the reports of 613 mothers (M age = 34.55 years, SD = 4.59), 506 fathers (M age = 37.28 years, SD = 5.50) and 585 preschool teachers about their 619 children (3-5 years; M = 48.99 months, SD = 5.92). Confirmatory factor analysis corroborated six correlated factors (associated with the six contexts) which loaded onto a single higher-order construct (BI). The scale presented good reliability: Cronbach's *alpha* was above .80 for all factor scores of the teacher and parents' reports (except for the father's report on the physical challenge domain; $\alpha = .72$); test-retest reliability of parents' reports was satisfactory, ranging from .55 to .78. The agreement between reports was also adequate, with strong positive correlations between mother's and father's total scores ($r = .69$) and with teacher's total score (mother: $r = .47$; father: $r = .43$). In support of convergent validity, the BIQ total score was strongly associated with the TABC inhibition subscale (Presley & Martin, 1994) completed by parents and teachers (r ranged between .85 and .87); observational ratings, obtained while children interacted with an adult stranger, also correlated positively with the BIQ total score (r ranged between .25 and .46).

The BIQ has been translated and adapted for use in four additional languages: Dutch (Broeren & Muris, 2010), American English (Kim et al., 2011), Israeli/Hebrew (Mernick et al., 2018), and Italian (Agostini et al., 2021). There is also a Dutch abbreviated version of BIQ, comprising 14 items (Vreeke et al., 2012). Considering BIQ's dimensionality, all these studies supported the original six-factor structure proposed by Bishop and collaborators (2003), although two of them did not test the existence of a second-order generic BI factor (Broeren & Muris, 2010; Mernick et al., 2018). All studies also confirmed good reliability for the BIQ total score (internal consistency: $.92 \leq$ Cronbach's $\alpha \leq .97$), both in preschool samples (3-5 years; Agostini et al., 2021; Kim et al., 2011) and in older samples (4-15 years; Broeren & Muris, 2010; Mernick et al., 2018). All BIQ subscales also demonstrated good reliability ($.79 \leq \alpha \leq .95$), except for the Physical Challenge subscale, which consistently exhibited lower internal consistency ($.41 \leq \alpha \leq .90$). When test-retest data are available, results also support excellent time stability for BIQ total score ($.58 \leq r \leq .95$) and subscales ($.42 \leq r \leq .93$).

To date, BIQ has been applied in multiple research domains, including studies on anxiety onset risk (Bourdon et al., 2019; Dodd et al., 2020; Stumper et al., 2017; Suarez et al., 2019) and selective mutism (Peter Muris et al., 2021). It has also been used to evaluate the effectiveness of early interventions for inhibited or anxious children (Chronis-Tuscano et al., 2021; Lau et al., 2017), validate observational measures (Faísca et al., 2021), and contributed to investigations on attentional bias to threat (Fu et al., 2019; Wise et al., 2021), brain regions associated with fear response (Auday & Pérez-Edgar, 2019), and EEG measures of social anxiety in behaviorally inhibited children (Anaya et al., 2021; Poole et al., 2020).

Given the robust psychometric properties and recent applications in empirical studies, the BIQ is deemed a valuable measure for assessing children's behavioral inhibition across various social and non-social contexts as reported by adults. However, there are still some unanswered questions regarding its measurement model. The original Australian validation study reported a second-order BI factor, but only two out of four subsequent versions of the BIQ confirmed this generic factor. The other two studies (Broeren & Muris, 2010; Mernick et al., 2018) did not provide any rationale for not testing its inclusion in BIQ's measurement model. Additionally, the adjustment of the BIQ's six-factor model has been suboptimal in some cases. For instance, in the original Australian study, the CFI for both mother's and father's models was below the desired level (.88 and .86, respectively), as well as the RMSEA index (.08 for both models); similar suboptimal fit indexes were reported for American Teachers (CFI = .87; RMSEA = .09), Israeli mothers (CFI = .83 and RMSEA = .09) and one of the Dutch age groups (CFI = .88; RMSEA = .08). This suboptimal fit suggests that the six-factor model might not be sufficient to capture the variance in the responses to BIQ. Each item of the questionnaire has a reversed version, one expressing an inhibited behavior (for instance, "Item 17. Is hesitant to explore new play equipment") and the other describing disinhibition and greater social adjustment of the child ("Item 29. Happily, explores new play equipment"). It is known that the presence of reverse items might affect response patterns (Suárez-Alvarez et al., 2018). While the inclusion of such items in a questionnaire aims to reduce acquiescence bias, they also make item interpretation difficult, causing confusion in the participant, activating a different response style, and even careless responding (van Sonderen et al., 2013). So, hypothesizing a method factor that encompasses all reversed items might account for the residual variance not explained by the BI six-factor model. Finally, the internal consistency of BIQ scores had been assessed almost exclusively through Cronbach's alpha index (although Composite and Guttman's split-half reliability were computed for the Italian version); but considering the BIQ hierarchical and multidimensional structure, model-based reliability analysis through omega coefficients seems to be more appropriate, since such coefficients represent the proportion of the variance of the scores due to each specific and generic factor (Brunner et al., 2012).

Our primary goal was to develop a European Portuguese version of the BIQ and assess its psychometric properties in a preschool sample using parent and teacher reports. We anticipate that this version would retain the established six-factor structure and incorporate a higher-order general BI factor, consistent with prior research. Furthermore, we plan to test a model including a method factor associated with reversed items. Additionally, we expect to observe robust reliability measures and positive correlations with established measures of behavior inhibition (e.g., TABC) and anxiety, encompassing social anxiety, generalized anxiety, and separation anxiety (e.g., Preschool Anxiety Scale – PAS). These measures have been used in prior studies that validated the BIQ (e.g., Broeren & Muris, 2010; Vreeke et al., 2013).

METHOD

PARTICIPANTS

Four hundred thirty-five children (217 girls, 49.9%), aged 3 to 6 years (M = 57.0 months, SD = 13.77), participated in the study. The study involved two versions of the BIQ: the Parent version, completed by 226 mothers, 37 fathers, and 172 by both parents (Mothers/Fathers), and the Teacher version, filled out by 54 preschool teachers.

Families with a preschool child aged between 3 and 6 years, who lived with at least one Portuguese-speaking biological parent, were eligible to participate. Children were recruited from 27 kindergartens and preschools in the Faro region (Portugal). Approximately 60% of the children had at least one sibling, occupying the first (37.4%) and second positions (50.4%,) birth order positions. Mothers had an average age of 36.2 years (SD = 5.17) and 14.9 years of schooling (SD = 3.77), while fathers were, on average, 38.6 years old (SD = 6.04) with 13.3 years of schooling (SD = 3.91).

Parents were invited to participate by providing them with an information letter and a consent form. Exclusion criteria included previous diagnosis of a major psychological or medical condition for both children and parents. Approximately 33% of the parents (443 out of the 1360 invited parents) responded positively and completed the questionnaires. Over 90% of the progenitors were Portuguese and none were excluded due to significant medical conditions or developmental disabilities. Eight parents for incomplete questionnaires.

After obtaining parental consent, teachers were asked to fill in the BIQ for each child. Fifty-four female teachers with an average age of 38.7 years (SD = 9.64) provided information about 314 children (return rate of 72.2%). To check for selection bias, children with and without teacher reports were compared based on BIQ parents' reports and did not differ in the total score or any of the six subscales.

To assess BIQ temporal stability, parents were contacted again to complete the questionnaire one month later. A total of forty-three participants (88.4% mothers: M =

37.6 years, SD = 3.94; 11.6% fathers: M = 39.5 years, SD = 5.44; Children: M = 67.1 months, SD = 18.28, 44.2% girls) completed the retest.

MEASURES

Behavioral Inhibition Questionnaire (BIQ; Bishop et al., 2003)

The BIQ assesses the frequency of children's inhibited behaviors in six contexts, which are grouped into three main domains: social novelty inhibition (adults, peers, and performance) (e.g. "Is very quiet around new (adult) guests to our home"), situational novelty inhibition (new situations, separation/preschool) (e.g., "Quickly adjusts to new situations (e.g., kindergarten, preschool, childcare)") and physical challenge (e.g., "Is confident in activities that involve physical challenge (e.g., climbing, jumping from heights)"). The BIQ has two versions, one for parents and the other for teachers. The parents' version consists of 30 items, and the teacher's version contains 28 items. Respondents classify items using a seven-point scale, ranging from 1 (almost never) to 7 (almost always). Ratings are summed up to create scores for each of the subscales (for the six contexts) and for the full scale. Items 2, 5-7, 9-11, 13-16, 19, 23-24, 26, and 29 in the parents' version and items 2-3, 5-6, 8-10, 12-15, 18, 21-22, 24, and 27-28 in the teacher's version should be reversed.

Temperament Assessment Battery for Children – Revised (TABC-R; Presley & Martin, 1994; Portuguese version, Almeida et al., 2010)

This scale measures two basic personality-behavioral dimensions in children: Inhibition and Impulsivity. To evaluate the convergent validity of the Portuguese version of the BIQ, we used the TABC-R inhibition subscale, which also has a version for parents and teachers. This inhibition subscale consists of eight items (parents' version) and nine items (teacher's version) that evaluate children's inhibited behavior (e.g., "He is shy with adults he doesn't know.") which are scored on a seven-point rating scale. The Portuguese version of the TABC-R study showed internal consistency coefficients ranging from .64 to .86 (Almeida et al., 2010). In the present study, the TABC-R inhibition subscale presented good internal consistency, both in the parents' version (Cronbach's $\alpha = .83$) and in the teacher's version ($\alpha = .87$).

Preschool Anxiety Scale (PAS; original version: Spence et al., 2001; Portuguese version: Almeida & Viana, 2013)

PAS is a parent-rated scale (28 items) measuring the level of anxiety of preschoolers (aged three to six years) in five dimensions: obsessive-compulsive disorder, social anxiety, separation anxiety, physical injury fears, and generalized anxiety. Parents are asked to rate the items from 0 (not true at all) to 4 (very often true) regarding their children's level of anxiety. Although the whole scale was applied, we only used Social Anxiety (six items; e.g., "My child feels afraid that (s)he will make a fool of him/herself in front of people"), Separation Anxiety (five items; e.g. "My child worries about being away from us/me") and the Generalized Anxiety (five items; e.g. "My child complains of feeling afraid") subscales, since there is a stronger relationship between BI and the later development of these types of anxiety. The original Australian scale, as well as the Portuguese version, demonstrated very good internal consistency, with Cronbach's *alpha* coefficients ranging from .67 to .89. In the present study, *alpha* was .69 for the Generalized Anxiety subscale, .64 for the Separation Anxiety subscale, and .75 for the Social Anxiety subscale.

PROCEDURE

Instrument Adaptation

After obtaining authorization from the BIQ authors to translate the questionnaire, two independent Psychology researchers, both native European Portuguese speakers, conducted the translation. Following Sousa and Rojjanasrirat's (2011) recommendations, a bilingual expert performed the back-translation of the consensual Portuguese version, and necessary adjustments were made. Finally, a pre-test with two participants was performed to address any comprehension issues.

Data Collection

The data collection protocol was explained to the coordinators of each preschool institution. Informed consent and questionnaires (BIQ, PAS, and TABC-R) were delivered to parents in an envelope for completion at home. Once finished, parents returned the questionnaires to preschool teachers in a sealed envelope. Additionally, 157 parents (25.8%) agreed to participate in a retest by completing the BIQ online after a 30-day interval.

This study received approval from the Portuguese National Commission for Data Protection (CNPD) and the Directorate-General for Education (nº 6313/2016).

Data Analysis

The psychometric analysis of BIQ comprised item analysis, confirmatory factor analysis, measurement invariance analysis, as well as reliability and validity assessment. Confirmatory factor analysis (CFA) was used to examine the models suggested in the literature for the BIQ factor structure. Item skewness and kurtosis in both BIQ versions fell within the acceptable limits for normality (Finney & DiStefano, 2006), with skewness ranging from -0.59 to 1.51 and kurtosis from −1.07 to 1.97. Nevertheless, Mardia's tests detected significant multivariate non-normality (all $p < .0001$). Accordingly, the measurement factor models were estimated using the MLM procedure (ML estimation with robust standard errors and scaled test statistic), as recommended by Satorra and Bentler (1988, 1994), and implemented in R's *lavaan* package (Rosseel, 2012).

Model goodness of fit was evaluated using various indices, including the chi-squared (X^2) test, Comparative Fit index (CFI), Tucker-Lewis index (TLI), and the Root Mean Square Error of Approximation (RMSEA). We used the robust version of these fit indexes, adjusted with the Satorra-Bentler scaling correction factor (Brosseau-Liard & Savalei, 2014). We evaluated the fit indices according to the recommended thresholds from Hu & Bentler (1999): RMSEA ≤ 0.06 and CFI and TLI ≥ 0.95.

To assess measurement invariance across gender and age groups, we conducted a series of tests, including configural invariance, metric invariance (factor loading invariance), and scalar invariance (intercept invariance). We omitted testing for strict invariance as residuals are not part of the latent factors and do not affect the interpretation of mean differences in the latent variables (Vandenberg & Lance, 2000). Fit criteria included the change in chi-square ($\Delta\chi^2$) and its associated *p*-value, considering that non-significant changes imply a good fit for the invariance model (Pauls et al., 2020). We also used the change in Comparative Fit Index (ΔCFI), recommended by Cheung and Rensvold (2002) as a less conservative yet viable index for model comparison in measurement invariance assessment; a ΔCFI smaller than .01 indicates invariance. When the indices present contradictory results, the decision was made based on the less conservative indicator, ΔCFI (Chen et al., 2005).

To assess the reliability of the BIQ scores, we computed Cronbach's *alpha* and two indices based on model loadings: the Omega (ω), which informs the measurement precision with which a composite score (based on the items unit weighted sum) reflects the constructs contributing to it, and the Hierarchical Omega (ωh), which evaluates how precisely such composite score assesses just one specific target construct (Brunner et al., 2012). These omega coefficients are more suitable than Cronbach's alpha for estimating the reliability of measures of hierarchically structured constructs. On the reliability domain, we also examined temporal stability (test-retest) using the observed test scores and assessed the agreement between parent and teacher reports.

To validity analysis, we calculated Pearson correlation coefficients to assess the convergence of BIQ scores with concurrent conceptually related measures.

RESULTS

CONFIRMATORY FACTOR ANALYSIS

To examine the structure of the BIQ, we conducted separate confirmatory factor analyses for parent and teacher reports, considering four different measurement models: (1) a single-factor model, (2) a three-factor model with correlated factors, (3) a six-factor model with correlated factors, and (3a) a six-factor model with all factors loading onto a higher-order factor. Cross loadings and correlated residuals were not allowed in any of these models, and factor covariances were freely estimated.

Model 1 assumes that all items load onto a single dimension. While all items had significant loadings on this dimension, the fit indices suggested that this one-factor solution did not adequately explain the data (Table 2.2.1.).

Model 2 proposes that the items clustered around three domains representing different contexts for BI (social novelty, situational novelty, and physical challenge). The factors showed strong correlations, except for the correlation between physical challenge and social novelty in the parents' report. All items loaded significantly on the corresponding factors. Although Model 2 provided a significantly better adjustment than Model 1, the fit indices still indicated a poor fit.

Model 3 hypothesizes that the items clustered around six correlated contexts (peer situations, unfamiliar adults, performance, separation/preschool, unfamiliar situations, and physical challenge). Factors showed moderate to high estimated correlations, with all items significantly loading onto their respective factors, most of them having standardized loadings above .50. While Model 3 demonstrated a better fit than Model 2 in both parent and teacher reports, the fit indices still did not reach satisfactory levels.

The correlation pattern between the first-order factors supported a second-order factor model (Model 3a), although a Heywood case occurred for the parents' data (the relationship between the second-order factor and the New Situation factor showed a standardized coefficient slightly above 1, resulting in a negative estimated variance). However, this negative estimate was statistically nonsignificant, likely due to sampling error rather (Dillon et al., 1987). Following Savalei and Kolenikov (2008) recommendation, we retained the estimated value of the variance. Since Model 3a proposes that the covariances between the six first-order factors are explained by a single higher-order factor representing general BI, the fit of this second-order model was expectedly worse than Model 3; however, the difference was minimal. Additionally, we calculated the target coefficient (Marsh & Hocevar, 1985), which indicated that the second-order general BI factor accounted for almost all of the covariance among the six BIQ contextual dimensions (the target coefficient was .98 for parent reports and .92 for teacher reports). The loadings of the factors on the higher-order factor were all significant and high. The loading of the New Situation factor on the general BI was notably high (close to one: parents = 1.01; teachers = 0.99), suggesting that New Situations and general BI may be addressing the same conceptual dimension.

Since none of the previous models yielded an optimal fit, we included a method factor, as hypothesized in the Introduction, encompassing all the reversed items that express disinhibition and greater social adjustment in the child (Model 4a).

Table 2.2.1.

Models for the Behavioral Inhibition Questionnaire (BIQ) – fit indexes for Parents' and Teacher versions

	Model	χ^2	*df*	*p*	χ^2 /*df*	CFI	TLI	RMSEA	*CM*	$\Delta\chi^2$	*Δdf*	*Δp*
	Parents' version (N = 435)											
1.	1 factor	2061.627	405	< .001	5.090	.673	.649	.107				
2.	3 correlated factors	1892.638	402	< .001	4.708	.705	.681	.102	M1	168.989	3	< .001
3.	6 correlated factors	1260.087	390	< .001	3.231	.828	.808	.079	M2	632.551	12	< .001
3a.	6 first-order factors, 1 second-order factor [a]	1279.810	399	< .001	3.208	.825	.805	.079	M3	19.723	9	.020
4a.	6 first-order, 1 second-order factor; method factor [a]	957.003	382	< .001	2.505	.885	.862	.065	M3a	322.807	17	< .001
4b.	6 first-order, 1 second-order factor; method factor [a]; 1 covariance [b]	870.024	381	< .001	2.284	.902	.888	.060	M4a	86.979	1	< .001
	Teacher version (N = 314)											
1.	1 factor	1447.267	350	< .001	4.135	.772	.753	.110				
2.	3 correlated factors	1198.452	347	< .001	3.454	.823	.808	.097	M1	248.815	3	< .001
3.	6 correlated factors	866.364	335	< .001	2.558	.891	.877	.078	M2	332.088	12	< .001
3a.	6 first-order factors, 1 second-order factor	937.115	344	< .001	2.724	.878	.866	.081	M3	70.751	9	< .001
4a.	6 first-order, 1 second-order factor; method factor	779.606	329	< .001	2.370	.908	.894	.072	M3a	157.509	15	< .001
4b.	6 first-order, 1 second-order factor; method factor; 1 covariance [c]	729.982	328	< .001	2.226	.918	.905	.069	M4a	49.624	1	< .001

Note. χ^2 = chi-square statistic; *df* = degrees of freedom; *CFI* = Comparative fit index; *TLI* = Tucker-Lewis index; *RMSEA* = Root mean square error of approximation; *CM* = Comparative Model
[a] Occurrence of a non-positive variance estimate
[b] Covariance between items 6 and 21 error terms was added
[c] Covariance between items 5 and 20 error terms was added

Model 4a displayed a significantly better fit compared to Model 3a for both BIQ versions (Table 2.2.1). All items retained significant loadings on the BI factors, most exceeding .50. The reversed items exhibited small to medium-sized loadings on the method factor (ranging from -.24 to -.52 in the parent version and from -.03 to -.49 in the teacher version). Nevertheless, Model 4a still provides only a suboptimal fit for the data.

Modification indices suggested adding a covariance path between error terms for two items in the Performance domain (items 6 and 21 for the parent version, r = .49; and the corresponding items 5 and 20 for teacher version, r = .44). This modification resulted in an adjusted model (Model 4b; Table 2.2.1) both for the parent ($\chi 2$ (381) = 870.024, CFI = .902, TLI = .888, RMSEA = .060), and teacher versions ($\chi 2$ (328) = 729.982, CFI = .918, TLI = .905, RMSEA = .069). Standardized coefficient estimates for the final model of parents' and teacher BIQ versions are provided in Figures 2.2.1. and 2.2.2., respectively.

Figure 2.2.1.

Measurement model for BIQ Parent version (standardized parameter estimates)

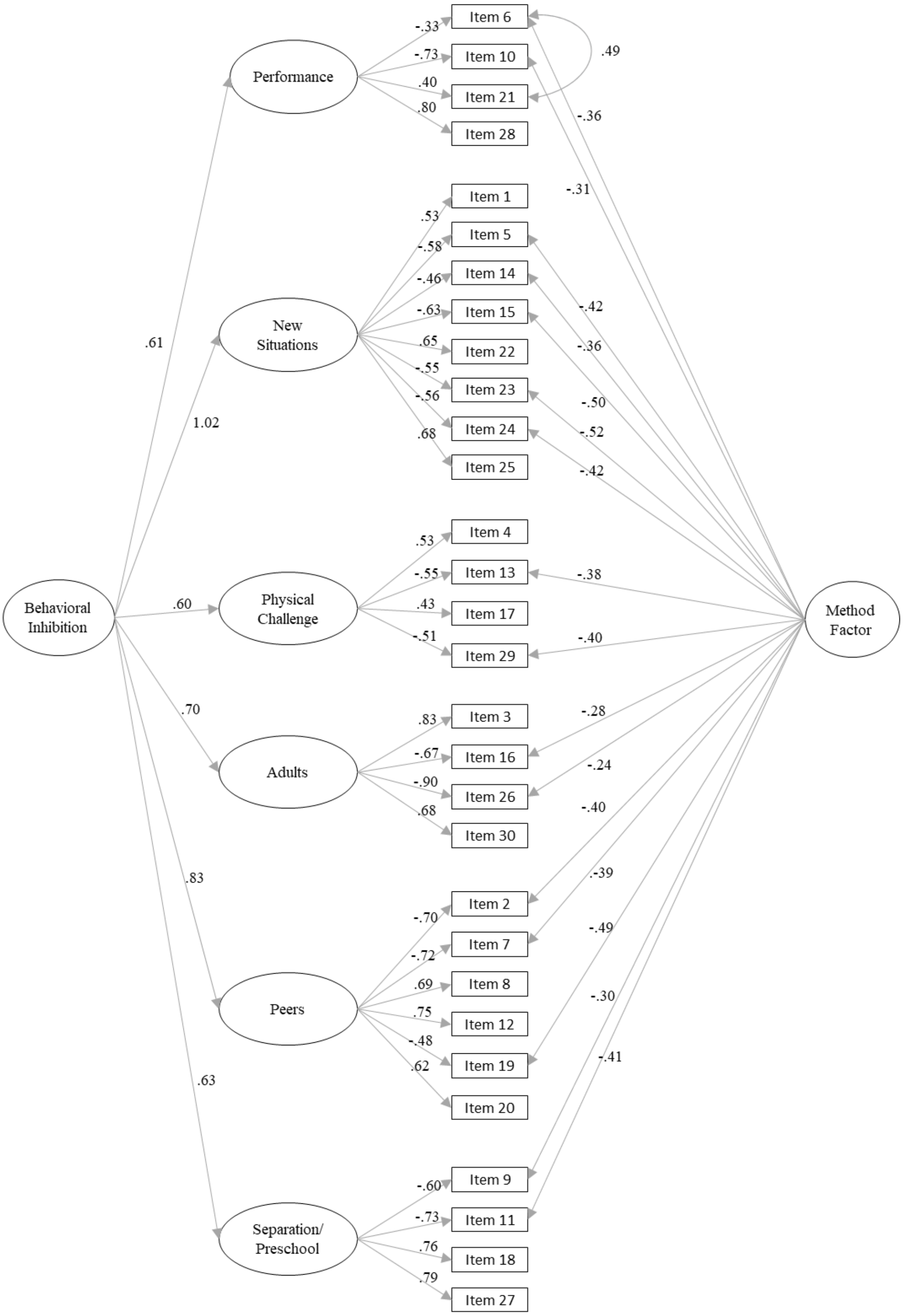
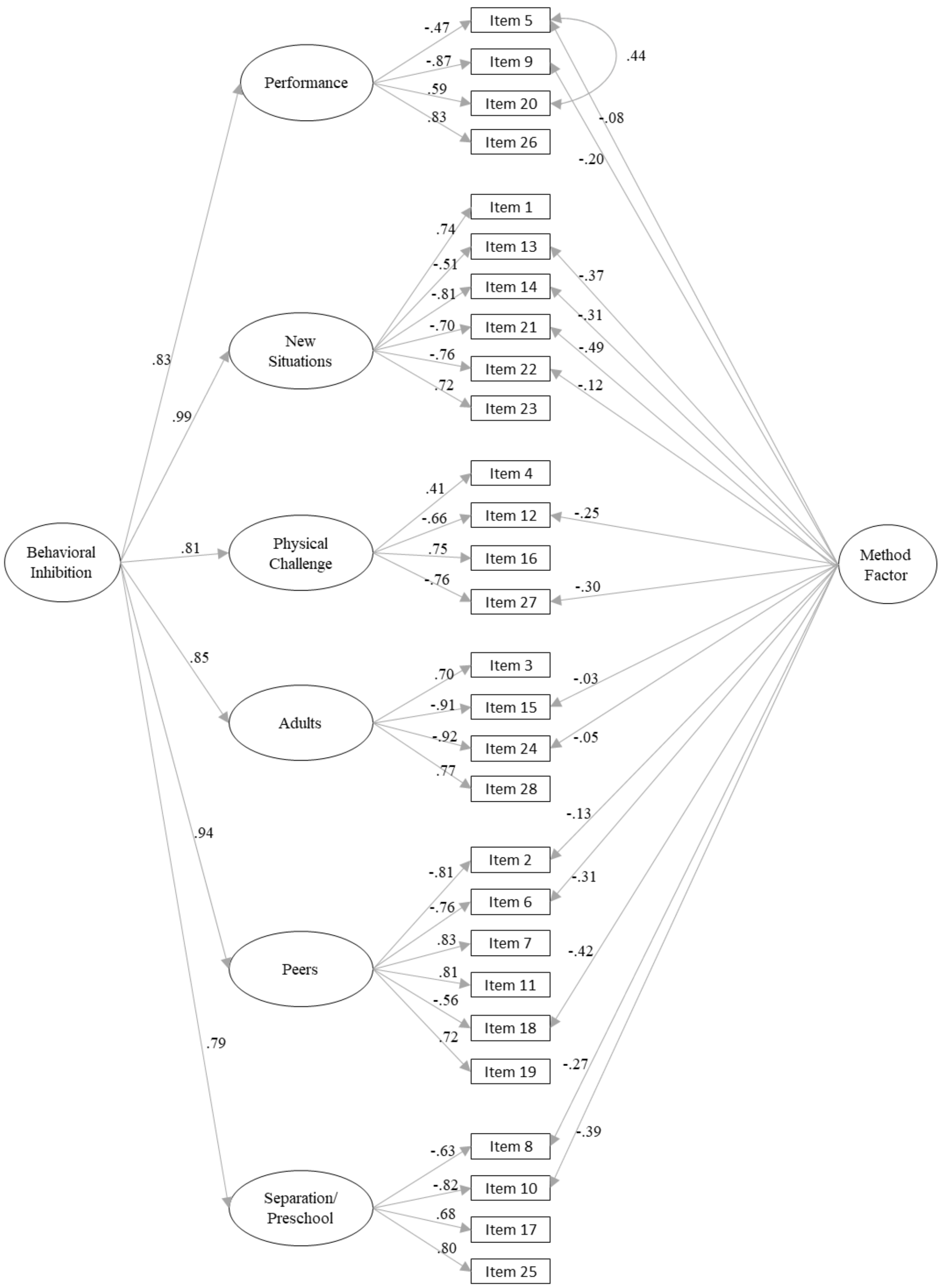


Figure 2.2.2.

Measurement model for BIQ Teacher version (standardized parameter estimates)



To determine if the final structure model for BIQ differs by gender or age group (3-4 vs. 5-6 years), we conducted measurement invariance analyses using a stepwise multigroup comparison approach. Table 2.2.2 presents fit measures for gender invariance testing in both parent and teacher models. Configural invariance imposed no cross-group constraints (Model 1) and showed a satisfactory fit for the entire sample, indicating that the factor structure of BIQ was the same for both girls and boys. Metric invariance was tested by constraining all first-order factor loadings to be equal across gender groups (Model 2a). Results revealed a significant but non-substantial change compared to Model 1 (significant $\Delta\chi2$ test), with minimal differences in CFI (ΔCFI = .002) for the parent version. For the teacher version, both the $\Delta\chi2$ test (p = .139) and CFI differences (ΔCFI = .002) indicated that first-order factor loadings were invariant across gender. When cross-group equality on second-order factor loadings was imposed (Model 2b), we obtained a satisfactory fit for both BIQ versions. This suggests that the second-order factor loadings were equivalent, allowing for meaningful comparisons between boys and girls. Scalar invariance, tested by constraining all item intercepts to be equal across gender (Model 3), led to

a significant reduction in overall model fit compared to Model 2b ($\Delta\chi2$ tests for both versions, $p < .001$). However, the changes in CFI were not substantial (ΔCFI < .01), indicating no appreciable difference in item intercepts across genders for both the parent and teacher versions of the BIQ.

Table 2.2.2.

Measurement Invariance across gender for BIQ parent and teacher versions

	Model	χ^2	***df***	χ^2/df	***CFI***	***TLI***	***RMSEA (90% CI)***	$\Delta\chi^2$	Δdf	Δp	ΔCFI	ΔTLI	$\Delta RMSEA$
							Parent version						
1	Configural	1235.845	764	1.618	.905	.892	.059 (.053-.065)	-	-	-	-	-	-
2a	First-order metric	1289.980	803	1.606	.903	.895	.058 (.052-.064)	52.159	39	.005	.002	.003	.001
2b	Second-order metric	1294.446	808	1.602	.903	.896	.058 (.052-.064)	3.499	5	.484	.000	.001	.000
3	Scalar	1378.974	838	1.646	.894	.890	.060 (.054-.065)	121.813	30	< .001	.009	.006	.002
							Teacher version						
1	Configural	1049.772	656	1.600	.920	.908	.067 (.060-.075)	-	-	-	-		-
2a	First-order metric	1095.028	692	1.582	.918	.911	.066 (.059-.074)	45.055	36	.139	.002	.003	.001
2b	Second-order metric	1099.832	697	1.578	.918	.912	.066 (.059-.073)	4.209	5	.440	.000	.001	.000
3	Scalar	1160.876	725	1.601	.913	.909	.067 (.060-.074)	71.367	28	< .001	.005	.003	.001

Note. χ^2 = chi-square statistic; *df* = degrees of freedom; *CFI* = Comparative fit index; *TLI* = Tucker-Lewis index; *RMSEA* = Root mean square error of approximation (and its 90% confidence interval); $\Delta\chi^2$ = change in chi-square; *Δdf* = change in degrees of freedom; *ΔCFI* = change in Comparative fit index; *ΔTLI* = change in Tucker-Lewis index; *ΔRMSEA* = Change in Root mean square error of approximation

Table 2.2.3.

Measurement Invariance across age for BIQ parent and teacher versions

	Model	χ^2	***df***	χ^2/df	***CFI***	***TLI***	***RMSEA* *(90% CI)***	$\Delta\chi^2$	Δdf	Δp	ΔCFI	ΔTLI	$\Delta RMSEA$
							Parent version						
1	Configural	1252.765	764	1.640	.900	.886	.061 (.055-.067)	-	-	-	-		-
2a	First-order metric	1303.883	803	1.624	.898	.889	.060 (.054-.066)	49.091	39	.093	.002	.003	.001
2b	Second-order metric	1307.533	808	1.618	.898	.890	.060 (.054-.066)	2.614	5	.601	.000	.001	.000
3	Scalar	1367.241	838	1.632	.894	.890	.060 (.054-.066)	68.021	30	<.001	.004	.000	.000
							Teacher version						
1	Configural	1181.763	656	1.801	.892	.875	.079 (.072-.086)	-	-	-	-		-
2a	First-order metric	1236.720	692	1.787	.887	.876	.079 (.072-.086)	56.146	36	.022	.005	.001	.000
2b	Second-order metric	1241.964	697	1.782	.887	.877	.078 (.071-.085)	5.401	5	.387	.000	.001	.001
3	Scalar	1346.479	725	1.857	.874	.869	.081 (.074-.088)	262.131	28	<.001	.013	.008	.003

Note. χ^2 = chi-square statistic; *df* = degrees of freedom; *CFI* = Comparative fit index; *TLI* = Tucker-Lewis index; *RMSEA* = Root mean square error of approximation (and its 90% confidence interval); $\Delta\chi^2$ = change in chi-square; *Δdf* = change in degrees of freedom; *ΔCFI* = change in Comparative fit index; *ΔTLI* = change in Tucker-Lewis index; *ΔRMSEA* = Change in Root mean square error of approximation

A multigroup comparison was also conducted to examine whether BIQ exhibits the same latent structure regardless of the child's age (Table 2.2.3). For both the parent and teacher versions, the configural and the full metric invariance models showed a satisfactory fit, supporting the equality of first- and second-order factor loadings across age groups. When all item intercepts were constrained to be equal across different child age groups (scalar invariance), the model's fit significantly deteriorated for both BIQ versions ($\Delta\chi 2$ test, $p < .001$). Nevertheless, due to minimal change in CFI (ΔCFI = .004), scalar invariance for age can be reasonably accepted.

In summary, BIQ features at least acceptable levels of measurement invariance (configural, metric, and scalar) across the male and female groups and age groups in the Portuguese preschool population, except for scalar invariance across age groups in the teacher version of BIQ.

RELIABILITY

The reliability coefficients for the BIQ total score (computed through item unit weighted sums) and the six context scores are shown in Table 2.2.4. Internal consistency, as measured by Cronbach's alpha (α), was found to be acceptable and good for all scores based on parent and teacher reports ($\alpha > .7$), except for the parent-reported Physical Challenge score ($\alpha = .58$).

Concerning omega reliability, the BIQ total score showed excellent levels ($\omega = .95$ for parents and $\omega = .97$ for teachers). The subscale scores also exhibited high reliability ($\omega > .7$, often surpassing .8), except for the Physical Challenge score in the parent version ($\omega \sim .6$; Table 2.2.4).

The omega hierarchical coefficient (ωh) allows for the determination of the contribution of each specific factor to the observed composite scores. The estimated proportion of variance attributed exclusively to the general BI factor was high for both versions of the BIQ (ωh = .74 for parents and ωh = .86 for teachers). The remaining proportion of variance was accounted for by specific BI contextual factors (ωh ~ .07 for both versions) and the reversed items method factor (ωh = .14 for parents and ωh = .04 for teachers). For the subscale scores, variance was primarily attributed both to the corresponding specific factor and the global BI dimension, with the method factor contributing the least (≤ .09). The specific factor often had a more substantial role than the general BI factor, although sometimes their contributions were nearly equal. This was particularly notable in the score for Adults and Physical Challenge in the parent version and the scores for Adults, Performance, and Separation scores in the teacher version.

Table 2.2.4

Scores computed from BIQ: Means, Standard Deviations, Coefficient alpha, and Model-based Reliabilities (ω and ωh) for Parent and Teacher BIQ versions

	BIQ Scores	M (DP)	α	Ω	ω without Method factor	Decomposition of the Scale Score Variance			
						% due to BI target construct	% due to BI nontarget constructs	% due to the Method factor	% due to error
Parent version (n = 435)	Total BI	3.21 (0.90)	.93	0.946	0.810	0.736	0.074	0.136	0.054
	Social inhibition	3.31 (1.02)	.89	0.906	0.820	0.618	0.202	0.086	0.060
	Adults	3.43 (1.32)	.87	0.870	0.846	0.441	0.405	0.024	0.130
	Peers	3.21 (1.19)	.84	0.855	0.770	0.249	0.520	0.085	0.145
	Performance	3.34 (1.20)	.74	0.707	0.651	0.441	0.210	0.056	0.293
	Situational Inhibition	3.16 (1.00)	.88	0.904	0.745	0.650	0.095	0.159	0.096
	Separation/preschool	3.19 (1.33)	.82	0.842	0.793	0.531	0.262	0.049	0.158
	New situations	3.14 (1.03)	.84	0.870	0.720	0.007	0.713	0.150	0.130
	Physical challenge	2.99 (1.06)	.58	0.638	0.555	0.332	0.223	0.083	0.362
Teacher version (n = 312)	Total BI	3.33 (1.06)	.96	0.968	0.931	0.859	0.072	0.037	0.032
	Social inhibition	3.65 (1.15)	.93	0.950	0.937	0.777	0.160	0.013	0.050
	Adults	4.05 (1.18)	.87	0.928	0.927	0.478	0.450	0.000	0.072
	Peers	3.19 (1.27)	.89	0.908	0.878	0.179	0.699	0.030	0.092
	Performance	3.92 (1.41)	.80	0.839	0.833	0.404	0.429	0.006	0.161
	Situational Inhibition	3.02 (1.17)	.91	0.926	0.858	0.756	0.102	0.068	0.074
	Separation/preschool	3.03 (1.36)	.84	0.870	0.835	0.401	0.434	0.035	0.130
	New situations	3.02 (1.21)	.87	0.887	0.812	0.031	0.782	0.075	0.113
	Physical challenge	3.01 (1.12)	.73	0.795	0.766	0.339	0.427	0.029	0.205

The New Situations subscale was mainly explained by the general BI construct (ωh = .71 for parents and ωh = .78 for teachers), with a large contribution from the method factor (ωh = .15 for parents and ωh = .08 for teachers). Similar patterns were observed for the Peers (in both versions) and the Physical Challenge scores (in the teacher version), but to a lesser extent.

In addition to the BIQ scores, two composite scores were also considered: social and situational inhibition. While these scores were not explicitly confirmed in our factor analysis, they have been used in the literature to assess the opposition between generic social and situational contexts (Spence, 2021). Both composite scores showed good internal consistency ($\alpha \geq .88$; $\omega \geq .90$). The Social Inhibition composite score had a substantial proportion of variance attributed to latent corresponding social contexts (ωh = .62 and ωh = .78 for parents' and teacher versions). Similarly, the Situational Inhibition composite score had a significant amount of variance explained by latent situational contexts (ωh = .65 and ωh = .76 for parents' and teachers' versions).

The method factor's contribution to the BIQ scores appeared to be more pronounced in the parents' version (ranging from .02 to .16) compared to the teacher version (ranging from .00 to .08), but its impact on the score variance was small, mostly below .10. Consequently, we proceeded with analyses involving BIQ scores without explicit concern for controlling the noise introduced by the method factor.

Test-retest reliability was excellent, with ICC values ranging from .85 to .94 for the total BI score and subscales (Table 2.2.5). Pearson correlations demonstrated strong positive associations between scores at both assessment moments ($r > .77$) for all measures.

Table 2.2.5.

Parent test-retest reliability (n = 43)

BIQ Scores	Test Mean ± SD	Retest Mean ± SD	ICC (95% CI)	Pearson's Correlation
Global BI	2.98 ± 0.89	2.94 ± 0.91	.94* (.89-.97)	.882*
Social inhibition	2.91 ± 0.94	3.05 ± 0.96	.93* (.87-.96)	.864*
Adults	3.09 ± 1.31	3.10 ± 1.30	.88* (.77-.93)	.774*
Peers	3.00 ± 1.11	2.93 ± 1.06	.87* (.77-.93)	.775*
Performance	3.14 ± 1.08	3.19 ±1.11	.87* (.77-.93)	.771*
Situational inhibition	2.91 ± 0.94	2.93 ± 1.04	.93* (.86-.96)	.862*
Separation/preschool	2.83 ± 1.33	2.90 ± 1.42	.91* (.84-.95)	.840*
New situations	2.92 ± 0.88	2.95 ±. 1.04	.89* (.80-.94)	.810*
Physical challenge	2.97 ± 116	2.59 ± 0.92	.85* (.65-.93)	.797*

Note: * $p \leq .001$

RELATIONSHIP BETWEEN BIQ PARENT AND TEACHER REPORTS

The correlations between scores obtained from parent and teacher ratings were positive and significant, (Table 2.2.6). Notably, the BIQ total score reported by both teachers and parents showed a moderate positive correlation (r = .42, p < .001). Apart from the Physical Challenge score, similar findings were observed for all the other BIQ subscales (.31 ≤ r ≤ .43). The correlations between corresponding subscale scores in teachers' and parents' reports consistently showed higher values compared to correlations between non-corresponding subscales. This indicates that teachers and parents tended to provide similar assessments for the same BIQ subscales, supporting cross-informant reliability. However, it is important to note that correlations between non-corresponding subscales were also positive and significant, suggesting that the BIQ scores may have limited discriminatory ability.

Table 2.2.6.

Correlations between BIQ scores for Parent and Teacher versions (n = 314)

BIQ Scores	Teacher-reported BIQ								
	1	**1.1.**	**1.1.1.**	**1.1. 2.**	**1.1.3.**	**1.2.**	**1.2.1.**	**1.2.2.**	**1.3.**
1. Global BI	.422***	.419***	.386***	.403***	.330***	.408***	.336***	.408***	.224***
1.1. Social Inhibition	.408***	.434***	.402***	.407***	.356***	.362***	.288***	.370***	.191***
1.1.1. Adults	.346***	.366***	.373***	.338***	.278***	.310***	.249***	.315***	.161**
1.1.2. Peers	.366***	.378***	.342***	.379***	.281***	.334***	.274***	.334***	.191***
1.1.3. Performance	.258***	.294***	.244***	.243***	.307***	.213***	.154**	.229***	.092
1.2. Situational Inhibition	.397***	.368***	.323***	.375***	.275***	.414**	.352***	.405***	.223***
1.2.1. Separation/ Preschool	.286***	.238***	.201***	.250***	.175**	.332***	.329***	.291***	.166***
1.2.2. New Situations	.387**	.377**	.337**	.378***	.284***	.380***	.293***	.395***	.214**
1.3. Physical Challenge	.118*	.089	.122*	.063	.066	.136*	.114*	.134*	.109

Note: *** $p < .001$; ** $p < .01$; *$p < .05$.

VALIDITY

To assess the convergent validity of the BIQ measures, we compared scores from parents and teachers on the BIQ with the TABC-R inhibition subscale (Table 2.2.7). The correlations between the scores were moderate to high, positive, and statistically significant for both the parent and teacher ratings, providing strong evidence for convergent validity. The only exception was the correlation between TABC-R inhibition and parents' Physical Challenge score ($r = .33$, $p < .001$).

Table 2.2.7.

Correlations between BIQ scores, TABC-R inhibition subscale, and PAS social anxiety subscale

	BIQ Scores	TABC-R inhibition		PAS social anxiety		PAS generalized anxiety		PAS separation anxiety	
		Parents (n = 422)	Teacher (n = 303)	Parents (n = 337)	Teacher (n = 304)	Parents (n = 338)	Teacher (n = 301)	Parents (n = 334)	Teacher (n = 297)
BIQ - Parents version	Total BI	.823***	.437***	.586***	.387***	.256***	.034	.280***	.058
	Social Inhibition	.813***	.409***	.567***	.391***	.168**	-.024	.192***	.013
	Adults	.749***	.335***	.416***	.358***	.047	-.040	.120*	.020
	Peers	.722***	.329***	.498***	.331***	.222***	.011	.186**	-.016
	Performance	.508**	.328***	.460***	.253**	.108*	-.040	.152**	.040
	Situational Inhibition	.772***	.423***	.517***	.341**	.270***	.101	.302***	.103
	Separation/ Preschool	.622***	.307***	.299***	.173**	.205**	.172**	.250***	.180***
	New Situations	.732***	.410***	.552***	.366***	.256***	.032	.274***	.029
	Physical Challenge	.334***	.142*	.306***	.130*	.280**	.006	.259***	.026
BIQ - Teacher version	Total BI	.434***	.869***	.297***	.762***	.068	.238***	.105	.290***
	Social Inhibition	.432***	.836***	.317***	.769***	.034	.146*	.074	.178**
	Adults	.413***	.751***	.306***	.702***	.018	.152**	.090	.168**
	Peers	.403***	.772***	.283***	.712***	.053	.171**	.070	.205***
	Performance	.343***	.710**	.267***	.649***	.012	.059	.041	.092
	Situational Inhibition	.420***	.794****	.260***	.669***	.127*	.329**	.126*	.379***
	Separation/ Preschool	.374***	.614***	.189**	.485***	.148**	.293***	.139*	.389***
	New Situations	.403****	.828***	.281***	.721***	.096	.312***	.101	.321***
	Physical Challenge	.229**	.673***	.147**	.545***	-.002	.198***	.104	.296***

*** $p < .001$; ** $p < .01$; *$p < .05$.

Significant positive correlations were observed between BIQ scores and the PAS social anxiety (.30 < r < .77), PAS generalized anxiety (.11 < r < .33), and PAS separation anxiety subscales (.12 < r < .30) for both parents and teachers. These findings provide support for the construct validity of the BIQ scores, given the theoretical relationship between Behavioral Inhibition and anxiety symptomatology, particularly Social Anxiety.

DISCUSSION

The objective of this study was to adapt the BIQ to the Portuguese language and evaluate its psychometric properties. The original BIQ, created by Bishop et al. (2003), reflects a six-correlated factor structure, which has been confirmed in studies conducted in different languages (Agostini et al., 2021; Broeren & Muris, 2010; Kim et al., 2011; Mernick et al., 2018). These factors reflect the different contexts in which children's BI may occur, including unfamiliar adults, peers, performance, physical challenge, unfamiliar situations, and preschool/separation.

Our first goal was to replicate this factor structure in a sample of Portuguese preschool children. The rejection of the unidimensional model indicated that BI in this population, as measured by the BIQ, is a multidimensional construct. Furthermore, despite the BIQ's intent to represent the three domains of childhood BI (social novelty, situational novelty, and physical challenge), the three-factor measurement model did not fully capture the variability in responses. Therefore, further specification for the latent structure of the BIQ seems necessary. As in previous BIQ psychometric studies, the model with six contexts received stronger empirical support. This indicated that contexts such as the Separation/Preschool or the New Situations, for example, are distinct enough to warrant separate latent constructs associated with each of them, despite being part of the same Situational novelty domain.

A second-order factor was included in the model to represent the contribution of a general BI construct to the specific contexts (Bishop et al., 2003; Kim et al., 2011). Although all contexts exhibited high loadings on this general dimension, some unshared variability remained, indicating the specificity of the six first-order factors. Notably, the New Situations factor showed an extremely high loading, close to the boundary of the interpretable region, in both versions of the BIQ, a result consistently reported in previous psychometric studies (Bishop et al., 2003; Kim et al., 2011). The consistency across studies suggests that, according to parents and teachers, children's reactions to new situations may be driven by their general BI temperament rather than being highly specific (Broeren & Muris, 2010). However, this might also be a characteristic feature of the questionnaire, given that the New Situations context is evaluated through very general items that could potentially overlap with other BIQ first-order factors. In one way or another, the BIQ's New Situations subscale may not effectively stand out as a fully independent component of BI.

Despite limitations in model fit, the results support the notion that BI, as measured by the BIQ, is a higher-order construct with situational specificity in multiple contexts (Fox et al., 2005).

To account for the unexplained variability in participants' responses, an orthogonal method factor was introduced to capture the impact of semantically reversed items in the BIQ (van Sonderen et al., 2013). Adding this method factor significantly improved the fit of the measurement model, suggesting that item wording, especially in the case of semantically reversed items, may lead participants (particularly parents) to respond to the BIQ items in a manner inconsistent with the intended content. While we cannot yet ascribe specific meaning to this method factor, reversed items might induce informants to adopt a social desirability or acquiescence bias response strategy (Podsakoff et al., 2012). Despite the significant contribution of the method factor to the model's fit, the item loadings on this factor were relatively modest (with a median of .40 for the parent's version and .27 for the teacher's version), suggesting that its impact on the ratings may not be overly strong. We believe that including the method factor preserves the integrity of the BIQ's theoretical model while shedding light on the potential impact of semantically reversed items in the questionnaire. Further research is needed to confirm the existence of this method factor, but our current results already indicate that item wording could influence responses to the BIQ.

The inclusion of covariance between two residual errors linked to the Performance factor was unplanned but deemed necessary to address item-specific content. This particular content related to enjoying versus disliking "being the center of attention", which could be perceived as describing attention-seeking behavior rather than greater or lesser inhibition. Importantly, this adjustment, crucial for models tested on two separate groups of informants (teachers and parents), may represent a unique feature of the

Portuguese BIQ version rather than an overfitting of the model to sample-specific characteristics.

Confirmation of full measurement invariance for gender (both in the parent and teacher versions) suggests that the BIQ latent structure and the meaning of BI scores are similar for boys and girls. While gender measurement invariance has been reported (Agostini et al., 2021), inconsistent findings regarding gender differences in BIQ scores were found (Bishop et al., 2003; Kim et al., 2011; Vreeke et al., 2013), possibly influenced by methodological or cultural factors, including gender roles and cultural stereotypes which can influence informants' perceptions about BI. Further research is needed to fully understand the role of gender in individual differences in BI. Full measurement invariance for age was confirmed only in the parents' version of the BIQ, indicating that the structure and meaning of BI measures reported by parents are similar across the two studied age groups. These results are congruent with the existing literature that characterizes BI as a relatively stable construct during childhood (e.g. Agostini et al., 2021; Möhler & Resch, 2018). However, the age range within a preschool population is inherently limited, and conducting studies with broader age ranges would be valuable to clarify BIQ measurement invariance across various stages of childhood (Besi & Sakellariou, 2019; Broeren & Muris, 2010; Möhler & Resch, 2018).

The reliability results for the parent and teacher versions of the BIQ were similar and satisfactory. The Cronbach's alpha coefficients for BIQ scores were systematically above .70, indicating excellent internal consistency. However, Cronbach's alpha may not be suitable for evaluating reliability in a complex, hierarchical measurement model. Therefore, a model-based reliability approach using omega coefficients was employed (Brunner et al., 2012), enabling us to weigh the contribution of each latent dimension to the variance in scores. The results demonstrated robust omega reliability, indicating that BIQ scores effectively captured the latent variables specified in the model (even after excluding the construct-irrelevant contribution of the method factor). However, when evaluating the reliability of the BIQ subscale scores as indicators of their specifically associated constructs, the omega hierarchical coefficients were notably lower. The presence of a general second-order BI factor accounted for a substantial portion of the variance in the subscale scores, resulting in relatively low omega hierarchical coefficients associated with the specific subscale constructs (below .53). Therefore, caution should be exercised when interpreting subscale scores as a reliable measure of BI in a specific context, given that these scores are mainly driven by the higher-order BI construct. It is worth mentioning that, consistent with previous validation studies, the reliability of the Physical Challenge subscale was the lowest in our study. These consistently lower results across all validation studies suggest that the Physical Challenge subscale differs qualitatively from the other BIQ subscales. This particular subscale stands out as the only one not primarily associated with the social aspects of BI and might be just capturing elements related to anxiety, specifically the fear of physical danger or body injury, rather than aspects of BI (Agostini et al., 2021). Future studies should explore the hypothesis of removing this motor component from BI, which may not adequately reflect the BI construct.

Since the contribution of the method factor to score variance was relatively small (never exceeded 16%), we proceeded with the temporal stability and validity analyses using the manifest item unit weighted sum scores, disregarding the potential nuisance introduced by the inclusion of reversed items.

The one-month test-retest reliability for the parent version was excellent, aligning with prior research (Agostini et al., 2021; Bishop et al., 2003; Mernick et al., 2018; Vreeke et al., 2013), reinforcing the temporal stability of the BIQ scores.

Intercorrelations between parent and teacher BIQ scores demonstrated cross-informant reliability. The correlations were positive and moderate ($.31 < r < .43$), except for the Physical Challenge subscale. The partial overlap between parents' and teachers' behavior ratings may stem from behavioral differences across settings (home vs. preschool; Wray et al., 2013), or could result from some informants having less historical knowledge of the child (Takeda et al., 2016). Regarding the inconsistency in the Physical Challenge subscale, teachers may not have the same level of access as parents to the child's daily life, where physically risky situations are more likely to occur. Overall, the partial agreement between parent and teacher reports supports using multiple informants for a more comprehensive understanding of preschool children's social-behavioral functioning (Bishop et al., 2003; Kim et al., 2011; Vreeke et al., 2012).

Evidence for the convergent validity was examined by comparing the BIQ scores with the TABC-R inhibition subscale. For both parents and teachers, TABC-R showed strong correlations both with the global BI score and all other BIQ scores ($r > .5$), except the Physical Challenge subscale in the parent version, confirming the validity of the BIQ as a measure of behavioral inhibition in children.

Considering the theoretical link between BI and social anxiety in children (Sandstrom et al., 2020), previous BIQ psychometric studies have employed a measure of social anxiety as an index of construct validity (Broeren & Muris, 2010; Mernick et al., 2018; Vreeke et al., 2013). In our study, the correlations between BIQ and the PAS social anxiety subscale were positive, although weaker compared to the correlations with the TABC-R inhibition subscale ($.3 < r < .6$), as expected due to the related yet distinct nature of the constructs. Previous research has established links between Generalized Anxiety and Separation Anxiety and high levels of BI in childhood (Pini et al., 2022; Zdebik et al., 2022), so we extended the exploration of construct validity by examining the association between the corresponding PAS subscales and BIQ scores. The correlations were always positive and significant ($.2 < r < .4$), particularly in contexts related to the Situational and Physical domains. Overall, these findings add to the evidence supporting BIQ's validity.

Several limitations should be considered in this study. Firstly, the sample was predominantly collected from private and urban preschool institutions. Participating parents tended to be somewhat older and had higher educational levels, which could potentially limit the generalizability of our findings to the broader Portuguese population. Second, this study targeted normal, psychologically healthy children, so the psychometric properties of BIQ in clinically referred children remain to be established. Thirdly, retest ratings from teachers were not collected, which prevented the assessment of temporal stability for the teacher BIQ scores. Moreover, the factor analysis of teacher responses did not consider that the same teacher assessed multiple children in their classroom, assuming instead scores independence; although it is a common practice, more complex measurement models should be used to describe accurately the nested structure of this kind of data. Another limitation arises from the fact that either parent (mother or father) could complete the BIQ questionnaire, and for over one-third of the sample it was not possible to clarify who had filled it in. This prevented us from exploring potential differences in perspective between mothers and fathers. Lastly, our findings rely solely on questionnaire data. The inclusion of alternative assessment methods, such as observational measures and semi-structured diagnostic interviews, could have strengthened evidence for the convergent validity of the BIQ.

Despite these limitations, the present study confirms the BIQ's good psychometric properties for assessing behavioral inhibition in Portuguese preschoolers. However, the questionnaire may have limited sensitivity in discriminating between different contexts where BI occurs, as the subscale scores showed high saturation in the general BI factor. This implies that interpreting the global BI score might be more reliable than relying on subscale scores as specific indicators of a child's inhibition in specific contexts. The study also highlighted a potential bias in responding to reversed items, although with a relatively minor impact on BIQ scores. Nevertheless, BI assessment through this questionnaire might be influenced by spurious wording effects, which should be taken into consideration when interpreting the results. To build on these findings, future studies should further investigate the reliability of the BIQ subscales and explore the presence and impact of the method factor. Additionally, conducting studies with larger, more diverse samples, including school-age children and clinically referred populations, will provide more insights into BIQ's psychometric properties across different contexts.

In summary, this study demonstrated that parents and teachers can provide valid and reliable reports of children's BI, establishing the BIQ as a practical and cost-effective alternative to observational measures of behavioral inhibition. Furthermore, the BIQ Portuguese version has proven its suitability for evaluation and screening purposes in preschool settings, enabling the identification of children at risk of adverse outcomes associated with a highly inhibited temperament. In this sense, the current study reinforces the value of the BIQ in both research and applied settings.

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CHAPTER THREE

STUDY THREE: The influence of parental variables and child behavioral inhibition on social anxiety in preschool children: The moderator effects of gender

ABSTRACT

The main objective of this study was to examine how parental characteristics, such as social anxiety (SA) and parental overprotection, and child's behavioral inhibition (BI) interact and contribute to the manifestation of SA symptoms in preschoolers. Parents (Mothers: n = 319; Fathers: n = 263) of children aged between 3 and 6 years answered to self-report measures of overprotection and SA and measures of SA and BI about their children. A positive moderate direct association was observed between children's BI and children's SA, independently of gender. Overprotection arises as a mediator of the effects of the parents' social anxiety on children's SA; however, this mediation depends both on the child's and parents' gender. Only mother's SA was directly related to children's SA, independently of the gender of the child. Overall, these findings extend to preschool children the previous studies that consider parents' overprotective styles and social anxiety, as well as child's BI, the main variables underlying the SA in childhood. In addition, our results highlight the importance of considering the moderator role of gender in the origin and maintenance of SA symptoms in preschoolers.

Keywords**:** social anxiety, behavioral inhibition, overprotection, preschool children, gender

INTRODUCTION

Social anxiety (SA) is one of the most prevalent psychological disorders in children and adolescents, with a negative impact in various domains of life and long-term implications for social adjustment (National Institute for Health Excellence and Care [NICE], 2013; Pickering et al., 2019). Besides its high prevalence, SA has an earlier age of onset and, when left untreated, persists into adulthood, resulting in significant personal and social costs (NICE, 2013). Despite the well-documented effectiveness of child anxiety treatments (James et al., 2013), research into the origins of SA remains comparatively limited. Understanding the factors that place individuals at risk of social anxiety, especially during the preschool years, considered the period prior to the typical age of onset, can provide valuable information regarding prevention.

One of the key early life predictors of social anxiety disorder is behavioral inhibition (BI; Clauss & Blackford, 2012). Kagan et al. (1987) and Rapee (2002) described BI as reactions of withdrawal, wariness, avoidance, and shyness in unfamiliar situations, usually associated with specific physiological responses (e.g., higher levels of cortisol and increased heart rate). Kagan et al. (1988) suggested that BI can be already identified in 15-20% of the two years old children. BI can manifest itself in different ways according to age: while pre-schoolers react with hesitation, inhibition of spontaneous conversation, and limited smile in unfamiliar situations, school-age children manifest extreme avoidance of adults and isolation from unknown peers (Ollendick & Benoit, 2012).

Longitudinal and meta-analytic studies on BI showed that, from an early age, inhibited children are significantly more prone to develop anxiety disorders earlier and over time than the uninhibited children (Clauss & Blackford, 2012; Frenkel et al., 2015; Hudson & Dodd, 2012; Sandstrom et al., 2020; Tang et al., 2020). However, a significant proportion of inhibited children do not subsequently develop SA (Henderson et al., 2015). In this context, it is important to identify which factors influence the longitudinal stability of the BI and its development into SA, as well as to recognize the presence of other developmental pathways to SA that may not involve BI (Chan, 2010; Ollendick & Benoit, 2012).

A considerable number of studies have identified key familial factors that increase the child's risk for SA (Chavira & Stein, 2005; Kathryn Amey Degnan et al., 2008; McLeod et al., 2007; Ollendick & Hirshfeld-Becker, 2002; Tang et al., 2020). Ollendick and Hirshfeld-Becker (2002) pointed out that the parents' influence on the development of children's SA may arise from their own SA, either through a specific genetic vulnerability to SA, or through the modelling of their social avoidance. A meta-analysis based on twelve twin studies (Scaini et al., 2014) points to the heritability of both the SA as a trait and as a disorder, although the amount of variance explained by genetic factors appears to vary widely among studies, ranging from 0.13 to 0.60 with an average of 0.41. The search for specific genes underlying the susceptibility to SA has been proven difficult (Bas-Hoogendam et al., 2018) and several candidate gene studies that reported associations with SAD and related traits have not been satisfactorily replicated (Stein et al., 2017; Stein & Galernter, 2014). A realistic hypothesis is that individual differences in the development of SA involve polygenic inheritance, which is controlled both by complex genetic mechanisms and environmental factors (Bas-Hoogendam et al., 2018; Olson, 2021).

Ollendick and Hirshfeld-Becker (2002) pointed out that the parents' influence on the development of children's SA is strongest in early childhood since parents represent the main socializing agent, and this influence may result from their own SA. For instance, a recent longitudinal study by Aktar et al. (2018) showed that SA in parents is linked with social avoidance in preschool children. The role of social learning in this transmission has also been demonstrated in studies showing parental modeling effects on child SA behavior (de Rosnay et al., 2006; L. Murray et al., 2008). In addition, Ollendick and Hirshfeld-Becker (2002) also highlighted the contribution of parenting behaviors and attitudes (such as overprotection, rejection, criticism, non-optimal fostering of social interaction), as well as the quality of the parent-child relationship (insecure attachment). Over-controlling parenting (Becker et al., 2010; Hudson et al., 2008) as well as overprotecting (Festa & Ginsburg, 2011; Lieb et al., 2000) limit the child's autonomy at early ages, such as toddler and preschool (Buss et al., 2021), and could increase the child's anxiety by reducing his or her cognitive sense of being able to cope with the environment. Such parenting practices may tacitly communicate to the child that the world is unsafe and unpredictable, and that danger and challenges are around every corner (Bögels & Brechman-Toussaint, 2006). On the other hand, parental practices characterized by flexibility of rules, strategies to support social participation, and appreciation of new situations with affective and behavioral restraint, appear to be associated with children less inhibited and more socially adapted (Degnan et al., 2010; Hane et al., 2008). In sum, the existence of an overprotective parental style toward the social world has been associated with the emergence of SA in children.

Parents' SA and parenting practices cannot be considered independent contributors to the child's SA. Anxious parents tend to be less socially active and may overprotect their children by restricting them or preventing them from being socially involved, diminishing the opportunity to develop social skills and thus perpetuating social fear (Caster et al., 1999; Norton & Abbott, 2017b). It has been shown that parents with anxiety disorders appear to have less secure, more restrictive, and overprotective parenting styles (Lindhout et al., 2006). Parents with SA are even more likely to show criticism and doubting of their children's competencies than parents with other types of anxiety (Budinger et al., 2013). Overprotective parenting has been described as having a moderator or a mediator role in the transgenerational transmission of SA. A ten-year longitudinal study that followed a sample of adolescents found that the risk of developing SA was increased in offspring of parents with SA who reported overprotection, rejection, or lack of emotional warmth (Knappe et al., 2009). In a prospective study, Borelli et al. (2015) found that maternal overcontrol acted as a mediator underlying the association between maternal and child anxiety. Although the role of overprotection as a mediator between mother and child anxiety has been recognized, evidence is mainly based on samples of older children and adolescents; studies with children at an early age, such as preschool children, are scarce.

On the other hand, although the literature points to a strong relationship between both parental behaviors, their child's BI, and social anxiety symptoms in childhood, different levels of SA may be related to similar parenting behaviors (McLeod et al., 2007), and not all behavioral inhibited children will present SA symptoms later (Clauss & Blackford, 2012). One possible factor moderating these associations is the gender of both children and parents (Rork & Morris, 2009).

According to Bögels & Perotti (2011), most of the studies failed to consider the differential role of mothers and fathers in the development of the child's SA, since the literature has focused mostly on mothers. Only a handful of studies have considered both parents to understand the phenomenon. Current literature has begun to emphasize the differential contribution of maternal and paternal variables to the child's anxiety. For example, Pereira et al. (2014) concluded that preventing school-aged child's anxiety requires reducing the exposure to the overt manifestation of mothers' anxious cognitions and behaviors as well as promoting fathers' role in child's exposure to risky situations, such as encouraging independence and helping children to confront gradually anxiety-provoking situations.

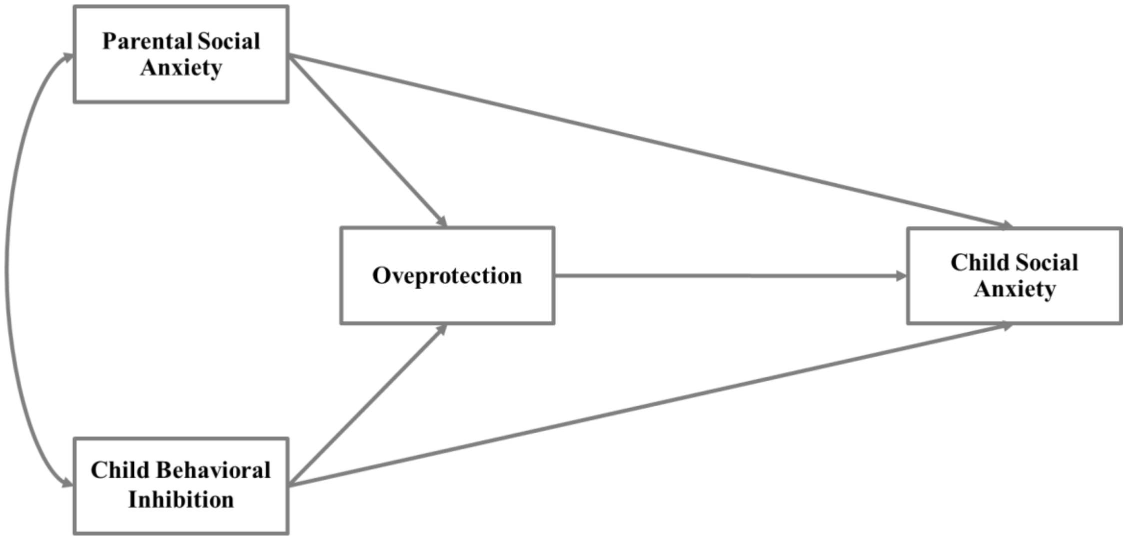
Few studies have explored the association between the child's SA and the parenting behaviors displayed specifically by the mother and father. Bögels et al. (2011) and Bögels and Perotti (2011) found that paternal behavior may have a stronger influence on the child's SA than maternal behavior. On the contrary, other authors have provided evidence for a significant relationship between maternal variables (SA and overprotection) and child's SA, but no significant relation between paternal factors and child's SA (Bögels et al., 2001; Pereira et al., 2014; Xu et al., 2017). In a longitudinal observational study with preschoolers, Majdandžić et al. showed that father's challenging parenting behavior (in which the child is encouraged to push his limits) diminished the risk of SA in their 4-year-old offspring, while mothers' challenging behavior contributed to higher levels of SA (Majdandžić et al., 2014). These mixed results suggest that, in order to better understand the cumulative and intersecting influences of parental overprotection and child's BI in the development of SA, it is necessary to consider the parenting behaviors of each caregiver and the parent-child relation according to gender (Bögels & Perotti, 2011; Bögels & Phares, 2008; Morris & Oosterhoff, 2016).

Regarding the child's gender, several authors pointed that girls are encouraged to adopt a gender role whose expression of fear and avoidance of feared objects and situations is socially acceptable; contrariwise, boys are encouraged to play a confrontational role in fear situations and to show active coping behaviors (Palapattu et al., 2006). Van der Bruggen et al. (2008) found a positive association between parental variables (overprotection and anxiety) and child's SA for girls, but not for boys, and attributed this difference to a greater susceptibility of girls to parenting behaviors. Graham and Weems (2015) concluded that girls may be more focused on mothers' reactivity in situations of fear, interpreting and coding information differently from boys. However, these studies were carried out with school-aged children and adolescents. Considering preschool children, Gagne et al. (2013) found that, when compared to boys, fear and shyness were higher in girls as young as three years, suggesting that gender differences in fearfulness are evident very early in development and seem to emerge between toddlerhood and preschool age. Overall, such evidence suggests that gender should be considered in the study of BI and SA symptoms at an early age.

Given the scarcity of studies addressing these questions, the impact of vulnerability factors in the development of SA, considering the moderator role of the gender of both child and parents, requires a more in-depth study to understand the weight these variables have in children's SA and how they interact (Graham & Weems, 2015). In this context, our main objective was to understand how parental variables (SA and overprotection) and child variables (BI) are related to SA levels of the children aged between 3 and 6 years, considering the gender of both children and parents. Thus, we propose an initial model that integrates the influence of these different variables (Figure 3.1).

Figure 3.1.

Hypothesized structural model



We hypothesized that (1) child's SA is positively associated with (1a) child's BI, (1b) parents' SA, and (1c) parental overprotection. We also hypothesized that (2) parental overprotection partially mediates the effect of (2a) parental SA and (2b) child's BI on child's SA. Finally, we hypothesized that (3) the intensity of the association between the variables described in the model is moderated by the gender of the parents and child.

METHOD

PARTICIPANTS

The sample was composed by the 319 mothers (M *age* = 35.81 years, *SD* = 5.37; 66.4% with high school or bachelor's degree) and the 263 fathers (M *age* = 38.20 years, *SD* = 6.05; 56.3% with high school or bachelor's degree) of 330 children recruited at several kindergartens and preschools in Faro (M *age* = 4.05 *yrs*, *SD* = 0.98; range: 3 to 6 years; 49.1% girls). Children and/or parents who had been previously diagnosed with a major psychological or medical condition were excluded from participation after a preliminary screening process by phone. Participants who had not completed more than 20% of the items of any of the questionnaires were also excluded; this criterion led to the exclusion of 38 of the initial 368 participants.

MEASURES

Behavioral Inhibition Questionnaire (BIQ parent version; Bishop et al., 2003)

Is a 30-item scale measuring child's BI characteristics as reported by their parents. BIQ comprises three dimensions: *social novelty inhibition*, *situational novelty inhibition*, and *physical challenges*. Social novelty (14 items) is measured regarding three contexts: peers (six items, e.g., "Is comfortable asking other children to play"), adults (four items; e.g., "Happily chats to new (adult) visitors to our home"), and performance situations (four items; e.g., "Dislikes being the center of attention"). Situational novelty (12 items) is measured in two contexts, namely preschool/separation (four items; e.g., "Takes many days to adjust to new situations") and unfamiliar situations (eight items; e.g., "Settles in quickly when we visit the homes of people we don't know well"). The physical challenges consist of four items (e.g., "Happily explores new play equipment"). Answers are given on a 7-points rating scale. The BIQ Portuguese version presents excellent internal consistency indexes for the total score as well as for the social and situational subscales ($\alpha > .90$). Only the physical challenges subscale presents a less satisfactory internal consistency ($\alpha = .61$). In the present study, the total BIQ score was used to assess the child's inhibited behavior frequency in a large range of contexts.

Social Interaction and Performance Anxiety and Avoidance Scale (SIPAAS, Pinto-Gouveia et al., 2003)

Is a 44-item self-report questionnaire, rated on a 4-point scale, to assess adults' level of anxiety and avoidance in social situations. SIPAAS comprises two subscales: the distress/anxiety subscale and the avoidance subscale, both showing high internal consistency (for anxiety, $\alpha = .94$; and for avoidance, $\alpha = .92$). In the present study, we used only the anxiety/distress subscale.

Parental Overprotection Measure (POM; Edwards et al., 2008; Portuguese version: Fernandes et al., n.d.-b)

Is a 19-item self-report questionnaire designed to assess parenting behaviours that restrict the exposure of the child to the perceived threat. Items have a behavioral or situation-specific focus (e.g., “I give my child extra attention when he/she clings to me” and “I try to protect my child from making mistakes”) and parents are asked to rate in a 5-point scale the extent to which each item represents their usual response towards the child. POM total score has been found to have strong test–re-test reliability, good construct and predictive validity, and high internal consistency in a sample of parents of 3-5 years old (α = .87) (S.L. Edwards et al., 2008) and 7-12 years old (α = .89) (Clarke et al., 2013) children. In the Portuguese version, internal consistency was higher than .87 for all age groups.

Preschool Anxiety Scale (PAS; Spence et al., 2001; Portuguese version: Almeida & Viana, 2013)

Parent-rated scale (28-item) measuring the frequency of symptoms of preschoolers aged three to six in five anxiety disorders: obsessive-compulsive disorder (five items), social anxiety (six items), separation anxiety (five items), physical injury fears (seven items), and generalized anxiety (five items). Parents are asked to rate each item regarding their children’s level of anxiety, using a 5-point scale. Although the whole scale was applied, we only used the *Social Anxiety* subscale. The original scale demonstrated a good internal consistency both for the PAS total score (α = .89) and for the *Social Anxiety* subscale (α = .74). The Portuguese version presented acceptable internal consistency for the *Social Anxiety* subscale (α = .70).

PROCEDURE

The study was initially approved by the Portuguese National Commission for Data Protection (CNPD) and the Directorate-General for Education. The data collection protocol was explained to the coordinators of each preschool institution. An informed, voluntary, written consent was obtained from parents before participation in the study. Finally, parents were asked to complete the questionnaires. The questionnaires were delivered to the parents in a closed envelope and were completed at home. Mother and father were asked to respond individually to the POM and SIPAAS questionnaires. Regarding child's measures (BIQ and PAS), parents were instructed to complete the questionnaires together.

Data Analyses

Descriptive analysis, correlation analysis, and *t*-tests were performed with SPSS 26. Measurement internal consistency was assessed by Cronbach's alpha coefficient. Cohen's *d* was used to estimate the magnitude of the differences between groups.

To test the hypothesized model (Figure 3.1), we conducted a Structural Equation Model analysis using SPSS AMOS 20. Model goodness of fit was evaluated using several indices, including the model's χ^2 test, the comparative fit index (*CFI*), and the root mean square error of approximation (*RMSEA*). A multi-group analysis was also carried out to identify differences between boys and girls regarding the influence of parental variables and child's BI on children's SA levels. When the model imposing equivalent structural weights on both genders failed to adjust, the critical ratios for the differences between parameters were used to identify which structural weights should be freed. After verifying the fit, indirect effects were estimated, and their significance was evaluated with a 95% bias-corrected percentile confidence interval (BCCI) based on 5000 bootstrap samples. Through the application of BCCI, it is possible to avoid power problems due to nonnormal asymmetric sampling distributions of indirect effects (Mackinnon et al., 2004). Finally, we used bootstrap confidence intervals to test the moderating role of gender on indirect effects (moderated mediation model). All the results were presented using non-standardized parameters.

RESULTS

DESCRIPTIVE RESULTS

Means and standard deviations of the main variables of interest in the study are presented in Table 3.1. All measures used in the study showed an acceptable level of internal consistency (Cronbach's alpha $\alpha > .7$). A comparison of means showed no differences between boys and girls regarding the studied variables.

Correlations between parents' and children's variables were computed attending gender (Table 3.2). Significant correlations were observed in almost all variables, especially in the measures related to the mother.

Table 3.1.

Descriptive statistics and mean comparisons between gender (t-test)

		Cronbach's α	Girls Mean ± DP	Boys Mean ± DP	*t*	*p*	*Cohen's d*
Parental Variables							
Social Anxiety (1-4)	*Mother*	.95	2.06 ± 0.44	2.07 ± 0.48	-0.22	.82	.02
	Father	.96	1.84 ± 0.45	1.85 ± 0.44	-0.23	.82	.02
Overprotection (0-4)	*Mother*	.92	2.04 ± 0.75	2.16 ± 0.72	-1.46	.15	.16
	Father	.92	2.07 ± 0.72	2.13 ± 0.80	-0.63	.53	.08
Child Variables							
Social Anxiety (0-4)		.75	1.18 ± 0.61	1.08 ± 0.67	1.41	.16	.16
Inhibition (1-7)		.90	3.37 ± 0.72	3.36 ± 0.79	0.14	.89	.01

Note. **Parental variables**. *Social Anxiety*: SIPAAS (Social Interaction and Performance Anxiety and Avoidance Scale); *Overprotection*: POM (Parental Overprotection Measure); **Child variables**. *Social Anxiety*: PAS (Preschool Anxiety Scale – social anxiety subscale); *Inhibition*: BIQ (Behavioural Inhibition Questionnaire).
Mother: *N* =156 girls and *N* = 163 boys; Father: *N* = 132 girls and *N* = 131 boys.

Table 3.2.

Pearson correlation for children and parents' variables, considering gender

		Mother		***Father***	
		Social Anxiety	**Overprotection**	**Social Anxiety**	**Overprotection**
Mother	*Social Anxiety*	1			
	Overprotection	.335**	1		
Father	*Social Anxiety*	.409**	.218**	1	
	Overprotection	.184**	.432**	.277**	1
Girls	*Social Anxiety*	.348**	.266**	.128	.071
	Inhibition	.249**	.138	.166	.142
Boys	*Social Anxiety*	.305**	.269**	.221**	.313**
	Inhibition	.233**	.178*	.136	.058

* $p < .05$; ** $p < .01$

MODEL ASSESSMENT CONSIDERING PARENT AND CHILD GENDER

To test the hypothesized model (Figure 3.1) a Structural Equation Model (SEM) was used. The purpose of the analysis was to characterize the relationship between these variables while considering both the gender of the parents and child. In this sense, a multi-group analysis was performed to test the moderating effect of the child's gender on these relationships. Since it was not possible to obtain the parental report of both parents for all the children, the models for mother and father were analyzed separately. In the present study, the BI-SA path estimates will necessarily be similar for the father and mother models, since these variables were based on the answers given by both parents simultaneously.

Table 3.3.

Summary of fit statistics across gender for Mother and Father model

		χ^2	*df*	*P*	χ^2/df	$\Delta\chi^2$	Δdf	Δp	CFI	ΔCFI	RMSEA
	Mother model										
1.	Equivalent regression weights	11.35	5	.045	2.27	-	-	-	0.97	-	0.06
1a.	Equivalent regression weights [a]	2.89	4	.577	0.72	8.46	1	.004	1.00	.029	0.00
	Father model										
1.	Equivalent regression weights	11.57	5	.041	2.31	-	-	-	0.95	-	0.07
1a.	Equivalent regression weights [b]	2.52	4	.642	0.63	9.05	1	.000	1.00	.036	0.00

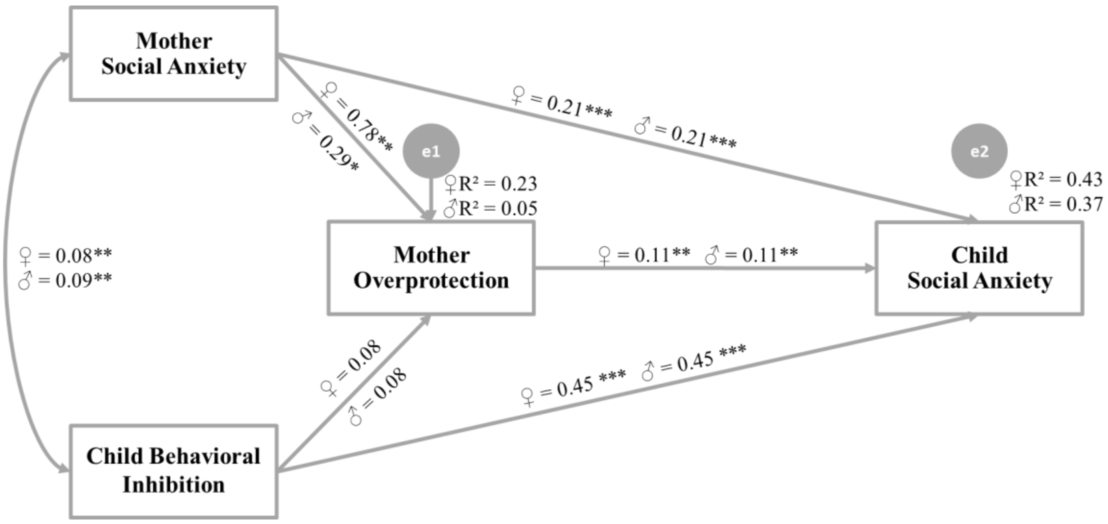
Note. χ^2 = chi-square statistic; *df* = degrees of freedom; $\Delta\chi^2$ = change in chi-square; Δdf = change in degrees of freedom; CFI = comparative fit index; ΔCFI = change in CFI

[a] Regression weights between SA parent and Overprotection were allowed to remain free across gender

[b] Regression weights between Overprotection and SA child were allowed to remain free across gender

Figure 3.2.

Mother's final model



Note: unstandardized regression weights; * p < .05; ** p < .01; *** p < .001

Mother Model

The first model assumed that the associations between variables were equivalent for boys and girls, and consequently all regression weights were constrained to be equal across gender groups (Table 3.3, Model 1). This model does not fit the data well ($X^2(5) = 11.35$, p = .045, *CFI* = 0.971, *RMSEA* = 0.063), so it was decided to release some restrictions. Through the inspection of critical ratios, it was found that the weight of the path between SA mother and Overprotection is significantly different regarding child gender (Z = -3.08, p < .001), and thus these regression weights were freely estimated for girls and boys. This parameters release provided a better fit for the model ($X^2(4) = 2.89$, p = .577, CFI = 1.00, RMSEA = 0.00; $\Delta X^2(1) = 8.46$, Δp = .004). This new model (1a) explains 43% of SA variance in girls and 37% of SA variance in boys. The final model obtained is shown in Figure 3.2.

Mother's final model shows an equal weight for all paths, except for the trajectory *SA mother → Overprotection*, which weight was higher for girls, despite being also significant for boys (♀ b = 0.776, SE = 0.123, Z = 6.29, p < .001; ♂ b = 0.288, SE = 0.115, Z = 2.50, p = .012).

Mother's SA has a significant total effect on their child's SA (total effect: ♀ *b* = 0.299, 95% BCCI = 0.213 – 0.406, *p* = .007; ♂ *b* = 0.245, 95% BCCI = 0.166 – 0.374, *p* = .007). Mediation analysis revealed that 29% of the total effect of mother's SA on her daughter's SA is mediated by overprotection (*b* = 0.086, 95% BCCI = 0.024 – 0.146, *p* = .018). Regarding boys, the mediated effect represents only 13% of the total effect (*b* = 0.032, 95% BCCI = 0.013 – 0.081, *p* = .005). These results suggest partial mediation for both genders.

To further verify whether these gender differences in mediation are statistically significant, we conducted a moderated mediation analysis. The results showed that the strength of the partial mediation effect differs significantly for girls and boys (difference between indirect paths: *b* = 0.054, 95% BCCI = 0.012 – 0.137; *p* = .008). Thus, the effect of the mother's SA changed according to the gender of the children, having a greater effect on overprotection when the child is a girl. These results indicate that socially anxious mothers are more overprotective when they have a daughter, compared to socially anxious mothers of boys.

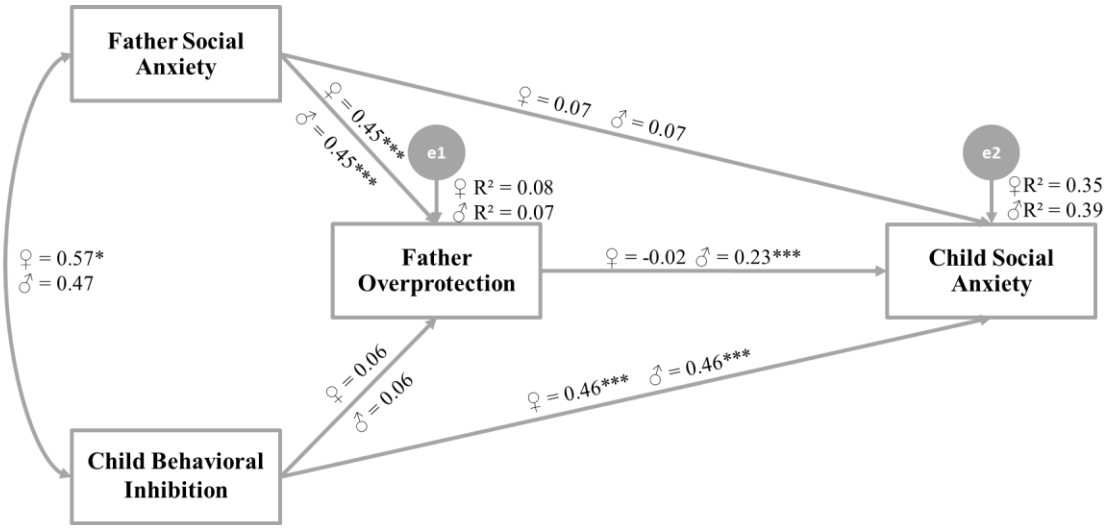
A direct positive significant association was found between child's BI and child's SA, independent of gender (*b* = 0.447, *SE* = 0.038, $p < .001$). Due to the absence of a reliable effect of child's BI on maternal overprotection, the indirect effect was proven to be non-significant (*b* = 0.008, 95% BCCI = -0.002 – 0.028, *p* = .100, for both genders).

Father Model

The first Father's model imposed the restriction of equality of all regression weights between boys and girls (Table 3.3, model 1) and did not fit the data ($X^2(5) = 11.57$, *p* = .041, CFI = 0.952, RMSEA = 0.071). This result supports the idea that the contribution of the variables varies according to the child's gender. Through the inspection of critical ratios comparing parameters, we decided to release the equality restriction imposed on the Overprotection → SA child path (difference between gender: *Z* = 2.831, *p* = .002). When the weight of this path was freely estimated for girls and boys, it provided a better fit of the model ($X^2(4) = 2.52$, *p* = .642, CFI = 1, RMSEA = 0; $\Delta X^2(1) = 9.05$, $p < .001$). This model explains 35% of SA variance in girls and 39% of SA variance in boys. The final model obtained is shown in Figure 3.3.

Figure 3.3.

Father's final model



Note: unstandardized regression weights; * $p < .05$; ** $p < .01$; *** $p < .001$

Father's final model shows an equal weight for all paths, except for the trajectory *Overprotection* → children's SA, which weight is significant only for boys (♀ *b* = -0.018, *SE* = 0.056, *Z* = -0.32, *p* = .753; ♂ *b* = 0.227, *SE* = 0.060, *Z* = 3.78, *p* < .001).

Father's SA has a significant total effect on their son's SA but not on their daughter's (total effect: ♀ *b* = 0.057, 95% BCCI = -0.100 – 0.206, *p* = .477; ♂ *b* = 0.167, 95% BCCI = 0.007 – 0.334, *p* = .042). This effect is partially mediated by paternal overprotection (*b* = 0.102, 95% BCCI = 0.041 – 0.178, *p* = .012) and this indirect effect corresponds to 61% of the total effect. For girls, the indirect effect is non-significant (*b* = -0.008, 95% BCCI = -0.061 – 0.029, *p* = .587): despite father's SA being strongly and positively associated with overprotection behaviours (*b* = 0.450, *SE* = 0.103, *p* < .001, for both genders), overprotection addressed to daughters have a negligible effect of girls' SA. A moderated mediation analysis confirmed that the strength of the mediation effect differs significantly for girls and boys (difference between indirect paths: *b* = -0.110, 95% BCCI = -0.199 – -0.047; *p* = .002). Thus, father's SA only influences the SA of their sons (but not daughters) and this effect is mainly mediated by overprotection behaviours.

The direct positive significant association between child's BI and child's SA was independent of gender (b = 0.461, SE = 0.041, $p < .001$). Due to the absence of a reliable effect of child's BI on father's overprotection, the indirect effect was proven to be non-significant for both genders (♀ b = -0.001, 95% BCCI = -0.015 – 0.004, p = .439; ♂ b = 0.014, 95% BCCI = -0.010 – 0.048, p = .241).

DISCUSSION

The main objective of this study was to examine how child's BI and parental variables (SA and overprotection) relate to preschooler SA symptomatology, considering parental and child gender as moderators.

For that purpose, we hypothesized that the child's SA levels depended on both his/her BI and the parents' SA as well as on parental overprotection, which was assumed to mediate the effect of the two previous variables (Figure 1). This model explained nearly 40% of the SA variance ($.35 \leq R^2 \leq .43$, for the four models tested), suggesting that the considered variables have a relevant contribution to explaining the individual differences in the SA symptomatology of preschoolers. However, the impact of some of these variables was moderated by gender, both for the parents and the child.

As expected, a positive moderate-to-large association between BI and SA was found. Our results suggest that this effect does not depend on the child's gender. Although the BI-SA association is already recognized in the literature (e.g., Clauss & Blackford, 2012), the moderating effect of gender has been little explored. A recent study with late childhood and adolescent participants (10-16 years) showed that temperamental shyness is more strongly associated with social anxiety among girls than boys (Tsui et al., 2017). Aktar et al. (2018) found that BI assessed when children were aged 1 to 2.5 years predicted the levels of fear and avoidance showed two years later in social and non-social tasks, regardless of gender. Another longitudinal study with temperamentally inhibited preschool children reported that inhibited young girls appeared to be at slightly higher risk for developing clinical-level anxiety and internalizing problems than were inhibited boys at the age of five but this difference tends to attenuate one year later (Bayer et al., 2019). Although our study focused on the same age group as Bayer et al., we did not find gender effects on BI-SA association, which may partly be due to the fact that we used a cross-sectional design and assessed specifically child's social anxiety symptomatology.

Gender differences in BI and SA trajectories during infancy are still not well known and more longitudinal studies would be pertinent to clarify their interdependence.

The abovementioned results suggest that BI may be a predominant precursor for SA development for boys and girls, although the moderator role of child gender is not fully clarified. The strong association found between a child's BI and SA may be due in part to the sharing of genetic and environmental etiological factors (Bourdon et al., 2019). Furthermore, both constructs share similar core characteristics such as social avoidance and shyness. Thus, early interventions for children with BI provide an opportunity to reduce the future risk of SA and subsequent negative outcomes (Sandstrom et al., 2020).

Considering that behaviourally inhibited children may elicit specific parenting behaviours (Ryan & Ollendick, 2018), our model also hypothesized a possible indirect path between BI and SA, mediated by parental overprotection. We expected that children with high levels of BI may induce overprotective behaviours, which in turn would reinforce avoidance, and prevent learning that a feared stimulus is safe (Hudson & Rapee, 2004), leading to a greater likelihood of developing SA later (Kiel et al., 2016; Kiel & Buss, 2012). However, in our study, the association between BI and overprotection was non-significant for either boys or girls in both mother and father models. Thus, the parental overprotection seems not to mediate the effect of BI on the child's SA.

Recently, Borelli et al. (2015) have found a mediation role of maternal and paternal overcontrol (a construct that partially overlaps overprotection) in the longitudinal effect of the child's avoidant characteristics on later anxiety. Although these results do not support those found in our study, there are clear differences between both studies, especially regarding the variables assessed (anxiety vs. SA; avoidant coping vs. BI; overprotection vs. overcontrol) and children's age (school-aged vs. preschool). Furthermore, children's BI may induce different parenting behaviors. For example, while Belsky et al. (2000) found that BI predicted increases in parents' encouragement of approach and discouragement of withdrawal, Kiel and Buss (2011) reported that fearful temperament predicts increases in maternal protective behavior. Parents react differently to children's BI and this heterogeneity may justify the lack of a clear relation between BI and overprotection. Although the child's gender might elicit different parental behavior and, thus, help to clarify such heterogeneity, our results did not support a gender moderation effect on the association between BI and overprotection behavior. Further studies are needed to better understand the role of specific parental overprotection behaviors in the association between children's BI and SA.

Regarding the transgenerational transmission of SA, the obtained results illustrated different pathways, depending on the gender of both parents and children.

Mother's SA seems to have a direct effect on their child's SA. Part of this influence may result from genetic transmission or modeling (Bögels & Brechman-Toussaint, 2006). In an experimental study (Gerull & Rapee, 2002), children (15-20 months) who saw their mother reacting negatively to a toy showed significantly more avoidance and persistent fear when compared to children whose mothers positively contacted the toy. This study demonstrates that signs of anxiety transmitted by the mother can contribute to signs of anxiety already in infants. More specifically for SA, Murray et al. (2014) found that anxious mothers' narratives may be implicated in the transmission of SA to their preschool children. The authors verified that when socially anxious mothers produced more negative (higher threat attribution) and less supportive (lower encouragement) narratives in a storytelling context, their children show higher SA responses.

The abovementioned studies suggest that maternal modelling may support the intergenerational transmission of SA. In the present sample, such direct influence was equivalent for boys and girls, being gender similarity between child and mother apparently not relevant in this transmission mechanism, at least for preschool children.

It is known that parent anxiety can indirectly affect children through parenting practices (Bayer et al., 2019). Indeed, an indirect effect of the mother's SA on the child's SA, mediated by overprotection was observed in our study. This effect was significant for children of both genders but stronger for girls. The moderation by gender results from the greater impact that the mother's SA has on overprotection when the child is a girl, compared to its impact on overprotection when the child is a boy: while the mother's SA explains 23% of the overprotection over the daughter, it only explains 5% of the overprotection when the child is a boy.

Several mechanisms have been suggested to explain why socially anxious parents adopt overprotective parenting strategies with their children. Socially anxious mothers are intolerant to uncertainty and may rely on overprotective and overcontrolling behaviors in part to curb their own anxiety (Woodruff-Borden et al., 2002). Besides that, the cognitive bias toward threat and avoidance of threat of SA mothers can make these mothers more overprotective and involved than less anxious mothers (Hudson & Rapee, 2002). Furthermore, anxious parents seem to be unable to adjust their controlling behavior to the child's developmental stage, their levels of control remaining constantly high regardless of age (Ballash et al., 2006). This evidence supports the mediation effect of overprotection but does not clarify possible gender differences. However, a hypothesis can be suggested: due to the expertise associated with their gender role, mothers tend to spend more time with their daughters than with their sons (Möller et al., 2012) and, therefore, it is expected that socially anxious mothers would predict more distress to a novel social situation for their daughters than for their sons, and consequently be more protective of girls. Moreover, since they are closer and talk more about emotions with their daughters (Fivush et al., 2000), it is reasonable to expect that socially anxious mothers would provide greater overprotection over their daughters than their sons.

Despite the impact of the mother's SA, the mother's overprotection levels seem to contribute significantly to the child's SA levels, regardless of gender. Several recent studies also supported our results, showing that higher maternal overprotection is a relevant predictor of child SA symptoms (Hudson & Dodd, 2012; Lewis-Morrarty et al., 2012; Verhoeven et al., 2012). Similarly, the absence of gender differences in this effect was reported by Verhoeven et al. (2012), who found that the relation between mother overprotection and child anxiety did not differ for boys and girls. Also, Kiel et al. (2016) observed no gender differences in how overprotective behavior predicted social withdrawal, concluding that, once the mother's overprotective response emerges, the child's gender has no importance in the consequences of that protective behavior. Despite the scarce literature, we can suggest that the impact of the mother's overprotection has the same weight whether the child is a boy or a girl.

Overall, our results suggest that socially anxious mothers can affect their child's SA directly; modeling and heritability may be possible mechanisms for that direct transmission. However, the mother's SA can also have a smaller indirect effect, mainly when the child is a girl, through parenting behaviors that convey the perception of the social world as dangerous. Conceivably, overprotection can make the child more aware of the threat, decrease the perceived control over the threat, withdrawing him/her from opportunities to explore the environment, and develop skills to deal with new situations (Verhoeven et al., 2012).

The influence of the father's SA on the child's SA had a different pattern from the one shown for mothers: the SA transmission was observed only for boys and was exclusively mediated through the father's overprotective behavior.

The absence of the father's direct transgenerational SA transmission was unexpected considering the putative role attributed to genetic factors (Bourdon et al., 2019). On the other hand, the transmission effects that can be attributed to modeling have not been consensual in the literature: while some studies reported a stronger direct influence of the father's SA on children, compared to the mother's SA (Burstein & Ginsburg, 2010), other studies showed a greater influence of mothers (P Muris et al., 1996). The lack of father's SA influence may be partially due to the reduced opportunities that the preschool child has to observe fathers' withdrawal and avoidant behavior in daily life. Indeed, not only do fathers, as male adults, tend to display a lower affective intensity in social interactions, but also preschool children spend more time with their mothers, considered the primary caretaker, than with their fathers. Although fathers have an increasing presence in the daily care of children, mothers continue to be perceived as more involved in emotional dimensions, such as caregiving and emotional and social development (de Rosnay et al., 2006). In this sense, the greater expression of anxiety in mothers is linked to greater levels of fears and worries in children (L. Murray et al., 2008).

Men are socially seen as those who take more risks in the external social world (Byrnes et al., 1999) and involve their children – especially boys – in challenging play, contributing to the development of children's social confidence (Paquette, 2004). In this sense, Bögels and Perotti (2011) suggested that fathers with SA behaviors will have a more exacerbated influence on the child's SA compared to the influence of the mother's SA since the father's avoidance and withdrawal behaviors are not expected and may be interpreted as a reliable signal of potential external threats. Our results can be interpreted according to Bögels and Perotti's model: the indirect transmission through overprotective behaviors may indicate that children interpret paternal overprotection as a strong negative signal about the external social world, thus promoting avoidant behaviors and fostering social anxiety symptomatology. However, this effect was observed only for boys. Indeed, girls are encouraged to be affectionate, sensitive, and sympathetic and expect to be protected by their parents; so, paternal overprotection may not be interpreted negatively. In contrast, boys are encouraged to control their emotions, to have autonomy, to explore the outside world, and to get involved in more socially risk-taking situations (Bögels & Phares, 2008; van der Bruggen et al., 2010). Therefore, boys may be more susceptible to a biased interpretation of fathers' overprotective behaviors (Bögels & Perotti, 2011). These results are very relevant because they suggest that parental behavior may be a key factor in the gender differences found in SA.

In summary, it was observed that the contribution of parental dimensions to children's SA is different for mothers and fathers. Contrary to what was observed in the father, the mothers' SA has a direct impact on the child's SA regardless of the child's gender, possibly through modelling of social avoidance and fear of evaluation. On the other hand, it was verified that maternal overprotection is associated with child's SA levels, independently of their gender, while paternal overprotection is only associated with boys' SA. The level of SA of mothers also has a greater impact on overprotection toward girls than in relation to boys, although its impact is significant in both genders. This result indicates that the total contribution of the mother's SA is greater for the SA of her daughters than of her sons since part of this contribution is indirectly conveyed by overprotection behaviours. For fathers, although their SA does not have a direct effect on the children's SA, it influences their overprotection behaviours towards sons and daughters. However, only boys seem to respond with social anxiety symptoms to paternal overprotection. Thus, regarding the transmission of SA from parents to children, a gender-dependent mediation through overprotection was found, especially considering the Mother-Daughter and Father-Son dyads.

These results also suggest that the overprotection behaviours of parents appear to depend more on parental characteristics (SA) than on the characteristics of the child (BI) and are affected by the gender of the parent and child. However, although the weight of parental SA and overprotection in the development of SA in children has been recognized (Fisak & Grills, 2007; Ronald M Rapee, 2001), there are still very few studies assessing the extent to which parental SA influences the SA of the child through overprotection. Future studies are needed to corroborate our results.

Despite the findings revealed by the current study, some limitations should be considered. Firstly, this is a cross-sectional study and causal associations among variables cannot be claimed. Another limitation was the exclusive reliance on measures reported by parents, providing only an indirect characterization of the child. Parents often underreport negative parenting behaviours (Bögels & Melick, 2004), suggesting that self-reports of overcontrol may underestimate the prevalence of these behaviours. Third, questionnaires were sent to the child's homes and aimed at both parents; there was no way of controlling whether the parents actually filled out the questionnaires separately or together. Finally, a close limitation can be the possible "common method variance" bias since all measures were collected at the same time and using the same informants.

Regardless of these considerations and although more studies are needed to replicate the current findings, using different sources of information about the child, this study extends previous work with the inclusion of both parents, allowing examining their influence on the development of the child's SA, and focused on mediation and moderation processes that help to understand these parental influences. These results emphasize the importance of considering gender and both parents for a deeper understanding of the factors associated with the development of SA, which may contribute to developing preventive parent education programs and improving the efficacy of interventions with SA children.

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CHAPTER FOUR

STUDY FOUR: Exploring the Pathways from Behavioral Inhibition to Social Anxiety: A Longitudinal Study on the Role of Attentional Bias, Executive Functions and Emotional Regulation Strategies

ABSTRACT

Behavioral inhibition (BI), a temperamental trait potentially impacting children's psychosocial development, has been linked to the development of anxiety disorders, particularly social anxiety. However, BI varies in its outcomes, with not all highly inhibited children developing psychological disorders. In this sense, our three-year longitudinal study aimed to explore differential developmental trajectories among one hundred children aged between 3 and 9-year-old with BI and to examine the cognitive, emotional, and environmental factors that contribute to the stability or change in BI over time, as well as how these factors may predict the emergence of SA. BI measurements were tracked over three years, alongside assessments of parental overprotection, social anxiety, children's attentional biases, emotional regulation and executive functions.

The study emphasizes the role of parental influences, particularly parental anxiety and overprotection, in shaping children's BI trajectories. Children of more anxious and overprotective parents were more likely to exhibit higher levels of BI, reinforcing the significance of parenting behaviors in the development of anxiety. The findings highlight the importance of early interventions targeting cognitive flexibility and emotional regulation to mitigate the risk of SA in behaviorally inhibited children.

Key findings also suggest that attentional biases, particularly towards threat-related stimuli, and executive functions such as inhibitory control and cognitive flexibility, play significant roles in moderating the BI-SA relationship. Children with lower inhibitory control exhibited stronger connections between attentional biases and SA, while those with higher cognitive flexibility demonstrated a weaker association. These findings suggest that cognitive flexibility and inhibitory control serve as protective factors against the progression of BI to SA by allowing children to regulate attentional biases more effectively.

This research offers insights into the complex mechanisms underlying BI and its potential role in the development of social anxiety, which may inform preventive strategies for anxiety disorders in childhood.

Keywords: behavioral inhibition; attentional bias; longitudinal study; cognitive factors; social anxiety

INTRODUCTION

Behavioral inhibition to the unfamiliar is a construct originally defined as the temperamental tendency to display heightened sensitivity to novel stimuli and to avoid unfamiliar situations, people, and objects (Kagan et al., 1984). When exposed to the unfamiliar, behaviourally inhibited children typically show reduced approach, seek close contact with familiar others and respond with initial restraint, caution, and quiet withdrawal (Degnan et al., 2014; Fox et al., 2001; Kim et al., 2011). Behavioral Inhibition (BI) may occur in different social and nonsocial contexts. For example, Kochanska et al. (G. Kochanska & Radke-Yarrow, 1992) observed inhibited behavior in children in unfamiliar settings as well as in the presence of unfamiliar adults or peers. Kagan et al. (e.g., Reznick et al., 1986) also found that BI may occur in response to novel objects and physical activities of minor risk.

BI can be observed as early as infancy (Kagan & Snidman, 2004), featuring approximately 15% of children (Kagan, 1989), and shows a moderate deal of stability from infancy to childhood (Fox et al., 2001), and sometimes from infancy into adolescence (Kagan et al., 2007). Moreover, BI appears to have a potential impact on children's psychosocial development (Bishop et al., 2003). For example, early BI has been recognized as a risk factor for the development of anxiety disorders later in childhood and adolescence (Chronis-Tuscano et al., 2009), namely generalized anxiety disorder, separation anxiety disorder, agoraphobia, specific phobias, and multiple anxiety disorders (Paulus et al., 2015; Stumper et al., 2017), but particularly social anxiety (SA) disorder. However, there is a wide range of variability in BI development: Clauss and Blackford (2012) conducted a meta-analysis and found that only some BI children (~40%) developed later social anxiety (vs. 12% of the uninhibited children).

Since not all children with high BI later develop social anxiety, studies are needed to identify the factors that influence the development of BI, as well as its association with anxiety symptomatology (Morales et al., 2017). Though BI is a relatively stable trait, environmental factors may affect its developmental course. One major environmental factor that interacts with BI to significantly shape developmental trajectories is parenting. It is consensual that caregivers, or parents, play a critical role in the developmental trajectories of behaviorally inhibited children (Fox et al., 2023). Parental characteristics, particularly parental anxiety and overprotective behaviors have long been recognized as critical factors in the development and maintenance of BI in children. One pathway by which parental anxiety may contribute to child BI is through heredity (Eley et al., 2015; Smith et al., 2012). However, parents who exhibit high levels of anxiety also may model fearful behaviors, which children then imitate (Aktar et al., 2014). This dynamic can lead to heightened levels of BI, as children learn to view unfamiliar situations as threatening or overwhelming (L. Murray et al., 2009). Furthermore, parents who are anxious are more likely to engage in overprotective behaviors, such as limiting their child's exposure to novel or challenging situations, which can prevent children from developing the social and emotional skills necessary to overcome their inhibition (Affrunti & Ginsburg, 2012)

The relationship between parental anxiety and child BI has been supported by numerous studies. Degnan & Fox (2007) found that children of anxious parents were significantly more likely to exhibit high levels of BI compared to children of non-anxious parents.

Similarly, Murray et al. (2009) found that the transmission of BI from parent to child was mediated by parental overprotection. Behaviors such as overprotection may contribute to greater stability in BI and subsequent anxious behavior by limiting the child's opportunities to explore the world (Rubin et al., 2002), inadvertently reinforcing the child's inhibited responses and creating a cycle of avoidance that maintains the child's BI over time (Murray et al., 2009).

The specific role of fathers in this process has also garnered attention in recent research. Bögels and Phares (2008) suggest that while mothers are more likely to engage in nurturing behaviors that may encourage dependence, fathers tend to promote autonomy and exploration. When fathers exhibit anxiety or overprotective tendencies, however, these roles may be reversed, and the father's anxiety may have a particularly strong influence on the child's BI, especially in boys (Möller et al., 2016).

Another factor that has been mentioned in the literature is attentional bias towards threat. Attentional mechanisms appear to influence the aspects of the environment that are selected for information processing (K. Pérez-Edgar et al., 2011). Studies have found that BI is associated with a bias to quickly process threat information (Henderson et al., 2015). The stability of this bias across children development increases the risk for SA disorder (Henderson et al., 2015).

However, studies examining this association are inconsistent and have found mixed results. A study conducted by Van Bockstaele et al. (2021) proposed that attentional bias to threat moderate the relation between BI and SA. However, the authors found that early BI (≈ 2.5 years) was related to later SA (≈ 7 years), independent of their attentional biases, indicating no moderation by attentional bias. On the other hand, Pérez-Edgar and colleagues with a sample of 15 aged adolescents found that attentional bias toward threat moderated the relation between BI and adolescent social withdrawal (K. Pérez-Edgar et al., 2010). Similar findings were observed in subsequently studies with children at age 5 (K. Pérez-Edgar et al., 2011). Using the same sample, the authors found that BI predicted anxiety at age 7 only when children exhibited an attentional bias toward threats, away from positive stimuli or showed a neutral bias (no bias) (White et al., 2017). The study identified that attentional biases moderated the relationship concurrently, suggesting that such biases may influence the expression and maintenance of existing anxiety rather than contributing to the emergence of anxiety disorders at a later stage. With the same sample, at age 10, the authors found for the first time a longitudinal moderation of threat-related attention biases (Nozadi et al., 2016). However, in this study there are no attentional bias to positive stimuli appears to not reveal significant results. In the same order, Morales et al. (2017) found that, independently of the task used to assess attentional bias, BI is associated with heightened detection of novel, salient or threatening information. In this study, independently of the direction of the attentional bias, children with a consistent bias across task had higher levels of anxiety. Most recently, Dodd et al. (2020) found that BI interacted with attentional bias towards threat and away from positive stimuli to predict trajectories of anxiety over the transition to school. These findings indicate that attentional bias may be an important factor sustaining BI over development, resulting in anxiety symptomatology (Henderson et al., 2015).

The inconsistency of results regarding the nature of attentional bias found in the literature can be reviewed in several aspects. First, most of these studies rely on reaction-time based measures of attention bias, such as the dot-probe task, which have been shown to have poor reliability in children due to the inherent variability in motor response times and cognitive processing speeds (Brown et al., 2014). These tasks are particularly problematic in young children because they involve slower and more variable motor functioning, which can compromise the accuracy of the results (Price et al., 2015; Van Damme & Crombez, 2009). The authors also suggest that these traditional measures often fail to capture the true attentional processes in children, as they are prone to inconsistencies and do not effectively reflect attentional engagement (Brown et al., 2014).

In contrast, free-viewing eye-tracking paradigms provide a more robust and accurate alternative, especially for young children. Eye tracking captures real-time visual attention and does not rely on reaction times, making it less susceptible to the motor variability seen in younger populations. Eye tracking allows researchers to use free-viewing paradigms that do not require complex instructions, which enhances both accuracy and reliability in measuring attentional bias (Price et al., 2015; Waechter et al., 2014). Moreover, studies have shown that eye tracking is particularly successful in identifying attentional biases in children, offering a more direct measurement of where visual attention is allocated, and thus serving as a more precise tool compared to traditional reaction-time-based tasks (Dodd et al., 2020).

Another factor that can lead to inconsistent results is the anxiety variable considered. While some studies focus on predicting generalized anxiety (e.g. Dodd et al., 2020; Nozadi et al., 2016; White et al., 2017), others focus on social withdrawal (e.g. Pérez-Edgar et al., 2010, 2011) measured using a composite of emotionality, activity, attention, sociability, soothability and shyness or based on withdrawal subscales. Only more recently have there been studies that specifically assess social anxiety (e.g. Morales et al., 2017; Van Bockstaele et al., 2021). The use of different variables may explain the different results obtained in the literature. For example, although Pérez-Edgar et al. (2010, 2011) and White et al. (2017) used the same dot-probe paradigm to assess attentional bias, they employed different predictor variables related to anxiety. Pérez-Edgar et al. (2010, 2011) focused on social withdrawal, whereas White et al. (2017) examined general anxiety.

In addition, most studies have only highlighted the relationship between BI and SA, considering the influence of threat detection (attentional bias) and have neglected other important variables that emerge in these age groups and that can lead to different paths in development from BI to SA. Namely, the control processes and how these can support or hinder the development of social skills. When exposed to an unfamiliar situation (e.g. when approached by a stranger) behavioral inhibited children are more likely to freeze and to exhibit reticent behavior, evaluating their environment as threatening. The detection of this potential threat takes the child's attention away from goal-directed behaviors, which can interfere with their ability to focus on tasks and regulate their emotions. This attentional shift is particularly relevant in children with BI, as it reflects underlying control processes that influence how these children respond to perceived threats. According to Fox et al. (2021), the type of cognitive control processes applied by BI children—such as the ability to shift attention away from threat or to inhibit threat-related responses—can serve as a critical moderator of the child's risk for anxiety. These control processes determine whether the child remains fixated on the threat or can redirect attention, ultimately influencing the likelihood of anxiety development.

Control processes can be subdivided into at least two types: automatic control and planful control. Automatic control concerns stimulus-driven processes and is associated with immediate, direct, and reactive responses to the situation or stimulus. A pattern of joint increased threat detection and automatic control is strongly associated with the avoidance, freezing and lack of approach behavior commonly in BI children at risk for anxiety (Buzzell et al., 2021). In turn, planful control, the category of goal-driven processes, concerns more prolonged and proactive responses that support specific objectives of the task/situation. Children with high planful control can redirect attention back to the ongoing activity. The combination of increased detection and planful control is protective and is associated with children with a history of BI who do not develop anxiety disorders (Fox et al., 2021).

Previous studies have suggested that the development of anxiety in inhibited children varies according to these control processes (Fox et al., 2021). For example, White et al. (2011) and Buzzell et al. (2021) found that higher levels of planful control (cognitive flexibility measured by task switching ability) are associated with a reduced risk of developing anxiety in high BI children (assessed in preschool age). In contrast, higher levels of automatic control (inhibitory control) increase the probability of develop anxiety. Similar results regarding inhibitory control are obtained in Troller-Renfree et al. (2019) study. These results suggest that developmental outcomes of children with BI is not only due to detection processes (attentional bias) but also to later control processes that maintain and/or amplify the detection response or moderate the attentional bias by flexibility shifting attention back to the goal-directed behavior (Fox et al., 2021; Troller-Renfree et al., 2019).

Emotional regulation (ER) may also be one factor through which BI confers risk for later SA (Suarez et al., 2021). Children with high BI tend to utilize more passive strategies to regulate their emotions (e.g., self-soothing behavior, passive tolerance, entail disengaging from the environment to cope with the source of distress).For example, in a longitudinal study conducted by Feng et al. (2011), high BI boys at 1.5 years show deficit in emotional regulation strategies during a delay of gratification task two years later. This deficit is likely due to the heightened sensitivity to threat and unfamiliar situations characteristic of high BI children, which can lead to increased emotional reactivity and difficulties in managing negative emotions effectively. These children often struggle to deploy adaptive regulatory strategies, such as redirecting attention or reappraising the situation, making it harder for them to cope with frustration and delay gratification. On the other hand, difficulties with emotion regulation have been postulated as a core mechanism of anxiety disorders (Hofmann, 2007; Werner et al., 2011). For example, in a longitudinal study conducted by Schneider et al. (2018) children aged 8–16 years who have difficulties in emotion regulation processes have higher probability to develop greater SA symptoms 36 months later. In addition, previous research suggests that emotional regulation strategies mediate the relation between early inhibited temperament and later difficulties with socioemotional functioning. Penela et al. (2015) found that emotional regulation strategies, measured with a disappointment task at age 5, mediate the relation between BI (measured at age 2 and 3) and social competence (at age 7): BI predicted difficulties with emotional regulation strategies and consequently lower levels of social competence. Similar results were obtained by Hipson et al. (2019) with a sample of children aged 2-5 years. Specifically with SA, more recently a longitudinal study conducted by Suarez et al. (2021) with 2-13 years aged children found that higher BI children (ages 2 and 3) demonstrated less engaged emotional regulation strategies (age 5), which in turn predict more socially anxious behavior (age 10-13). These findings demonstrate the importance of emotional regulation strategies in the link between early BI and social anxious outcomes. However, to our knowledge, only one study has focused on SA as outcome to study the effect of emotion regulation (Suarez et al., 2021) and no study has sought to integrate emotion regulation as a variable that can influence the effect of BI and attentional bias on the SA development.

Finally, to our knowledge, the studies conducted by Morales et al. (2017) and Van Bockstaele et al. (2021) are the only longitudinal studies that have evaluated whether attention bias predicts SA over time in behavioral inhibited children, and importantly, neither considered cognitive factors such executive functions (inhibitory control and attentional shifting) and emotional regulation to complement and understand the results obtained. Furthermore, these studies relied on reaction-time based measures of attention bias.

In this context, our main objective was to firstly understand differential developmental trajectories of BI among children and their potential role in the emergence of SA symptomatology through a three-year longitudinal study. To address our first objective, firstly we intent to characterize the trajectory of BI from early childhood through the school years, identifying potential factors that might influence its stability and change over time. We hypothesize that BI is not a static trait but rather a dynamic characteristic shaped by various cognitive, emotional, and environmental factors. Specifically, we will explore how individual differences in executive functions, such as inhibitory control and cognitive flexibility, emotional regulation, and attentional, contribute to the persistence or reduction of BI over time. In addition, we will consider the influence of parental factors and sociodemographic variables. By identifying these predictive factors, we aim to provide a comprehensive understanding of how BI develops and the mechanisms that may lead to diverse developmental outcomes, including the risk of anxiety disorders like SA.

For the second objective, we considered attentional bias as a potential moderating variable. Attentional bias was measured using a free-viewing eye tracking task, as this is a simpler, ecologically valid and more child-friendly task. We hypothesized that BI children would display a higher bias towards threat throughout the entire stimulus presentation. Furthermore, we also expected that higher levels of threat bias would be associated with a stronger relationship between BI and SA, suggesting that attentional bias towards threat may amplify the risk of developing SA in children with BI.

In addition to the moderating role of the attention bias, we also include the influence of executive functions, namely inhibitory control and cognitive flexibility, to understand whether these variables can moderate the BI development or can moderate the impact of attentional bias in BI development. We expect that the control processes moderate the relation between BI and SA, so that behaviorally inhibited children with high levels of inhibitory control and/or reduced cognitive flexibility are more likely to develop SA. We expect that these three categories of processes (attentional bias, inhibitory control and cognitive flexibility) function together to determine whether BI children are able to regulate their initial reactions to novelty, and consequently, decrease risk for SA (Fox et al., 2021). Finally, it is expected that emotional regulation mediates the relation between BI and SA and between attentional bias and SA, so that children with high levels of BI or with an attentional bias towards threat and who have deficits in regulation emotional are more likely to develop an SA.

METHOD

PARTICIPANTS

The sample was composed by one hundred children recruited at several schools in Algarve, Portugal (M *age* = 4.34 years, *SD* = 1.24; range: 36 to 108 months; 56% girls). Mothers had an average age of 38.83 years (SD = 3.89) and 15.98 (SD = 2.90 years of schooling, while fathers were 40.92 (SD = 5.90) years old with 14.79 (SD = 4.14) years of schooling. Parents were invited to participate in the study by providing them with an information letter along with a consent form. The previous diagnosis of a major psychological or medical condition was considered an exclusion criterion for both children and parents. None of the participants were excluded due to significant medical conditions or developmental disabilities. Participants who had not completed more than 20% of the items of the questionnaire were also excluded. Two parents were excluded because their questionnaires contained too many missing values. The second and third moment of assessment took place at university. The average time between baseline and second moment of evaluation was 441.68 days (DP = 176.23) and between the second and third moment was 706.46 (DP = 40.49).

MEASURES

To simplify the presentation, the instruments will be organized by respondent type, including parent self-reports, parental reports, observational measures, and others as applicable.

Self-report measures (adults)

Adult Measure of Behavioral Inhibition

Adult Measure of Behavioral Inhibition (AMBI; Gladstone & Parker, 2005; Portuguese version: Fernandes et al., n.d.) is a 16-item self-report measure of behavioral reticence, wariness, and fearfulness in response to unfamiliar stimuli. This measure was designed to capture indices of behavioral inhibition or avoidance in response to unfamiliar social situations and non-social situations. Items were rated on a 3-point scale, i.e. ‘‘no/hardly ever’’ (0), ‘‘some of the time’’ (1), ‘‘yes/most of the time’’ (2). Total scores range from 0 to 48 and are subdivided in four subscales: non-approach, fearful inhibition, risk avoidance and low sociability. The original and the Portuguese scale demonstrated a good internal consistency (α = .87 and .82, respectively). While in AMBI original scoring procedure, AMBI high scores indicate a low level of behavioral inhibition, in this study we reversed the scoring for easier interpretation. Therefore, higher scores on the AMBI should now be interpreted as indicating a strong tendency towards behavioral inhibition.

Social Interaction and Performance Anxiety and Avoidance Scale

The Social Interaction and Performance Anxiety and Avoidance Scale (SIPAAS; (Liebowitz, 1987; Portuguese version: Pinto-Gouveia et al., 2003) is a self-report questionnaire used to evaluate the level of anxiety and avoidance of adults in situations of social interaction. The scale includes 58 items, which are rated on a four-point scale. The Portuguese version of this instrument demonstrated good internal consistency, with Cronbach’s alphas of .95 for the anxiety subscale and 0.94 for the avoidance subscale.

Parental Overprotection Measure

The Parental Overprotection Measure (POM; Edwards et al., 2008; Portuguese version:Fernandes et al., n.d.-b) aims to assess parental overprotecting behaviors in situations where the children are exposed to a possible perceived threat (with items such as: “I protect my child from conflict”). The scale comprises 19 items, evaluated on a five-point rating scale, ranging from “Never” (0) to “Almost Always” (4); a high total score is indicative of high levels of parental protection. The original scale showed high internal consistency (α = .87). The Portuguese adaptation of this measure presents excellent reliability (α = .90).

Parental-report measures

Behavioral Inhibition Questionnaire

Behavioral Inhibition Questionnaire (BIQ; Bishop et al., 2003; Portuguese version: Fernandes et al., 2024) is a 30-item scale measuring child's BI characteristics as reported by their parents. BIQ comprises three dimensions: *social novelty inhibition*, *situational novelty inhibition,* and *physical challenges*. Social novelty (14 items) is measured with reference to three contexts: peers (six items; e.g., "Is comfortable asking other children to play"), adults (four items; e.g., "Happily chats to new (adult) visitors to our home"), and performance situations (four items; e.g., "Dislikes being the center of attention"). Situational novelty (12 items) is measured in two contexts, namely preschool/separation (four items; e.g., "Takes many days to adjust to new situations") and unfamiliar situations (eight items; e.g., "Settles in quickly when we visit the homes of people we don't know well"). The physical challenges consist of four items (e.g., "Happily explores new play equipment"). Answers are given on a 7-points rating scale.

The BIQ Portuguese version presents excellent internal consistency indexes for the total score as well as for the social and the situational subscales (α > .90). Only the physical challenges subscale presents a less satisfactory internal consistency (α = .61).

Preschool Anxiety Scale

Preschool Anxiety Scale (PAS; Spence et al., 2001; Portuguese version: Almeida & Viana, 2013) is a parent-rated scale (28-item) measuring the frequency of symptoms of preschoolers aged three to six in five anxiety disorders: obsessive–compulsive disorder (five items), social anxiety (six items), separation anxiety (five items), physical injury fears (seven items), and generalized anxiety (five items).

Parents are asked to rate each item regarding their children's level of anxiety, using a 5-point scale. Although the whole scale was applied, we only used the *Social Anxiety* subscale. The original scale demonstrated a good internal consistency both for the PAS total score (α = .89) and for the *Social Anxiety* subscale (α = .74). The Portuguese version presented acceptable internal consistency for the *Social Anxiety* subscale (α = .70).

Emotional Regulation Checklist

Emotional Regulation Scale (ERC; Shields & Cicchetti, 1997; Portuguese version: Alves & Cruz, 2011). This instrument is a parent-rated scale and aims to measure the emotional regulation of children. ERC is composed of 24 items and evaluates two subscales, the Lability/Negativity, which consists of items that assess the lack of flexibility, emotional activation, reactivity, anger dysregulation and mood lability, and the of Emotional Regulation, which assesses levels of socially appropriate emotional manifestations, empathy, and emotional self-awareness. Items are scored on a 4-point Likert scale (1 – never and 4 – always) (Alves, 2013).

The original instrument obtained Cronbach's alpha values of .96 for Lability/Negativity and .83 for Emotional Regulation. In the Portuguese version, they only included the Emotional Regulation subscale, which obtained a Cronbach's alpha value of .74 (Alves, 2013). In our study we will also only analyze the emotional regulation subscale.

Children Behavior Questionnaire

The Children Behavior Questionnaire – short form (CBQ; Putnam & Rothbart, 2006; Rothbart et al., 2001; Portuguese version: Lopes et al., 2011) is a parent-rated scale (94 items) used to measure specific dimensions of temperament. Parents are asked to rate each item using a 7-point scale. In the present study, only the Inhibitory Control (6 items) was used. The original scale demonstrated a good internal consistency (α = .72) and the Portuguese version presented a moderated internal consistency (α = .57).

Child observational measures

Laboratory Temperament Assessment Battery

Laboratory Temperament Assessment Battery (Lab-TAB; Goldsmith et al., 1993, 2010) is a standardized instrument developed for the observational assessment of temperament. This battery consists of several episodes designed to elicit different temperament responses. In the present study, Lab-TAB was used to assess BI, emotional regulation and inhibitory control through episodes taken from the preschool version (the four Fear episodes) and the middle childhood version (the Fear episode and the Social Inhibition and Shyness episode). The Lab-TAB episodes used to assess BI in preschool children (3–5 years) were: Risk Room, Stranger Approach, Jumping Spider, and Scary Mask. Concerning school children (6–9 years), the assessment of BI was based on two episodes: Scary Mask and Storytelling. Coding scores procedures were based on those used in Faísca et al. (2021). To assess emotional regulation, Box empty was used in preschoolers and Wrong Gift was used in middle childhood. Two measures were obtained regarding emotional regulation: Angry emotional regulation and Sad emotional regulation. Finally, to access inhibitory control, was used Patience Tower e both versions. Coding scores procedures to emotional regulation and Inhibitory Control were based on the original authors (Goldsmith et al., 1993, 2010).

Although the original authors did not compute these specific measures, studies specifically dedicated to the Lab-TAB psychometric properties show satisfactory internal consistency for the different composite scores based on Lab-TAB episodes ($0.50 \leq$ Cronbach's alpha ≤ 0.94) (Gagne et al., 2011). The Portuguese version of Lab-TAB only presented a BI index and presented good levels of internal consistency (α = .81 and α = .91, to preschool and middle school versions, respectively).

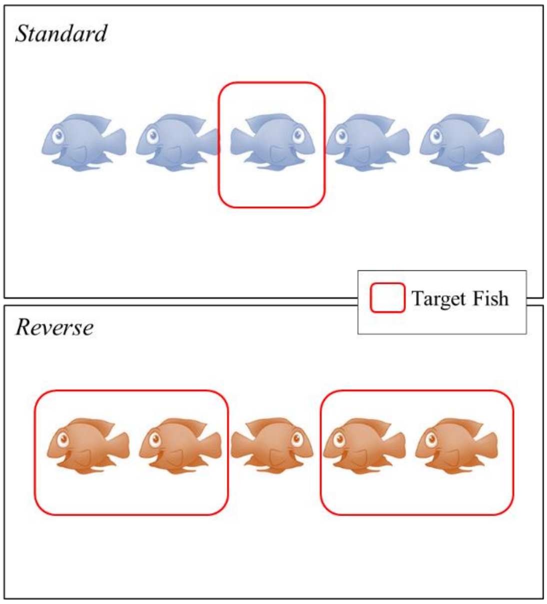
Child behavioral measures

Flanker Task

A child-appropriate version (Diamond et al., 2007) of the Flanker Task (Eriksen & Eriksen, 1974) was used. The Flanker Task was programed in Presentation® program by Neurobehavioral System (https://www.neurobs.com/). The task consisted of three conditions: (a) standard, (b) reverse, and (c) mixed trials. Considering the early ages of some children in our sample, we included a familiarization phase before task instruction, considered crucial for task completion (Oeri et al., 2019). In this phase, a single blue fish was presented, and children were instructed to press the key on the side of the keyboard that represented the direction in which the fish was facing. In the standard condition, the target blue fish is presented in the middle of four more fishes (Figure 4.1). The orientation of those flanking fishes could be congruent or incongruent with the orientation of the target fish. Children were instructed to press the key on the side of the keyboard that represented the direction in which the middle fish was facing as quickly as possible while ignoring the flanking fishes appearing on both sides of the target. In the reverse condition, all fishes were orange. In contrast to the previous task, children were instructed to press the key that represented the direction in which the four flanking fish were facing, ignoring the middle fish. In the third condition, standard and reverse tasks were randomly intermixed, requiring flexible application of the rules for each. Standard and Reverse condition have twenty trials and mixed condition have twenty-four trials. Each condition had the same number of congruent (all fish are facing the same way) and incongruent (target fish and distractors are facing different sides) trials and began with specific instructions and a short block of four practice trials. A correct response was followed by positive feedback (cheers such as "yuppy" produced by the computer program), whereas an incorrect response was followed by negative feedback (e.g., "oopsi"). The stimulus presentation time was 1500 *ms*, the feedback interval was 1000 *ms*, and the interstimulus interval (cross image) was 500 *ms*.

Figure 4.1.

Flanker task: representation of the target in the Standard and Reverse conditions



Flanker task was used to measure inhibitory control and cognitive flexibility. Following Marianne et al. (2012) and Peralbo-Uzquiano et al. (2020), inhibitory control was measured by an overall reaction time score (reaction time in milliseconds for correct responses, averaged across all trials from the Reverse condition) and an interference score (subtracting reaction time for incongruent trials from the reaction time for congruent trials considering data from the Reverse condition); a negative interference score expresses a slower correct response to incongruent trials compared to congruent trials, reflecting the difficulty to inhibit the interference from the flanking stimuli. Cognitive Flexibility was measured using overall accuracy (percentage score) and reaction time in milliseconds for the congruent trials from the Mixed condition.

Responses faster than 150 *ms* were considered anticipatory responses (Oeri et al., 2019; Schulte Holthausen et al., 2016) and were excluded from the analyses.

Eye Tracking task

Eye movements were recorded with the SensoMotorics Instruments (SMI) Hi-speed 1250 Hz system (http://www.smivision.com). Participants sat 70 cm away from the monitor. A free viewing eye-tracking task were conducted during which the children were asked to look at the pictures while standing still and avoid blinking during the stimulus presentation. The recording session started with a 9-point calibration procedure, and this initial calibration was repeated for tracking errors larger than 1 deg. Each trial started with a fixation cross (1500 *ms*), followed by a stimulus (2700 *ms*). The presentation order of face pairs was randomized across subjects.

Stimuli consisted of pairs of faces of adult and child actors. We used adult pictures taken from the Karolinska Directed Emotional Faces database (KDEF; Lundqvist et al., 1998), and validated for the Portuguese population by Fernandes and Bramão (2013) and child pictures from Child Affective Facial Expression (CAFE, LoBue & Thrasher, 2015).

Our stimulus set comprised three emotional expressions (happiness, anger, neutrality) and a neutral object (basket). The experimental stimuli consisted of 96 face pairs of actors (50% female; 12 angry-neutral pairs, 12 happy-neutral pairs, 12 happy-angry pairs, and 12 neutral–object pairs, each presented two times). Trials pairs were pseudorandomized into 3 blocks (32 trials per block). Calibration was repeated between each block to ensure data quality.

Faces were laid over a white background, left and right to the central point of the stimulus. The images were 140 mm × 126 mm wide (103 mm x 126 mm for adults' actors), and their centers were separated by 192 mm. Each stimulus was presented with a visual angle of 7.628º. The central fixation cross had a crucial role in securing attention to an initial neutral target, so that participants may afterwards manifest their engagement in emotional *vs* neutral stimuli.

Two areas of interest (AOIs) were identified for each trial, corresponding to the two faces presented. Fixations were defined as a stable gaze for at least 100 *ms*.

Ocular data were excluded if there were no fixations in the first 900 *ms* of the trial and/or if major tracking loss was observed (greater than 35% of stimulus presentation time). Only participants with valid data were included in each analysis.

Considering Skinner et al. (2018) recommendations, fixation-based measures were categorized according to the component of attention they are proposed to measure: overall, early, or late attention.

Overall attention reflects the viewing pattern across the total stimulus duration, considering early and late-stage processing. To measure this attentional component, we used Dwell time bias (e.g. dwell time bias for angry faces paired with neutral faces = dwell time for angry faces/(dwell time for angry faces + dwell time for neutral faces), averaged across trials). This measure expresses the overall preference for attending one face compared to the other face; if the Dwell time bias measure is 0.5, it will indicate no preference for either face.

Early attention refers to the first viewing pattern, immediately after the stimulus is presented, which may be crucial for threat detection (Armstrong & Olatunji, 2012). For target this component of attention, we used two measures. The Initial vigilance (e.g. initial vigilance for angry faces paired with neutral faces = number of trials where the first fixation was on the angry face/(number of trials where the first fixation was on the angry face + number of trials where the first fixation was on the neutral face) is a ratio that reflects the priority in processing one of the faces compared to the other. Again, a value of 0.50 indicates that there is no initial preference for either face. The Latency bias to first fixation (e.g. latency bias to first fixation on angry faces paired with neutral faces = mean of the latency of first fixation on angry faces – mean of the latency of first fixation on neutral faces) reflects the difference in the time it takes for each face to be fixated for the first time. A null latency bias indicates that both faces took the same amount of time to capture the participant's initial attention.

Finally, late attention follows the initial viewing pattern and is believed to represent rumination or maintenance. To assess late attention, we used the second-run dwell time bias (e.g. second-run dwell time bias for angry faces paired with neutral faces = mean of the second-run dwell time for angry faces/(the second-run dwell time for angry faces + second-run dwell time for neutral faces), average across trials). This is also a ratio index expressing the overall preference for attending one face compared to the other face during the second fixation; a value of 0.5 indicates no preference for either face during this second run.

STATISTICAL ANALYSIS

The data analysis was conducted using *IBM SPSS Statistics version 28* and *R Studio version 4.0.2*, with key analyses performed using *AMOS* for structural equation modeling and the lavaan package in R for *Latent Growth Class Analysis* (LGCA) and cross-lagged models.

Descriptive statistics were calculated for all variables, including measures of central tendency (mean), variability (standard deviation), and bivariate correlations using Pearson's correlation coefficient.

For the analysis of BI developmental trajectory, a series of *Latent Growth Models (LGM)* were computed. For LGM, time points were fixated at 0, 1.26 and 3.19 years, corresponding to the average time between assessments. The models were estimated using the Maximum Likelihood estimation method. Model fit was evaluated using several fit indices: the chi-square *(χ^2) test, Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), and Root Mean Square Error of Approximation (RMSEA).* According to Hu and Bentler (1999), model fit was considered good if *CFI* and *TLI* were greater than or equal to .95, and *RMSEA* was less than or equal to .06.

Pearson correlations were calculated to assess the relationship between BI, SA, attentional bias, emotional regulation, inhibitory control and cognitive flexibility across the three-time points, as well as to examine the association between BI changes over time and potential predictors.

To identify distinct trajectories of BI over time, a *Latent Growth Class Analysis* (LGCA) was conducted. The model fit was assessed using several fit indices, including the Bayesian Information Criterion (BIC) and the Akaike Information Criterion (AIC), with lower values indicating a better fit. To further explore the differences between the identified latent classes (stable BI and decreasing BI), a series of independent samples t-tests were conducted. These analyses examined whether the two classes differed in terms of emotional regulation, inhibitory control, cognitive flexibility, and attentional bias measures at different time points (T2 and T3). The assumptions of normality were checked and deemed acceptable for t-test analysis.

To investigate the bidirectional relationship between BI and SA over time, cross-lagged panel models were estimated using *AMOS* software. This type of model represents an elegant way to test the causal direction. It also has the advantage of controlling for some possible confounders. This is done by controlling for the values on the variables of interest at the previous wave (i.e., the stability coefficients) and with the time-specific correlations. The cross-lagged model examined the causal directions between BI and SA across the three assessment points. Model fit was evaluated using the *Chi-square (χ^2) test, the Comparative Fit Index (CFI), the Tucker-Lewis Index (TLI), and the Root Mean Square Error of Approximation (RMSEA).*

Moderation and mediation analyses were performed using the SPSS *PROCESS* macro (Model 4 for simple mediation, Model 1 for simple moderation and Model 3 for moderated moderation; Hayes, 2018) to explore the role of emotional regulation as a mediator and inhibitory control, cognitive flexibility and attentional bias as moderators. Bootstrap sampling (5,000 samples) was applied to test the significance of indirect effects. The mediation was considered significant if the 95% bias-corrected confidence intervals did not include zero.

PROCEDURE

In the initial assessment moment, the data collection protocol was explained to the coordinators of each school institution. The informed consent and the questionnaires (BIQ and PAS) were delivered to parents in a closed envelope and were completed at home. Once completed, the questionnaires were returned in a sealed envelope to teachers. In the first collection we obtained a total of 368 participants. All the participants were invited to continue for subsequent phases of the study.

About a year later, all parents were contacted to come to the university campus with their children to carry out the eye tracking task, the Lab-TAB and the flanker task, as well as to repeat the questionnaires. At this time, only 126 children participated (34.24% of the original sample).

Finally, about two years later, all participants were contacted again to repeat all the tests from the second moment and the emotion regulation questionnaire and Children Behavior Questionnaire in our laboratory at the university. In this third moment, 100 children participated (79.37% of the previous sample and 27.2% of the original participants).

This study was approved by the Portuguese National Commission for Data Protection (CNPD) and the Directorate-General for Education (nº 6313/2016).

RESULTS

SAMPLE DESCRIPTION

Table 4.1 describes the key outcome variables of the study at different time points (T1, T2, T3), namely BI and SA.

Table 4.1.

Descriptives Analysis of Behavioral Inhibition and Social Anxiety (n = 100)

MEASURES		MEAN	STD. DEVIATION	CORRELATIONS					
				BI T1	**BI T2**	**BI T3**	**SA T1**	**SA T2**	**SA T3**
BI	T1	3.177	0.717	-					
	T2	3.178	0.795	.721*	-				
(RANGE: 1-7)	T3	2.886	0.836	.697*	.778*	-			
SA	T1	0.961	0.637	.603*	.559*	.552*	-		
	T2	1.219	0.607	.538*	.692*	.585*	.606*	-	
(RANGE: 0-4)	T3	1.252	0.616	.410*	.484*	.664*	.499*	.510*	-

Note. * $p < .001$

The data suggest that our sample presents average BI levels below the middle point of the response scale for BIQ over the three years: there is a tendency for BI to be maintained during the first two years (ΔM ~ 0.001; Cohen's *d* ~ 0.00) and to decrease slightly during the final year (ΔM = 0.292; Cohen's *d* ~ 0.35). In contrast, SA average levels tend to increase, especially from the first to the second moment (ΔM = 0.258 Cohen's *d* ~ 0.41). The correlations between BI scores across the three years are positive and strong ($r \geq .7$); the correlations between SA scores are also high and positive, but smaller ($r \geq .5$). BI and SA scores are positive and moderate-to-high, reflecting a significant relation between these variables ($r \geq .410$, $p < .001$), especially when measured on the same year.

Table 4.2.

Descriptives Analysis of Attentional Bias measures (n = 100)

	MEASURES	MOMENT T2		MOMENT T3	
		Mean	SD	Mean	SD
INITIAL ATTENTION	Initial Vigilance for…				
	Angry faces (vs. Neutral faces)	0.532	0.168	0.556*	0.121
	Angry faces (vs. Happy faces)	0.509	0.121	0.473*	0.093
	Happy faces (vs. Neutral faces)	0.569*	0.145	0.567*	0.099
	Basket (vs. Neutral faces)	0.243*	0.165	0.284*	0.145
	Latency bias for First Fixation for…				
	Angry faces (vs. Neutral faces)	-853.6*	1065.9	-919.9*	772.3
	Angry faces (vs. Happy faces)	-625.7*	571.1	-446.1*	367.0
	Happy faces (vs. Neutral faces)	5.6	98.8	-8.8	58.6
	Basket (vs. Neutral faces)	-42.0	501.6	-82.9*	311.3
LATE ATTENTION	Second-run dwell time bias for…				
	Angry faces (vs. Neutral faces)	0.464	0.201	0.441*	0.159
	Angry faces (vs. Happy faces)	0.477	0.155	0.547*	0.141
	Happy faces (vs. Neutral faces)	0.421*	0.181	0.423*	0.146
	Basket (vs. Neutral faces)	0.706*	0.241	0.667*	0.203
OVERALL ATTENTION	Dwell Time Bias for…				
	Angry faces (vs. Neutral faces)	0.559*	0.082	0.528*	0.072
	Angry faces (vs. Happy faces)	0.515	0.086	0.497	0.067
	Happy faces (vs. Neutral faces)	0.535*	0.077	0.538*	0.069
	Basket (vs. Neutral faces)	0.296*	0.097	0.314*	0.108

* $p \leq .05$ for one sample t-test (hypothesized value: 0.5 for ratio indexes and 0 for latency bias indexes)

Considering the descriptive analysis of attentional bias indexes (Table 4.2), our sample demonstrated an initial heightened attention towards emotional and social stimuli compared to neutral and nonsocial stimuli, both in T2 and T3. While the results indicate some stability across assessment moments for all measures, the bias for attending preferentially to emotional stimuli (vs. neutral) became more evident at T3; at this assessment point, a higher number of indexes revealed a reliable bias emotional stimuli for the entire sample, significantly exceeding chance levels. In contrast, as expected, late attention (measured by the target of the second fixation during the trial) was predominantly directed towards neutral and nonsocial stimuli, especially at T3. Notably, the information conveyed by initial attention indexes appears to be complementary to that conveyed by late attention indexes, with these indexes exhibiting a strong negative correlation (-.829 < $r \leq$ -.670, $p \leq$ .001; -.794 < r < -.620, $p \leq$ .001 for T2 and T3, respectively). Finally, regarding overall attention, the sample demonstrated a greater focus on emotional and social stimuli, with total fixation time being significantly longer for angry faces when paired with neutral ones; the overall attention indexes do not reveal preference only when two emotional faces were presented at simultaneously (angry and happy).

Table 4.3.

Descriptives Analysis of Executive Functions and Emotional Regulation

		MOMENT T2		MOMENT T3	
	MEASURES	**Mean**	**Std. Deviation**	**Mean**	**Std. Deviation**
LABTAB	Behavioral Inhibition	-0.043	0.465		
	Inhibitory Control	-0.034	0.600		
	Emotional Regulation Angry	-0.029	0.799		
	Emotional Regulation Sad	-0.008	0.855		
FLANKER	Inhibitory Control (Reaction Time)	941.8	166.3	819.4	130.5
	Inhibitory Control (Interference Score)	-60.8	176.6	-134.6	136.2
	Cognitive Flexibility (Accuracy)	41.37	12.37	44.82	7.62
	Cognitive Flexibility (Reaction Time)	1014.5	150.0	915.8	103.3
CBQ	Inhibitory Control (range: 1-7)			5.120	1.037
ER	Emotional Regulation (range: 1-4)			3.334	0.391

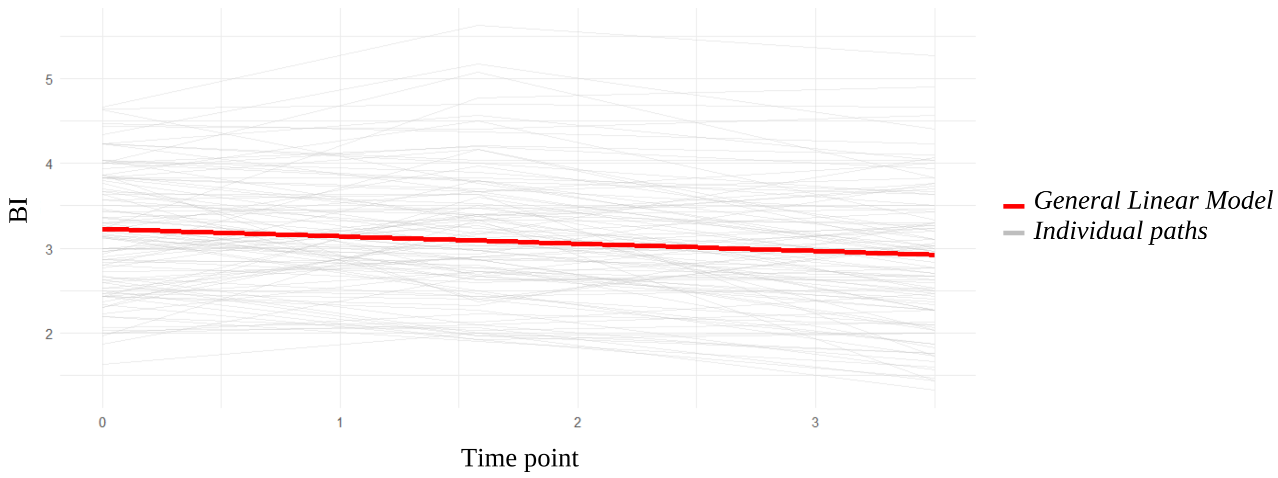
Considering executive functions and emotional regulation (Table 4.3), the data indicates overall improvements in inhibitory control and cognitive flexibility over time, particularly highlighted by faster reaction times in the Flanker task from T2 to T3. LabTAB scores (expressed as composite z-scores) are not interpretable in absolute terms, due to the inexistence of normative data. Emotional regulation scores suggest variability but no direct comparison between T2 and T3 is possible due to the inexistence corresponding measures at the two assessment points.

TRAJECTORIES OF BI: UNCONDITIONAL LATENT GROWTH MODEL (LGM)

A linear unconditional growth model was employed to examine the temporal dynamics of children's BI. Results showed a good fit (χ^2 =7.183, df = 3, p = .066, TLI = 0.976, CFI = 0.976, $RMSEA$ = .119), suggesting that the growth trend can be grossly described as linear across the three years period. The model estimated the mean intercept slightly below the scale midpoint (*M* = 3.223, *SE* = .071, $p < .001$, 95% *CI* [3.082, 3.362]), suggesting a tendency towards lower initial scores, as already observed in the BI descriptive statistics for T1 (Table 4.1). The variance of the intercept was significant ($\sigma^2_{intercept}$ = .376, $p <$ .001), indicating the presence of heterogeneity in the BI levels among children at the first year of observation. The magnitude of the variance magnitude represents approximately 19% of the BI mean value, an indicator of moderate variability, highlighting the diversity in initial BI levels among children. Regarding slope, BI showed a significant decrease from the first moment to the third moment, although the magnitude of the slope suggest that this decrease corresponds to the reduction 0.1 to the average score for each year (*M* = -.096, *SE* = .019, $p < .001$, 95% *CI* [-.133, -.059]) (Figure 4.2). Slope variance was not significant (σ^2_{slope} = .006, p = .372), which suggests that the BI linear descending trajectory appears to be homogeneous among the children in the sample. Due to the residual variance of the slope, there was no correlation between intercept and slope (r = .020, p = .185).

Figure 4.2.

Latent Growth Curve Model of BI across three years



To further explore the role of parental and child variables in the developmental trajectory of BI, as described by the unconditional linear LGM, we first individually examined the impact of each predictor on the trajectory by entering them one at a time into the model (Table 4.4).

Table 4.4.

Predictive effects of sibling and parent's sociodemographic variables on the BI initial status (intercept) and growth (slope)

Predictors	Standardized effect of the predictor on individual intercepts (*p*)	Standardized effect of the predictor on individual slopes (*p*)
Child personal variables		
Gender	.095 (.409)	-.073 (.767)
Age	.150 (.189)	-.122 (.622)
Sibling variables		
Siblings	-.105 (.361)	-.084 (.734)
Number of siblings	-.132 (.248)	-.128 (.604)
First child	**-.261 (.020)**	.057 (.817)
Mother variables		
Age	-.164 (.151)	-.111 (.652)
Schooling	.103 (.368)	-.405 (.097)
Social Anxiety	**.353 (.001)**	.087 (.724)
Behavioral Inhibition	.060 (.600)	.133 (.590)
Overprotection	.145 (.205)	.162 (.513)
Father variables		
Age	-.144 (.207)	-.404 (.099)
Schooling	.011 (.921)	-.065 (.793)
Social Anxiety	**.238 (.035)**	-.051 (.836)
Behavioral Inhibition	**.273 (.014)**	**.515 (.033)**
Overprotection	.195 (.086)	.172 (.486)

Gender: 0 = Boy; 1 = Girl; Siblings: 0 = Don't have siblings; 1 = Have siblings; First child: 1 = Is the first child; 2: Isn't the first child; Social anxiety, as measured by SIIPAS total score; Behavioral Inhibition, as measured by AMBI behavioral inhibition score; Overprotection, as measured my POM total score.

* All mean intercept and mean slope are significant at the level $p < .001$

Among parental variables, only the SA of both parents and the father's BI have a significant influence on their children's BI initial level (intercept). The results suggest that more socially anxious parents ($\beta = .353$ for mothers and $\beta = .238$ for fathers, $p < .04$)

and more inhibited fathers (β = .273, p = .014) tended to evaluate their children in the first observational moment as having higher BI levels.

We also considered the existence of siblings as a predictor variable of the evolution of BI. There only seems to be an influence at the level of the intercept – children who are the second or later child have lower initial levels of BI (β = -.261, p = .020) than those who are the first child.

Only greater inhibition in fathers seems to significantly affect the slope of BI development of their children, contributing to a longitudinal linear increase of BI in their children during the three years period (β = .515, p = .033)

Children personal variables do not seem to significantly affect the BI trajectory.

To explore the specific and shared contribution of the predictors, we tested conditional linear model including simultaneously all children and sibling variables as predictors. Results confirmed that only the birth position (first vs. late child) had a significant effect on the BI starting point (intercept) (β = .292, p = .007). However, the conditional linear model including all parents' variables as predictors showed some differences compared to the analysis of the individual predictors, possibly due to the correlation between these predictors. While the BI intercept was positively influenced by the mother's level of social anxiety (β = .313, p = .003), both the intercept and slope were moderated by mother's educational level (β = .276, p = .008 and β = -.366, p = .034, respectively). This suggests that children from highly educated mothers tend to exhibit a more decreasing BI trajectory. Similar to the previous analysis, the BI slope was positively moderated by the father's level of behavioral inhibition (β = .489, p = .005). Additionally, both the father's social anxiety (β = -.493, p = .004) and age (β = -.334, p = .054) negatively influenced the BI trajectory, indicating that children of social anxious and older fathers tend to exhibit a more pronounced decline in BI over time.

CORRELATION ANALYSIS BETWEEN PREDICTORS AND BI

In the previous section, we investigated whether the BI trajectory over the three-year period was influenced by individual characteristics of child and parents, using only predictors assessed at T1. To prevent assuming retroactive effects, we opted not to include variables measured at T2 and T3 as predictors of the LGM, since the developmental trajectory was modelled using data collected one or two years prior. Thus, to identify associations between predictors assessed at T2 and T3 and the BI levels exhibited at the concurrent and posterior time points, as well as with the changes in BI between time points, we used a linear correlation analysis. Pearson correlation coefficients are displayed in Table 4.5, 4.6 and 4.7.

Considering predictors assessed at the first moment (Table 4.5), children age was marginally associated with BI at the first time point (r = .181, p = .071), suggesting that higher BI levels are associated with older children at the initial stage; this effect was already present in the conditional LGM, although not significant. Age was also marginally associated with BI decrease between T1 and T2. Child's gender did not seem to affect BI's level at any time point.

Being the first child was associated with BI at the three-time points (-.252 ≤ r ≤ -.193, p ≤ .054), indicating that firstborn children may consistently show slightly higher BI levels; this effect was already reported for the conditional LGM. The effect of the other predictors related to siblings was not significant.

Considering parental variables, Mother SA appears to have a positive, significant association with BI at the three-time points (r ≥ .216, p ≤ .031), suggesting that children with higher BI have mothers with higher SA. A weaker but similar correlational pattern was observed for Father SA (.156 ≤ r ≤ .196) and father overprotection (.164 ≤ r ≤ .197). Children's BI was also negatively associated with father's age (-.222 ≤ r ≤ -.119) and with fathers' AMBI score (.204 ≤ r ≤ .336). Overall, these results indicate that children with higher BI will likely have younger fathers with higher BI and stronger SA and overprotection behaviors. However, some of these associations are only marginally significant, so caution is needed in their interpretation. Finally, only father's BI is significantly associated with incremental changes in children's level BI between T1 and T3 and between T1 and T3, as previously detect with the conditional LGM.

Table 4.5.

Correlation between predictors assessed at T1 and BI evolution

	Predicting…	BI at T1	BI at T2	BI at T3	Change in BI (T2-T1)	Change in BI (T3-T1)	Change in BI (T3-T2)
Child	Age	**.181 ᵗ**	.023	.104	**-.196ᵗ**	-.070	.126
	Gender	-.103	-.032	-.061	.086	.038	-.047
	First child	**-.195ᵗ**	**-.252***	**-.193ᵗ**	-.106	-.035	.072
	Siblings	.086	.097	.100	.026	.035	.012
	Number of Siblings	-.086	-.159	-.120	-.115	-.063	.049
Mother	Age	-.142	-.138	-.154	-.014	-.044	-.035
	Scholarity	.096	.020	-.039	-.092	-.165	-.090
	Social Anxiety	**.350****	**.216***	**.312****	-.139	.016	.164
	Overprotection	.131	.122	.158	.006	.062	.064
	Behavioral Inhibition	-.022	-.107	-.067	-.121	-.065	.053
Father	Age	-.119	**-.168 ᵗ**	**-.222***	-.084	-.163	-.096
	Scholarity	.021	-.016	-.004	-.049	-.031	.017
	Social Anxiety	**.196 ᵗ**	**.190 ᵗ**	.156	.017	-.017	-.038
	Overprotection	**.173 ᵗ**	.164	**.197***	.011	.067	.063
	Behavioral Inhibition	**.204***	**.320****	**.336****	**.190 ᵗ**	**.219***	.048

Gender: 0 = Boy; 1 = Girl; Siblings: 0 = Don't have siblings; 1 = Have siblings; First child: 1 = Is the first child; 2: Isn't the first child.

Note ***p* < .01; **p* < .05; ᵗ *p* < .099

The analysis of the predictors assessed at T2 (Table 4.6) revealed that Inhibitory control (as measured by LabTAB) was negatively correlated with BI at the second time point (r = -.225, p = .025), indicating that higher inhibitory control is associated with lower BI levels. The Lab-Tab observational measure of BI was also positively associated with BI at the second and third time points ($r \geq .315$, $p \leq .001$), demonstrating a moderate consistency between measurements. Emotional Regulation measures (LabTAB) did not correlate with BI levels.

From the executive measures assessed with the flanker task, only cognitive flexibility (accuracy) showed a significant association with BI at the second time point (r = .232, p = .020), indicating that better cognitive flexibility might be associated with higher BI levels.

Table 4.6.

Correlation between predictors assessed at T2 and BI evolution

	Predicting…	BI at T2	BI at T3	Change in BI (T2-T1)	Change in BI (T3-T1)	Change in BI (T3-T2)
Lab-TAB	Inhibitory Control	**-.225***	-.122	-.023	.104	.141
	Emotional Regulation Angry	-.090	-.040	.108	.162	.070
	Emotional Regulation Sad	.122	.128	.145	.151	.019
	Behavioral Inhibition	**.315****	**.339****	.162	**.205***	.062
Flanker Task	Inhibitory Control (Reaction Time)	.100	.124	.020	.058	.045
	Inhibitory Control (Interference Score)	-.123	-.105	.077	.087	.018
	Cognitive Flexibility (Accuracy)	**.232***	.147	.005	-.096	-.114
	Cognitive Flexibility (Reaction Time)	.070	.100	.148	**.183** ^{t}	.052
Early attention	Initial Vigilance for…					
	Angry faces (vs. Neutral faces)	.116	.050	.053	-.034	-.094
	Angry faces (vs. Happy faces)	**-.179** ^{t}	**-.343****	.023	**-.214***	**-.265****
	Happy faces (vs. Neutral faces)	.125	.133	.080	.093	.021
	Basket (faces Neutral faces)	-.005	.021	-.054	-.015	.039
	Latency bias for First Fixation for…					
	Angry faces (vs. Neutral faces)	-.091	-.032	-.032	.044	.083
	Angry faces (vs. Happy faces)	.159	**.316****	-.091	.140	**.253***
	Happy faces (vs. Neutral faces)	.079	.068	-.017	-.026	-.011
	Basket (faces Neutral faces)	-.057	-.040	.029	.046	.021
Late attention	Second-run dwell time bias for…					
	Angry faces (vs. Neutral faces)	-.103	-.069	-.024	.018	.045
	Angry faces (vs. Happy faces)	**.199***	**.246***	.058	.132	.088
	Happy faces (vs. Neutral faces)	-.151	-.161	-.043	-.064	-.027
	Basket (faces Neutral faces)	.048	-.051	.091	-.048	-.148
	Dwell Time Bias for…					
	Angry faces (vs. Neutral faces)	.003	-.064	.133	.031	-.103
	Angry faces (vs. Happy faces)	-.118	-.154	.038	-.021	-.064
	Happy faces (vs. Neutral faces)	-.013	.113	.062	**.229***	**.193** ^{t}
	Basket (faces Neutral faces)	.127	.019	**.167** ^{t}	.016	-.156

Note * $p < .05$; ^{t} $p < .090$

The measures of attentional bias obtained from the eye tracking task were found to have only sporadic correlations with BI levels. The initial vigilance towards angry faces (when paired with happy faces) correlated negatively with BI levels: thus, more inhibited children in T2 and T3 tend to avoid first fixations on angry faces, taking more time to fixate their look on angry faces for the first time. As previously mentioned, this pattern reverts for later stage attention, when the second fixation of these children is preferably directed toward angry faces.

Finally, additional analysis of predictors collected at the third assessment point (Table 4.7) suggested that emotional regulation was negatively associated with BI at T3 (r = -.505, p < .001), indicating that better emotional regulation as a predictor of BI lower levels. Executive functions measured through the flanker task at T3 did not correlate with BI levels. Regarding attentional bias indexes, only a negative marginally significant association with initial attention to nonsocial stimuli (Basket) indicates that children with higher BI were faster to fixate (r = -.198, p = .051) and fixate more frequently first on nonsocial stimuli. (r = .182, p = .069). In later stages, children with high BI fixated more on happy faces (paired with neutral ones) (r = .207, p = .039).

Concerning BI changes between time points (T2-T1, T3-T1, and T3-T2), additional correlation analyses were conducted to understand their associations with the different predictors. The results revealed several significant and marginal predictors.

An incremental change in BI levels between the second and first time points (T2-T1) seems to be negatively associated with the child's age (r = -.196, p = .051) but positively with father's BI level (r = .190, p = .058) and with overall attention towards nonsocial stimuli (r = .167, p = .096). However, these connections are only marginal.

Concerning the change in BI between the third and second time points (T3-T2), no significant correlations were found with child's and parent's characteristics. Attentional bias toward angry faces (paired with happy faces), measured at T2, was associated with a decrease in BI levels from T2 to T3 (r = -.265, p = .008, for first fixation ratio index; r = .253, p = .011, for latency bias index). Considering overall attention assessed at T2, longer dwell times in Happy faces (paired with neutral ones) are positively associated with an incremental change in BI from T2 to T3 (r = .193, p = .054). Finally, considering variables assessed at T3, emotional regulation, as well as cognitive control, maintain a negative association with BI change (r = -.403, p = .001 and r = -.212, p = .034, respectively), indicating that more regulated children, both at emotional or cognitive level, tend to experience a decrease in BI levels between T2 and T3. Furthermore, late attention to Happy (paired with neutral expression) seems to positively be associated with change in BI (r = .241, p = .016).

Table 4.7.

Correlation between predictors assessed at T3 and BI evolution

	Predictors	Predicting BI at T3	Predicting Change in BI (T3-T1)	Predicting Change in BI (T3-T2)
ER	Emotional Regulation	**-.505****	**-.251***	**-.403****
CBQ	Cognitive Control	-.018	-.141	**-.212***
Flanker Task	Inhibitory Control (Accuracy)	.009	-.031	.075
	Inhibitory Control (Reaction Time)	-.023	.006	-.067
	Inhibitory Control (Interference Score)	.062	-.015	.084
	Cognitive Flexibility (Accuracy)	-.076	-.041	-.066
	Cognitive Flexibility (Reaction Time)	.074	.098	.076
Early attention	Initial Vigilance for…			
	Angry (with Neutral)	.042	.008	.013
	Angry (with Happy)	.090	-.032	-.030
	Happy (with Neutral)	-.029	-.007	-.069
	Basket (vs. Neutral faces)	**.182 ᵗ**	.089	-.030
	Latency bias for First Fixation for…			
	Angry (vs. Neutral faces)	-.016	-.002	-.037
	Angry (vs. Happy faces)	-.074	.013	-.013
	Happy (vs. Neutral faces)	-.159	.053	-.029
	Basket (vs. Neutral faces)	**-.198 ᵗ**	**-.233***	-.009
Overall attention	Dwell time bias for…			
	Angry (vs. Neutral faces)	.052	.008	.116
	Angry (vs. Happy faces)	.047	.017	-.033
	Happy (vs. Neutral faces)	.036	.101	.008
	Basket (vs. Neutral faces)	.051	-.011	-.096
Late attention	Second-run dwell time bias for…			
	Angry (vs. Neutral faces)	.015	-.052	-.003
	Angry (vs. Happy faces)	.017	-.090	-.002
	Happy (vs. Neutral faces)	**.207***	**.251***	**.241***
	Basket (vs. Neutral faces)	-.139	-.077	.018

Note **p* < .05; **ᵗ** *p* < .090

Finally, examining the observed changes between the beginning and the end of the observational period (T3-T1), levels of BI of both the father's (as measured by AMBI) and child's (as measured by Lab-TAB) appear to be positively associated with a longitudinal increment in BI (r = .219, p = .029 and r = .205, p = .041, respectively). This association with father's BI was previously described in the analysis of the conditional LGM. A marginal positive association was also found for cognitive flexibility (r = .183, p = .069), indicating that higher cognitive flexibility at T2 may be associated with an increase in BI from T1 to T3. Initial attentional bias toward angry faces (paired with happy faces), measured at T2, and toward nonsocial stimuli, measured at T3, were associated with a decrease in BI levels from T1 to T3 (r = -.214, p = .033 and r = -.233, p = .021, respectively). Conversely, an overall longer dwell time on happy faces (paired with neutral ones) at T2 and late attention toward happy faces (paired with a neutral ones) at T3 were positively associated with increase in BI from T1 to T3 (r = .229, p = .022 and r = .251, p = .012, respectively). These findings suggest that attentional bias toward happy faces may be a risk factor for an increase in BI over time. Furthermore, among the control measures assessed at T3, only emotional regulation demonstrated a significant association with BI change (r = -.251, p = .012), indicating that children with better emotional regulation might experience a less detrimental change in BI from T1 to T3.

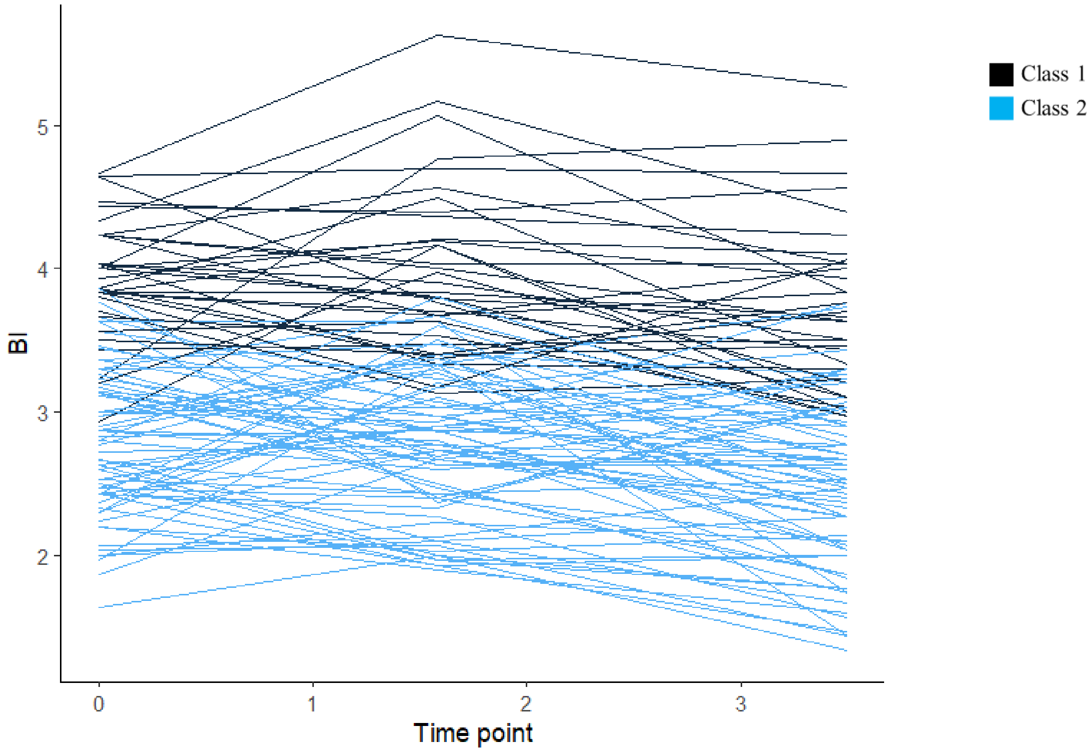
IDENTIFICATION OF TRAJECTORY CLASSES

Despite the relatively small estimated variance for the slope in the linear LGM, suggesting a homogeneous BI evolution in our participants, we investigated the possibility of identifying distinct subgroups within the sample that might exhibit different BI developmental trajectories, potentially masked by the overall sample trend. We conducted a Latent Growth Class Analysis (LGCA) to identify distinct patterns of BI development over time in our sample. LGCA is a statistical approach that allows for the identification of homogeneous subgroups within a heterogeneous population based on longitudinal growth trajectories (Mara & Carle, 2021). The model with two latent classes demonstrated the best fit to the data (lowest BIC = 618.56 and AIC = 602.93).

The two-class model identified two distinct developmental trajectories. Class 1 (n = 33) was characterized by higher levels of BI across the three assessment moments. In addition to presenting higher initial values (intercept), the tendency is to maintain higher BI levels over the three years, presenting only a reduced and non-significant decrease in the slope. In turn, Class 2 (n = 67) exhibited slightly lower initial values (intercept) and a tendency to significantly decrease over the three years (Figure 4.3).

Figure 4.3.

Latent Growth Class Analysis (LGCA) of BI trajectory



To understand whether these two classes of trajectory may be associated with our predictors, a series of t-tests were performed. The results of these analyses indicated that the group with higher/stable BI (Class 1) presents significantly higher levels of BI as measured by Lab-TAB (t(98) = 2.791, p = .006) and more difficulties in emotional regulation assessed at T3 (t(98) = -3.127, p = .002). Considering inhibitory control as assessed at T2 though the Flanker task, children from Class 1 seem to have longer reaction times in inhibitory control responses (t(98) = 1.892, p = .061) and small interference scores (t (98) = -1.735, p = .086), thus demonstrating a better capacity for inhibitory control, being able to suppress or ignore distractions more efficiently. These children with stable BI (Class 1) also seem to show better cognitive flexibility (t(98) = 2.978, p = .004) when compared to the group that decreases BI over time (Class 2).

Regarding attentional bias, at T2, the group with high/stable BI (Class 1) tends to initially avoid angry expressions (when paired with happy faces), as evidenced by greater latency to fixate on Angry faces ($t(98) = 2.116$, $p = .037$), fewer first fixations ($t(98) = -1.948$, $p = .054$), and shorter dwell time on Angry faces ($t(98) = -2.053$, $p = .043$). Conversely, there is a tendency to prefer happy faces, which is evident not only in the presence of Angry faces but also by a greater number of fixations on Happy faces when paired with neutral expressions ($t(98) = 1.811$, $p = .073$). At T3, the results reverse, with children with /stable BI tending to initially fixate more often on Angry faces (when paired with Happy faces) ($t(98) = 1.981$, $p = .050$).

Finally, there is a tendency for the Class 1 group (Stable BI) to always present a significantly higher level of SA, in all three moments ($t(98) \geq 2.791$, $p \leq .006$).

TRAJECTORIES OF BEHAVIORAL INHIBITION TO SOCIAL ANXIETY: CROSS-LAGGED MODELS, MEDIATIONS, AND MODERATIONS.

To understand the causal direction of BI and SA, we analyzed the available longitudinal data with a cross-lagged model. However, the initial model demonstrates a poor fit ($\chi 2 = 72.978$ $df = 6$, $p = .000$, $CFI = .814$, $TLI = .536$, $RMSEA = .336$). In this sense, we add a time-specific correlations between residuals to capture the correlation between the two variables of interest at each point in time that is not shared with their antecedent predictors (Figure 4.4). The fit of this more complete model was improved ($\chi 2 = 15.787$, $df = 4$, $p = .003$, $CFI = .967$, $TLI = .878$, $RMSEA = .173$); the unsatisfactory value for RMSEA might be attribute to the small number of degrees of freedom (REF).

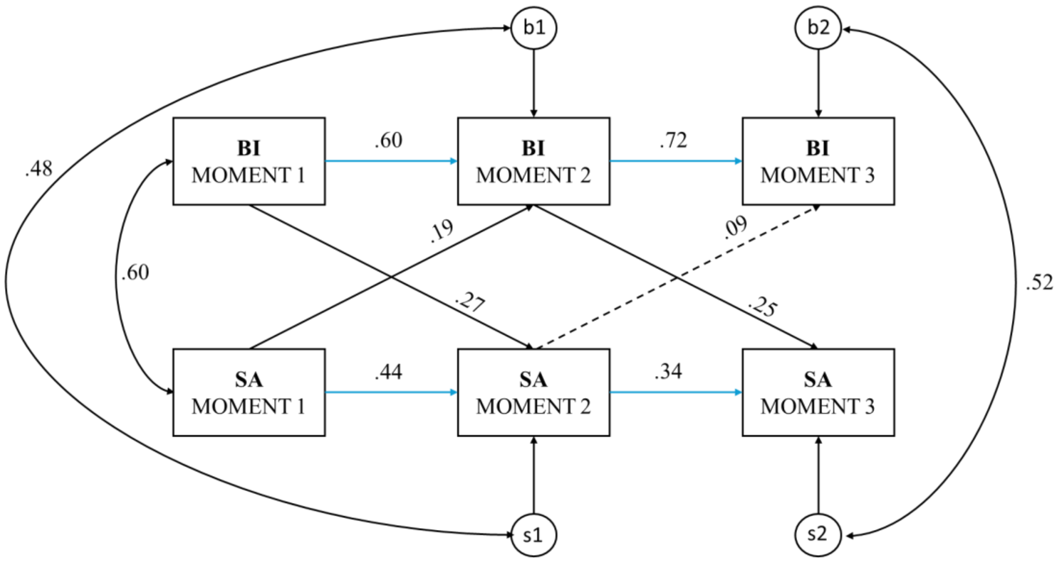
The direct paths (blue lines) indicate that both measures, BI and SA, have stability over time (BI: $\beta \geq .604$, $p < .001$; SA: $\beta \geq .344$, $p < .001$), although the stronger BI paths suggest a more reliable stability across the three assessment moments.

The cross-lagged effects indicate that the impact of BI on SA is stronger than the impact of SA on BI at both assessment points (T1 to T2 and T2 to T3). The causal relationship from SA to BI is weaker and becomes non-significant in the later stage (T2 to T3) ($\beta = .090$, $p = .204$), demonstrating that the causal direction is predominantly from BI to SA. This suggests that BI has a consistent and significant impact on the development of SA, significantly above the direct contribution of the previous SA level. On the other hand, the development of BI appears to be less influenced by SA.

Including time-specific correlations between residuals not only improved the model's fit but also allow to estimate the shared variance between BI and SA that extends beyond the longitudinal influence. This suggests that concurrent confounding factors might influence a significant part of the covariation between BI and SA scores at each time point, independently of their cross-lagged effects.

Figure 4.4.

Standardized Cross-lagged relationships between BI and SA



Note. Dashed lines indicate non-significant paths.

MEDIATION AND MODERATION ANALYSIS

To explore if the developmental trajectory of BI to SA is influenced by cognitive and emotional predictors, mediation and moderation analyses were conducted where inhibitory control, cognitive flexibility, and attentional bias were considered as moderators, while emotional regulation was considered as a mediator.

To examine whether the relationship between BI and SA is mediated by emotional regulation, we tested the simple mediation model (*PROCESS* Model 4; Hayes, 2018) with 5,000 bootstrap samples.

Concerning the relationship between BI assessed at T1 and SA assessed at T2, only the direct effect was significant ($b \geq .454$, $p < .001$), being the mediation effect of emotional regulation, as measured at T2 by Lab-TAB, non-significant (Sad ER: BI: b =

.001, *Boot 95%CI* [-.016, .022]; Angry ER: *b* = -.032, *BootCI* [-.081, .006]). Considering the relation between BI assessed at T2 and SA assessed at T3, we also found that BI had a significant direct effect on SA symptoms (*b* = .319, *SE* = 0.068, *t*(97) = 4.721, *p* < .001, 95% *CI* [0.185, 0.453]). Additionally, the indirect effect of BI on SA through emotional regulation was significant (*b* = .056, *BootSE* = .035, 95% *BootCI* [.007, .138]). The bootstrapped confidence interval for the indirect effect did not include zero, indicating that emotional regulation partially mediated the relation between BI and SA in later stages (T2 to T3).

A simple moderation analysis (*PROCESS* Model 1; Hayes, 2018) was conducted to test whether cognitive predictors modulate the relationship cross-lagged between BI and SA (Table 4.8).

Table 4.8.

Moderating effects of cognitive variables on the relationship between BI and SA

Predicted Variable		**B**	**SE**	**t**	***p***	**95%CI**
	Attentional Bias (T2) - Latency First Fix Happy (with Neutral)					
	BI T1	.343	.052	6.611	.000	.240-.446
BI(T1) → SA(T2)	Latency Happy-Neutral	-.019	.051	-0.378	.706	-.121 - .083
	BI x Latency Happy-Neutral	.124	.061	2.033	.045	.003 - .244
	Attentional Bias (T2) – Dwell Time Happy (with Neutral)					
	BI T1	.333	.051	6.479	.000	.231 - .435
BI(T1) → SA(T2)	Dwell Time Happy-Neutral	.024	.051	0.475	.636	-.078 - .127
	BI x Dwell Time Happy-Neutral	-.109	.059	1.848	.068	-.226 - .008
	Inhibitory Control (T2) – Lab TAB					
	BI T1	.3122	.053	5.906	.000	.207 - .417
BI(T1) → SA(T2)	Inhibitory Control	-.0486	.054	-0.909	.366	-.155 - .058
	BI x Inhibitory Control	-.1060	.060	1.780	.078	-.224 - .012
	Cognitive Flexibility (T2) - Accuracy					
	BI T1	.317	.053	5.974	.000	.212 - .422
BI(T1) → SA(T2)	Cognitive Flexibility	.034	.056	0.603	.548	-.078 - .145
	BI x Cognitive Flexibility	.114	.053	2.133	.036	.008 - .219
	Lab-TAB: Inhibitory Control (T3)					
	BI T2	.290	.054	5.369	.000	.183 - .397
BI(T2) → SA(T3)	Inhibitory Control	.050	.055	0.909	.366	-.059 - .158
	BI x Inhibitory Control	.125	.058	2.161	.033	.010 - .240

Note: Only significant or marginally significant results are presented.

Considering the pathway between BI assessed at T1 and SA assessed at T2, were found a significant moderation of cognitive flexibility, attentional bias and inhibitory control (assessed by Lab-TAB).

The interaction term between BI and cognitive flexibility was significant (b = .114, SE = .053, $t(96)$ = 2.133, p = .036), suggesting that the relationship between BI and SA is moderated by cognitive flexibility. Specifically, the association between BI and SA was stronger at higher levels of cognitive flexibility ($p \leq .006$).

Attentional bias acts at two levels like moderator: early and overall attention. It appears that early attention to Happy faces (paired with neutral ones) represented by latency (b = .114, SE = .053, $t(96)$ = 2.133, p = .035) and overall attention to Happy faces (paired with neutral ones) represented by dwell time (b = -.109, SE = .059, t(96) = -1.85, p = .068) acts as a moderators, although dwell time only have a marginally significant effect. There were no other significant results with the remaining emotions pairs. The results concerning attentional bias indicates that children with higher latency to fixate Happy faces (paired with neutral ones) presents a stronger relationship between BI and SA. In the same sense, the marginally significant negative interaction indicates that the strength of the relationship between BI and SA decreases as higher levels of dwell time to happy faces ($p < .001$). In synthesis, it appears that children who avoid happy faces (i.e. showing greater latency and shorter dwell time) exhibit a stronger relationship between BI and SA, suggesting that avoidance of positive stimuli may amplify the link between BI and SA.

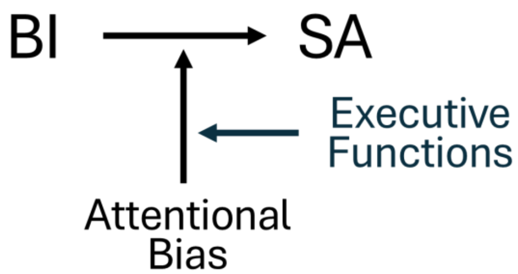
Finally, the interaction term between BI and inhibitory control was negatively and marginally significant (b = -.106, SE = .060, $t(96)$ = 1.780, p = .078), suggesting that the relationship between BI and SA is marginally moderated by inhibitory control. Specifically, the association between BI and SA was weaker at higher levels of inhibitory control ($p \leq .017$).

Regarding the pathway between BI assessed at T2 and SA assessed at T3, only inhibitory control (assessed by CBQ) appears to act as a moderator. The interaction effect between BI and inhibitory control was also negative and significant (b = .125, SE = .058, $t(96)$ = 2.161, p = .033). These results suggest that the relation BI-SA was moderated by inhibitory control. Specifically, the association between BI and SA was weaker and non-significant at lower levels of inhibitory control (b = .135, p = .143). And was higher at moderate and higher levels of inhibitory control (*b* = .316, *p* = .000; *b* = .413, *p* = .000, respectively).

Following the moderation analysis of cognitive variables in the BI-SA relationship, we will now explore second-order moderated moderation effects using the PROCESS macro (Model 3; Hayes, 2018). Specifically, we aim to test whether executive functions – namely inhibitory control (Table 4.7) and cognitive flexibility (Table 4.8) – moderate the impacts of attentional bias as moderator in the BI-SA relationship (Figure 4.5). In this analysis, executive functions will be examined as potential factors that further influence how attentional bias modulates the association between BI and SA, providing a deeper understanding of the interaction between these cognitive mechanisms.

Figure 4.5.

Schematic representation of the explored moderated moderations



Considering inhibitory control at T2 (Table 4.9) as a second-order moderator, we found that when latency to fixate Angry (paired with Happy one) is a moderator was significant, (*b*= 0.256, *SE*= 0.104, *t*(92)= 2.468, *p*= 0.016), indicating that the effect of latency to fixate Angry (paired with Happy one) on the BI-SA relationship is contingent upon levels of inhibitory control. Specifically, for children with lower inhibitory control (*b* = - 0.850), the attentional bias has a stronger effect on the BI-SA relationship (*b*= 0.596, SE= 0.127, *t*(92)= 4.689, *p*< 0.001). As inhibitory control increases, the strength of the BI-SA relationship diminishes, particularly when latency to fixate Angry (paired with Happy one) is low.

Table 4.9.

Moderated Moderation effects of Inhibitory Control and Attentional Bias on the relationship between BI and SA

Predicted Variable		B	SE	t	*p*	*95% CI*
	Model 1					
	BI T1	.311	.052	6.00	.000	.208 - .415
	Late attention Angry-Happy	-.021	.054	-0.382	.704	-.128 - .087
SA T2	BI x Late attention Angry-Happy	.015	.055	0.264	.792	-.095 - .124
	Inhibitory Control (IS)	-.148	.057	-2.587	.011	-.261 - -.034
	BI x Inhibitory Control	-.116	.054	-2.128	.036	-.224 - -.008
	Late attention Angry-Happy x Inhibitory Control	.053	.069	0.765	.447	-.085 - .191
	BI x Late attention Angry-Happy x Inhibitory Control	.257	.104	2.468	.016	.050 - .462
	Model 2					
	BI T1	.310	.054	5.695	.000	.202 - .418
	IV Angry-Neutral	.062	.055	1.126	.263	-.047 - .172
	BI x IV Angry-Neutral	.049	.061	0.801	.425	-.073 - .171
SA T2	Inhibitory Control (RT)	-.008	.055	-0.147	.884	-.117 - .100
	BI x Inhibitory Control	.036	.050	0.719	.474	-.063 - .135
	IV Angry-Neutral x Inhibitory Control	-.036	.058	-0.629	.531	-.150 - .078
	BI x IV Angry-Neutral x Inhibitory Control	.096	.052	1.835	.070	-.008 - .200
	Model 3					
	BI T2	.310	.057	5.476	.000	.198 - .422
	First Fix Happy-Neutral	-.072	.059	-1.233	.221	-.189 - .044
	BI x First Fix Happy-Neutral	-.070	.057	-1.236	.220	-.184 - .043
	Inhibitory Control (IS)	.024	.059	0.409	.684	-.093 - .142
SA T3	BI x Inhibitory Control	.020	.051	0.384	.702	-.082 - .121
	First Fix Happy-Neutral x Inhibitory Control	.035	.071	0.496	.621	-.105 - .176
	BI xrst Fix Happy-Neutral x Inhibitory Control	.125	.061	2.042	.044	.003 - .247

Note: Only significant or marginally significant results are presented. IS – Interference Score; RT – Reaction Time

Although only marginal (*b* = 0.096, *SE* = 0.052, *t*(92) = 1.835, *p* = 0.070), we also found that children with faster reaction times (indicating greater inhibitory control, b = .924) the initial vigilance to angry faces (paired with neutral ones) had a weaker effect on the BI-SA relationship (*b*= 0.229, *SE*= 0.111, *t*(92)= 2.053, *p*= 0.04). Thus, children with greater inhibitory control are less affected by initial vigilance to angry faces in the BI-SA relationship.

Considering inhibitory control at T3, we found a moderated mediation: three-way interaction was significant, (*b*= 0.125, *SE*= 0.061, *t*(92)= 2.042, *p*= .044), suggesting that the effect of first fixation on Angry-Neutral on the BI-SA relationship depends on levels of inhibitory control. Specifically, for children with low inhibitory control (*b* = -1.113), first fixation on Angry-Neutral had a stronger effect on the BI-SA relationship (*b*= 0.513, *SE*= 0.132, *t*(92)= 3.884, *p*= 0.000). As inhibitory control increases, the influence first fixation on Angry-Neutral on the BI-SA relationship diminishes.

Across both time points (T1-T2 and T2-T3), the results indicate that the moderating role of attentional bias on the relationship between BI and SA is further influenced by levels of inhibitory control. Specifically, children with lower inhibitory control are more affected by attentional biases, leading to a stronger relationship between BI and SA. In contrast, children with higher inhibitory control exhibit a weaker relationship between attentional bias and SA, suggesting that inhibitory control serves as a protective factor.

Regarding cognitive flexibility, we only found results with response time (RT) and the results obtained is mainly associated with attentional bias to nonsocial vs. social stimulus (Table 4.10). We found a three-way interaction between BI, initial attentional bias (expressed by initial vigilance) towards nonsocial-social stimuli, and cognitive flexibility marginally significant (*b*= −.0819, *SE*=.047, *t*(92)= -1.755, *p*= .083), suggesting that cognitive flexibility may moderate the relationship between attentional bias and SA. Specifically, children who exhibited higher cognitive flexibility demonstrated a less pronounced association between BI and SA when their initial vigilance was directed towards nonsocial stimuli.

We also found a marginally significant interaction of overall attentional bias (dwell time) to non-social vs. social stimulus with BI and cognitive flexibility (*b*= -.076, *SE*=.043, *t*(92)= -1.78, *p*= .078). Children with greater cognitive flexibility showed a weakened relationship between BI and SA even when they exhibited a longer dwell time on nonsocial stimuli. This suggests that cognitive flexibility may enable these children to disengage more effectively from nonsocial cues, potentially reducing avoidance behaviors and allowing for better regulation of anxiety responses.

Table 4.10.

Moderated Moderation effects of Cognitive Flexibility and Attentional Bias on the relationship between BI and SA

Predicted Variable		B	SE	t	*p*	95%CI
SA T2	**Model 1**					
	BI T1	.301	.054	5.541	.000	.193 - .409
	IV Basket-Neutral	-.017	.058	-0.289	.773	-.132 - .098
	BI x IV Basket-Neutral	-.081	.065	-1.253	.214	-.211 - .048
	Cognitive Flexibility (RT)	.088	.054	1.628	.107	-.019 - .194
	BI x Cognitive Flexibility	.030	.048	0.619	.537	-.066 - .126
	IV Basket-Neutral x Cognitive Flexibility	.014	.050	0.276	.783	-.085 - .112
	BI x IV Basket-Neutral x Cognitive Flexibility	-.082	.047	-1.755	.083	-.175 - .011
SA T2	**Model 2**					
	BI T1	.322	.050	6.385	.000	.222 - .422
	Dwell Time Basket-Neutral	.133	.052	2.542	.013	.029 - .236
	BI x Dwell Time Basket-Neutral	.028	.059	0.467	.642	-.090 - .145
	Cognitive Flexibility (RT)	.083	.054	1.535	.128	-.024 - .190
	BI x Cognitive Flexibility	.060	.049	1.241	.218	-.036 - .156
	Dwell Time Basket-Neutral x Cognitive Flexibility	-.010	.047	-0.207	.837	-.104 - .084
	BI x Dwell Time Basket-Neutral x Cognitive Flexibility	-.076	.043	-1.781	.078	-.161 - .009
SA T2	**Model 3**					
	BI T1	.333	.051	6.499	.000	.231 - .435
	Late attention Happy-Neutral	.007	.052	0.127	.900	-.097 - .111
	BI x Late attention Happy-Neutral	-.029	.052	-0.564	.574	-.133 - .074
	Cognitive Flexibility (RT)	.117	.052	2.237	.028	.013 - .220
	BI x Cognitive Flexibility	-.000	.046	-0.007	.994	-.091 - .090
	Late attention Happy-Neutral x Cognitive Flexibility	.093	.064	1.460	.148	-.033 - .219
	BI x Late attention Happy-Neutral x Cognitive Flexibility	.137	.061	2.241	.028	.016 - .259

Note: Only significant or marginally significant results are presented. IS – Interference Score; RT – Reaction Time

Lastly, in T2 assessment, we found a statistically significant interaction between late attention bias to Happy-Neutral, BI and cognitive flexibility (*b*= .137, *SE*=.061, *t*(92)= 2.241, *p*= .028), suggesting that for late attention towards happy-neutral stimuli, cognitive flexibility again emerged as a significant moderator. Children who showed greater cognitive flexibility experienced a reduced association between BI and SA, especially when their late attention was directed towards happy faces.

Regarding the last assessment (Time 3) there are no significant moderated moderations with cognitive flexibility.

In summary, the findings suggest that attentional biases towards nonsocial stimuli, whether through initial vigilance or prolonged dwell time, are associated with stronger BI-SA connections. However, cognitive flexibility plays a key role in moderating these effects, especially in contexts where late attention to happy stimuli or adaptive shifts in attention occur. Children with higher cognitive flexibility are better able to manage attentional biases, thereby reducing the impact of BI on the development of SA.

DISCUSSION

The present study aimed to analyze the development of behavioral inhibition (BI) in children, as a key etiological factor for anxiety disorders. A thorough understanding of the developmental trajectory of BI, as well as its relation to individual and family environmental factors, is crucial. To this end, we conducted a three-year longitudinal study involving one hundred children aged 3 to 9 years. We employed individual measures and parental reports to assess BI at three distinct time points.

BI developmental trajectory

Our findings indicate a linear decrease in BI across the study duration. Despite individual differences in initial BI levels (ranging from 1.63 to 5.93), the overall trajectory appeared consistent. The observed decrease in BI, though statistically significant, was relatively small (*M* = -.307, *SE* = .061, 95% *CI* [-.427, -.187], with mean scores of T1 = 3.18, T2 = 3.18, and T3 = 2.89).

These results align with a parallel longitudinal study by Anaya et al. (2023), which found a general decline in BI from early childhood to late childhood (through eighteen months to seven years). This trend challenges prevailing developmental psychology theories that suggest temperamental traits, including BI, remain relatively stable from early childhood (Rothbart & Bates, 2006). Notably, studies supporting stability in BI often focus on samples selected for extreme levels of inhibition (Chronis-Tuscano et al., 2009; Fox et al., 2001). For instance, in the Chronis-Tuscano et al. (2009) study, adolescents reveal a BI (assessed at 14 and 24 months) with mean scores higher than 4.05 (scores ranged from 1 to 7) in a parental report assessment of temperament. Our study, along with Anaya's, maps trajectories in a general sample, reinforcing the notion that our study's findings in a general population signify a normative developmental trend from infancy to middle childhood.

While a general homogeneity was observed in the developmental trajectory of BI, individual child characteristics and parental influences produced diverse patterns of BI development. At the first assessment moment (T1), BI levels demonstrated considerable variability among children. However, over the subsequent three years, the linear decrease in BI exhibited a somewhat uniform path for most participants. Despite this trend, we explored how particular characteristics of children and familial factors contributed to the developmental variability observed in some cases.

Individual Child Characteristics

Regarding child individual characteristics, our results suggest an association between birth order and BI, where children born second or later in the family exhibit lower levels of BI. Although this variable only achieved significance in the initial assessment, subsequent analyses indicated that birth order influenced not only initial BI levels but also its developmental trajectory, demonstrating a substantial association with BI across all assessment points. This supports previous findings by Coll et al. (1984), suggesting that first-borns and only children often demonstrate higher levels of cautious and inhibited behaviors compared to their later-born siblings, potentially due to differential parental expectations and child-rearing strategies (Harrington, 2006). The dynamics of sibling interactions and the child's role within the family unit may exert unique pressures or support systems that shape BI (Pollet & Nettle, 2009).

Specifically, Sulloway (1996) posits that first-born children are more likely to conform to parental expectations and societal norms, while later-born children might exhibit greater openness to new experiences due to relaxed parenting styles and the influence of siblings. First-borns may experience more direct parental oversight and higher expectations, which can lead to more cautious and controlled behavior, whereas later-born children are often exposed to more opportunities for social interaction through observation of their older siblings' experiences, allowing them to navigate social environments with more confidence and less inhibition (Paulhus et al., 1999). This highlights the need for future studies to further dissect the relationship between birth order and parenting and familiar dynamics regarding BI.

Conversely, other individual factors such as gender, and the number of siblings did not significantly impact BI trajectories or changes over time. This may suggest that the pronounced effects of familial, environmental, and genetic interactions overshadow the influence of child-specific variables. Developmental trajectories may sometimes mask individual variability—children may respond differently to similar environmental contexts. For example, Bao et al. (2016) found that while overall trajectories might imply certain patterns, individual differences yield a diverse array of developmental outcomes that cannot be fully accounted by child-specific factors.

However, while our conditional model only indicates the significant role of birth order in BI development, subsequent analyses highlight the additional influence of age, suggesting it may also be a relevant factor associated with BI trajectories. Our results confirm that children's age correlates positively with initial BI levels but negatively with BI changes between the first and second assessments (T1-T2). Older children might show heightened BI initially due to their increasing awareness of societal norms and expectations, resulting in elevated levels of anxiety and inhibition during unfamiliar situations. The significant impact of age on changes in BI aligns with the notion that developmental transitions during this period may be particularly influential, as growing older confers an improved ability to regulate emotions and adapt to social contexts.

This pattern could reflect the natural maturation process where, although older children initially exhibit more BI, they also have greater cognitive and emotional resources to manage their fears and anxieties as they encounter repeated social situations and gain more social experience. These findings align with the developmental trajectory of BI, which shows that while BI tends to be relatively stable, it may decrease as children grow older and acquire better emotional regulation skills (Clauss & Blackford, 2012; Fox et al., 2005).

Moreover, findings from studies on emotional regulation indicate that older children are better equipped to manage negative emotions, which may contribute to the decrease in BI (Eisenberg et al., 2010). This age-related improvement in emotional regulation and coping strategies likely explains why older children, despite having higher BI at an earlier stage, exhibit a more substantial reduction in BI over time.

Parental Characteristics

Considering parental characteristics, our results identified elevated symptoms of SA in both parents as significant predictors of children's initial BI levels. This aligns with existing literature demonstrating that children of parents with anxiety disorders are at increased risk for developing BI (Degnan & Fox, 2007; Murray et al., 2009). Parental anxiety likely fosters a heightened perception of threat in their environments, which in turn reinforces inhibited behaviors in children. The inclination of anxious parents to adopt more controlling parenting practices may lead children to perceive their surroundings as more threatening, cultivating avoidant behaviors (Affrunti & Ginsburg, 2012; Azham et al., 2021).

Furthermore, Henderson et al. (2018) revealed that the stability of BI across development is connected to parental practices that restrict children's opportunities for exploration, potentially solidifying avoidant behaviors. These findings suggest an intergenerational transmission of anxiety-related behaviors, warranting further research into this phenomenon for implications concerning preventive interventions (Sameroff, 2009).

Further studies have mentioned the distinct roles fathers play in shaping developmental trajectories. Among the studied parental factors, in our study only paternal BI significantly moderated changes in children's BI over time, indicating the necessity of considering both maternal and paternal influences when analyzing BI trajectories in children (Belsky & Pluess, 2009). Indeed, we previously observed that paternal SA affects boys' SA indirectly through overprotectiveness, while mothers' SA has a direct impact on their child's SA, irrespective of the child's gender (Fernandes et al., 2023).

Considering correlation analysis, Mothers SA level appears to be significantly associated with BI, not only in the first moment but across all the three moments of assessment. Considering fathers, BI and SA are associated with children BI across all the moments and also with BI changes. The novel result is the paternal overprotection and age that stands out as having a significant impact on the trajectory of BI, even though it did not demonstrate relevance in the conditional model.

The impact of parental characteristics such BI and SA may reflect the environmental and genetic mechanisms through which parental characteristics influence child development. For instance, parental BI and SA could influence parenting styles, like overprotection, or create a family atmosphere that either exacerbates or mitigates children's BI through modeling or through the emotional climate of the home.

Additionally, the age of fathers was found to influence the trajectory of BI, with older fathers associated with a greater decrease in BI over time. Older fathers might possess greater emotional maturity and stability, which translates to a calmer and more supportive parenting approach, fostering a secure environment that mitigates BI. The identification of paternal overprotection and age as salient factors adds depth to discussions on family influences on BI, indicating that paternal characteristics may exert considerable influence as children mature (Lamb & Lewis, 2010).

The novel identification of paternal overprotection and age as an associated variable adds a new dimension to the discourse on family influences on BI, suggesting that paternal factors may exert a more significant influence as children mature. This could be attributed to changes in father-child interactions over time or the evolving psychological impact of the father's presence and behavior on the child (Lamb, 2010).

Based on the results, it is evident that parental variables play a crucial role in the development and trajectory of BI in children, with fathers demonstrating a significant impact. Specifically, paternal BI, SA, age, and overprotection are associated with children's BI levels and changes over time. The results suggest that fathers may have a unique role in moderating the expression of BI, potentially due to the societal expectation that fathers contribute to children's social development by encouraging exploration and risk-taking behaviors. However, when fathers themselves display high levels of BI, SA, or overprotection, these characteristics may conflict with their role in helping children overcome their inhibitions, potentially exacerbating BI in children. This is supported by research indicating that fathers typically promote autonomy and encourage children to engage with novel situations, which contrasts with maternal roles often associated with nurturing and protection (Bögels & Phares, 2008; Lamb & Lewis, 2010). When fathers exhibit anxiety or overprotective tendencies, it may undermine their ability to encourage this social risk-taking, contributing to the persistence or exacerbation of BI in their children (Möller et al., 2016).

Overall, the absence of direct child predictors in determining the BI trajectory invites a reevaluation of the weight attributed to intrinsic child factors versus environmental influences in shaping BI. This suggests that although BI has a temperamental basis, it may be more malleable and responsive to environmental influences than previously believed.

Cognitive and emotional factors

As children age, the factors influencing the developmental trajectory of BI become increasingly complex. In our study also intends to comprehend the association between cognitive components and BI development as children age. Specifically, cognitive flexibility emerged as a significant predictor of BI change (T3-T1) and BI levels assessed at T2, alongside inhibitory control, which inversely correlated with BI and its changes at later stages. Enhanced emotional regulation skills also correlated with reduced BI, suggesting that children adept at managing their emotions exhibit lower BI levels. This is congruent with existing literature underscoring the integral role of emotional regulation in mitigating anxiety and inhibition (Eisenberg et al., 2010; Spence & Rapee, 2016).

Notably, our results regarding cognitive flexibility appear complex. Children demonstrating superior cognitive flexibility exhibited elevated BI levels over time, suggesting that greater cognitive adaptability may heighten sensitivity to perceived threats and, consequently, exacerbate anxiety in novel situations. This might occur if cognitive flexibility allows children to amplify their awareness of potential risks, thereby contributing to a cautious and inhibited demeanor. Similarly, while inhibitory control generally serves as a protective factor, it also presents a dual outcome, contributing to both adaptive and maladaptive responses. Research indicates that children with elevated inhibitory control may initially manage their reactions to anxiety-provoking stimuli, yet excessive control may hinder engagement in exploratory behavior, exacerbating avoidant tendencies (Fox et al., 2021; Gunther & Pérez-Edgar, 2021).

Furthermore, the effectiveness of cognitive inhibition and flexibility may vary depending on emotional context, with emotional stimuli potentially interfering more significantly in children with high flexibility, thereby increasing inhibition in emotionally charged situations.

Although recognized the importance of inhibitory control in BI development, its relation is complex and multi-faceted, with research indicating both protective and risk pathways. In some contexts, higher inhibitory control is associated with reduced BI over time, as inhibitory control allows children to better regulate their responses to novelty and potential threats. For example, Fox et al. (2021) proposed that higher inhibitory control, help behaviorally inhibited children flexibly manage their initial reactions to unfamiliar situations, thereby reducing their risk of developing SA. The Fox et al. study aligns with our results and with the idea that inhibitory control can serve as a protective factor by supporting adaptive responses and decreasing maladaptive avoidance behaviors in social contexts. However, some literature also recognizes that higher levels of inhibitory control have been linked with increased BI in some children. For example, Gunther and Pérez-Edgar (2021) highlighted that while inhibitory control is generally seen as a beneficial cognitive skill, it can also increase the risk of anxiety in BI children by promoting excessive control and heightened attention to threatening stimuli. This increased attentional focus on negative or novel cues can reinforce BI, making it more stable and resistant to change over time. Overall, these studies illustrate that while inhibitory control is a critical factor in the development and modulation of BI, its effects are not universally protective and can vary significantly depending on individual differences and contextual factors. Future research should continue to explore how different aspects of inhibitory control interact with BI to influence developmental trajectories, particularly in the context of risk and resilience to anxiety disorders.

Improved emotional regulation proficiency correlates with diminished BI, indicating that effective emotional management equips children to navigate social situations, enabling them to modulate their reactions to anxiety-inducing contexts. Early BI, characterized by ineffective regulation strategies, correlates with long-term social competence (Penela et al., 2015).

Attentional Bias

Our study identified a potential influence of attentional bias in predicting BI development. Specifically, children exhibiting attentional bias toward angry faces, contrasted with happy stimuli, at T2, demonstrated a reduction in BI levels over time. Early avoidance of threatening stimuli may serve as a maladaptive coping strategy.

However, simultaneously, our results demonstrate an overall preference for happy faces during the stimulus presentation, which may delineate critical coping mechanisms employed by children to mitigate emotional discomfort in social settings.

This suggests that these children use a protective strategy to avoid negative emotional stimuli and focus on more positive cues in social situations. This behavior aligns with research indicating that children with BI tend to avert their gaze from threat-related stimuli to mitigate social discomfort or anxiety (Pérez-Edgar & Fox, 2005; Waters et al., 2010).

Besides that, this suggests that preference for happy social cues may not always lead to better social adjustment. Sustained focus on happy faces may indicate difficulty in engaging with more neutral or complex social cues, reflecting avoidance of less straightforward social situations and potentially leading to increased BI (Dodd et al., 2020; Schmidtendorf et al., 2018). On the other hand, positive stimuli can be interpreted as threatening to the child, as evidenced in the study of (Fernandes et al., 2018). The authors conclude that positive social cues may not be perceived as protective by the child but rather as a risk factor for persistence of inhibited or anxious characteristics.

Interestingly, during stimulus presentation progresses, children show a shift in attentional bias, with increased fixation on angry faces during the later stages of viewing (second fixation). This shift could reflect the dual-process model of attention, where early attentional biases serve as a protective avoidance mechanism, but later, the child's attention is drawn to the perceived threat—in this case, the angry face—due to heightened vigilance for social threats (Bar-Haim et al., 2007). This shift in attention towards angry faces during the later fixation may indicate that children with high BI, while initially avoiding the threat, cannot completely disengage from it. This late fixation could signal heightened discomfort or difficulty managing their emotional responses, perpetuating BI tendencies.

This pattern also suggests that children maintaining focus on threatening stimuli, even in the presence of positive cues, may experience increased BI due to difficulties in disengaging from negative emotional information or integrating complex emotional cues (Bar-Haim et al., 2007; Dodd et al., 2020). These findings underscore the role of emotional context in understanding the relationship between attentional biases and BI, indicating that inability to shift attention away from threats in the presence of positive cues may exacerbate BI tendencies.

In summary, the change in attentional bias within the same stimulus presentation suggests a more nuanced and complex emotional processing in children with high BI. Initially focusing on happy stimuli may represent a short-term coping strategy, but their eventual focus on angry faces highlights an underlying anxiety or hypervigilance towards threats. This pattern aligns with theories that children with BI may initially avoid threatening stimuli but later become more attuned to potential threats as a result of heightened discomfort (Bar-Haim et al., 2007; Dodd et al., 2020).

By T3 (last assessment moment), children with higher levels of BI displayed a preference for nonsocial stimuli, suggesting a potential withdrawal from engaging social dynamics. These results present an interesting aspect of attentional processing that can contribute to the understanding of BI development. Such patterns of attentional processing might reflect a broader disengagement from social interactions, contributing to the stability of their BI over time.

This pattern of focusing on nonsocial stimuli might reflect an avoidance strategy, where children with higher BI avoid potentially challenging social interactions or emotional stimuli by diverting their attention to nonsocial elements in their environment. Studies have shown that children with BI tend to show greater avoidance of emotionally charged stimuli, such as faces or social scenes, opting instead for neutral or less engaging stimuli as a means of emotional self-regulation (Pérez-Edgar et al., 2010; White et al., 2017). This preference for nonsocial stimuli may reduce immediate discomfort but might also reinforce social avoidance over time, exacerbating BI.

As the stimulus presentation progresses, children show again a shift in attentional bias, with increased fixation on happy faces (paired with neutral ones) during the later stages of viewing (second fixation) positively associated with change of BI in all the three assessment moments. A study by Dodd et al. (2020) found similar patterns, indicating that children with SA who focused excessively on happy faces during free-viewing tasks were less likely to engage with neutral or ambiguous social stimuli. This finding resonates with your result that a sustained preference for happy faces may not be beneficial for social development in children with high BI. The sustained attention to happy faces, while potentially comforting, could reduce opportunities for children to practice social engagement in more complex and varied social settings.

The study reveals how attentional biases influence the developmental trajectory of BI in children and suggests a shift in strategies from T2 to T3. At T2, the initial avoidance of angry faces and preference for happy faces reflects an early-stage strategy to cope with social discomfort by focusing on emotionally positive cues and avoiding perceived threats. This behavior is typical in children with BI, as they seek out less threatening social stimuli to regulate their emotional responses (Pérez-Edgar & Fox, 2005). The later shift towards angry faces, however, suggests that while this avoidance strategy may work initially, children with high BI are ultimately unable to fully disengage from potential threats, reinforcing their inhibited behavior over time.

However, by T3, the shift in attentional bias to nonsocial stimuli in the initial stages suggests a more entrenched form of avoidance. By T3, children with high BI appear to be withdrawing not only from negative social stimuli but from social stimuli altogether. This increasing preference for nonsocial objects reflects a broader disengagement from the social world, which could contribute to the stability of BI over time (White et al., 2017). The eventual return to happy faces at the later stages of stimulus presentation indicates that children with high BI still seek out positive emotional cues, but their initial withdrawal from social stimuli suggests an avoidance pattern that may become more pronounced with age.

In summary, the changes in attentional bias from T2 to T3 suggest that children with high BI initially use avoidance strategies to cope with social discomfort, but over time, these strategies become more generalized, leading to a broader withdrawal from social stimuli. This pattern highlights the importance of addressing attentional biases early in the development of BI to prevent these avoidance strategies from becoming more ingrained.

In conclusion, this study offers insights into the developmental trajectory of BI in children over time, highlighting the complex interaction of individual, familial, and cognitive factors. These results reinforce the idea that while BI has temperamental roots, it is highly malleable and shaped by both environmental and cognitive factors.

To further understand these dynamics, the next phase of our analysis will divide the sample into distinct BI classes based on trajectories observed over time. By dividing the sample into classes based on BI levels and progression over time, we aim to uncover whether cognitive and emotional factors, such as attentional bias, inhibitory control, cognitive flexibility, and emotional regulation, play differential roles in children with stable versus fluctuating BI profiles.

Although the overall sample suggested a homogeneous decline in BI, our *Latent Growth Class Analysis* (LGCA) identified two distinct subgroups with differing developmental trajectories. This finding emphasizes the importance of identifying subgroups within a population, as different developmental paths can be masked by average trends (Jung & Wickrama, 2008). The two-class model revealed that Class 1, characterized by consistently high BI levels, exhibited a stable trajectory over time, with little change in BI, while Class 2, with slightly lower initial BI levels, showed a significant decrease over the three years. This divergence highlights the variability in how BI develops in different subgroups of children.

Key cognitive and emotional variables were found to differentiate these two classes. Children in Class 1, who exhibited stable and high BI, demonstrated superior cognitive flexibility and inhibitory control, which is somewhat counterintuitive given their stable high levels of BI. As observed in the total sample, cognitive flexibility, typically associated with adaptive functioning, may not always serve as a protective factor in children with high BI. Their ability to navigate complex cognitive tasks may heighten their sensitivity to threats, exacerbating BI over time.

In turn, the results presented regarding inhibitory control seem to be contrary to those obtained in the total sample. While in the previous analysis, children with higher levels of BI showed lower inhibitory control in later phases (T3), class 1 (Stable BI) presents higher levels of inhibitory control, but these are only evident in earlier phases (T2). These results reinforce the previously mentioned idea that inhibitory control appears to have a dual outcome as a protective and risk variable. While inhibitory control is generally seen as a protective factor, helping children regulate impulsive responses and manage social situations, excessively high levels of inhibitory control in children with elevated BI may have the opposite effect. Rather than promoting flexibility and adaptive social behaviors, it could contribute to rigid, overly controlled responses that prevent children from engaging in social exploration and adaptive risk-taking. This rigidity might hinder emotional and social development by reinforcing avoidance behaviors and limiting opportunities to learn from novel experiences. Studies suggest that excessive inhibitory control can lead to inflexibility in emotional regulation, which may exacerbate internalizing behaviors like anxiety and social withdrawal (White et al., 2011). Children with high BI and high inhibitory control might become overly focused on avoiding mistakes or social threats, further reinforcing their inhibited temperament and preventing them from adapting to changing social environments (Murray & Kochanska, 2002).

Interestingly, emotional regulation followed a changing pattern over time. At T2, children in Class 1 had better emotional regulation, particularly in managing sadness, but by T3, they exhibited more difficulties in emotional regulation compared to Class 2. This shift may indicate that while children with stable high BI may initially have compensatory emotional regulation skills that may not be sustainable in the long term. Prolonged exposure to social stress and the anxiety that accompanies social interactions may, over time, deplete these children's emotional resources, leading to greater difficulties in managing emotions like sadness and anxiety Henderson et al. (2018). This decline in emotional regulation abilities can be understood as a cumulative process, where the continuous confrontation with social challenges eventually overwhelms their emotional regulation system. This is consistent with the notion that children with high BI may become more vulnerable to emotional difficulties as they grow older (Kiel & Buss, 2014).

Additionally, the worsening of emotional regulation may also reflect the growing complexity of social dynamics as children age. As social situations become more nuanced and emotionally demanding, the demands placed on a child's emotional regulation abilities increase, particularly for those with high BI. These children may struggle to adapt to more complex emotional cues, contributing to a heightened sense of stress and difficulty in managing emotions in later stages (Kiel & Buss, 2014). Overall, the findings suggest that while children with high BI may initially compensate through strong emotional regulation, these abilities may erode over time as the emotional and social demands they face increase.

Attentional bias also played a significant role in differentiating the classes consistent with the results obtained from the overall sample. At T2, children in Class 1 showed avoidance of angry faces and a preference for happy faces, behaviors often linked to anxiety and social avoidance strategies (Pérez-Edgar & Fox, 2005). However, by T3, their attentional patterns shifted towards greater fixation on angry faces, which may reflect a growing difficulty in managing threat-related stimuli over time, possibly contributing to the persistence of their BI (Bar-Haim et al., 2007).

The consistent association between stable high BI (Class 1) and SA across all time points underscores the strong link between early BI and later anxiety outcomes, aligning with Murray et al. (2009). These findings highlight the need for early interventions targeting cognitive and emotional processes to prevent the escalation of BI into more severe anxiety disorders.

This analysis of latent BI trajectories not only underscores the complexity of BI development but also suggests that dividing BI into distinct classes allows for a more nuanced understanding of how cognitive and emotional factors influence its trajectory.

In sum, our results underscore the interaction between developmental maturation and parental psychological factors in shaping children's inhibitory behaviors. They highlight the need for a multifaceted approach to understanding and intervening in BI development, considering factors ranging from child-specific (such as attentional bias, emotion regulation, and cognitive control) to environmental influences (such as family characteristics). The developmental trajectory of BI presents numerous influences that must be considered to comprehend the diverse pathways of BI in young children, even as early as preschoolers.

BI and the SA manifestation

After describing the trajectory and development of BI in children, our main objective was to explore how BI progresses into SA and identify the predictors associated with this relationship. Understanding the factors that influence the transition from BI to SA is crucial because not all children with high BI develop SA. Therefore, identifying key predictors can help in distinguishing which children are at greater risk and inform targeted interventions. To achieve this, firstly, we tried to understand the causal relation between BI and SA. For that purpose, we realize a cross-lagged model. The cross-lagged model used in this study provides crucial insights into the bidirectional relationship between BI and SA over time. The findings reveal that while both BI and SA initially have a reciprocal influence on each other, this dynamic changes as children develop. Specifically, the significant influence of SA on BI appears to diminish in the later stages (T2 to T3), suggesting that while SA can exacerbate BI early on, its ability to affect BI may wane as children grow older. This pattern is consistent with previous longitudinal research that highlights the lasting impact of early temperament traits like BI on later emotional and social outcomes, including SA (Chronis-Tuscano et al., 2009).

The early bidirectional relationship between BI and SA, identified from T1 to T2, suggests that both BI and SA can mutually reinforce each other in young children. This finding is supported by work from Fox and colleagues (2005), who have consistently shown that high BI in early childhood increases the likelihood of developing SA later on. The association between BI and SA is often explained through the cognitive-behavioral theory, which posits that inhibited children may experience heightened attention to threatening social cues, leading to increased social withdrawal, which in turn may reinforce their social fears and anxiety (Rapee & Spence, 2004).

At the same time, the significant influence of SA on BI suggests that children who display early signs of SA may become more behaviorally inhibited over time. This aligns with the idea that anxiety can exacerbate avoidance behaviors, leading children to withdraw from social interactions, which further entrenches their BI tendencies (Henderson et al., 2014). The amplification of BI by early SA can also be linked to parental behaviors, particularly overprotection and control, which tend to increase in response to a child's anxiety symptoms, potentially restricting their opportunities for social engagement (Affrunti & Ginsburg, 2012).

The persistence of the path from BI to SA into the later stages (T2 to T3) underscores the central role that early BI plays in the development of SA. This is consistent with the temperament perspective, which asserts that BI is a relatively stable trait that continues to exert influence over a child's social experiences well into adolescence and beyond (Kagan & Snidman, 1999). Research by Pérez-Edgar et al. (2010) further supports this finding, showing that children with high BI are more likely to develop SA, particularly when their early inhibition persists over time.

The continued impact of BI on SA can also be explained through cognitive mechanisms, such as attentional biases. Inhibited children tend to focus more on negative or threatening social cues, which exacerbates their feelings of fear and apprehension in social situations, eventually leading to the development of SA (Bar-Haim et al., 2007). This suggests that once a child exhibits high levels of BI, this trait may predispose them to a chronic pattern of avoidance and anxiety in social settings.

Interestingly, the influence of SA on BI diminishes from T2 to T3, indicating that SA may become less of a determinant for BI as children mature. One possible explanation is that, over time, children may develop coping mechanisms or social skills that reduce the impact of anxiety on their behavior. By mid-childhood, children with SA may have either habituated to their social fears or developed compensatory strategies that mitigate their tendency to withdraw from social situations.

Another factor contributing to this reduced impact could be changes in the environmental context. As children grow older, they are likely exposed to more diverse social experiences, such as school environments, where they may have more opportunities to practice and refine their social skills. This broader exposure may dilute the impact of SA on their BI tendencies (Gazelle & Ladd, 2003).

Overall, these results suggest that while both BI and SA are interrelated early in childhood, BI exerts a stronger and more enduring influence on the development of SA.

Next, we investigated various cognitive and emotional predictors, namely attentional biases, emotional regulation, and executive functions, to determine how they impact the progression from BI to SA. For that, mediation and moderation analysis were performed.

The mediation analysis exploring whether emotional regulation mediates the relationship between BI and SA showed mixed results. While no significant mediation effects were found between BI at T1 and SA at T2, a significant indirect effect emerged between BI at T2 and SA at T3, mediated by emotional regulation. This suggests that, although emotional regulation may not immediately impact the relationship between BI and SA, its influence becomes more prominent in later stages of development.

This result aligns with studies suggesting that emotional regulation plays a crucial role in the development of anxiety-related behaviors over (Nancy Eisenberg et al., 2010;

Suarez et al., 2021). Specifically, it appears that children who exhibit better emotional regulation skills, especially later in development, are better able to manage the anxiety that stems from BI. This ability to regulate emotions may help reduce the tendency for BI to develop into SA, as shown by the partial mediation effect in the T2-T3 pathway. Penela et al. (2015) emphasized that emotional regulation acts as a buffer for BI, helping children cope with anxiety-provoking social situations, which is consistent with our finding of its mediating effect later in childhood. In contrast, the absence of mediation at the earlier stages (T1-T2) may reflect that emotional regulation mechanisms are still developing and may not yet be robust enough to influence the BI-SA relationship significantly.

These results suggest that targeting emotional regulation strategies in interventions may not only help reduce BI but also prevent the escalation of BI into SA. These findings reflect cognitive-behavioral models of anxiety, which emphasize the importance of emotional regulation in modulating BI and anxiety outcomes in children.

The moderation analyses provided further insight into the factors influencing the BI-SA relationship. Cognitive flexibility, attentional bias, and inhibitory control were explored as potential moderators.

The moderation analysis revealed that cognitive flexibility significantly moderated the relationship between BI and SA, with stronger associations between BI and SA observed at higher levels of cognitive flexibility. This finding, although somewhat unexpected, suggest that children with higher cognitive flexibility may be more attuned to environmental changes, which could exacerbate their sensitivity to socially threatening stimuli. As a result, children with greater cognitive flexibility may overanalyze or overreact to ambiguous social situations, leading to heightened SA. This highlights the complex role that cognitive flexibility plays in both adaptive and maladaptive responses, as higher flexibility could potentially facilitate both effective coping and heightened awareness of social risks.

Attentional bias also acted as a significant moderator in the BI-SA relationship, particularly regarding early attention and dwell time on happy faces. Previous research has suggested that children with BI exhibit attentional biases toward both positive and negative emotional stimuli, influencing their anxiety outcomes (Pérez-Edgar & Fox, 2005). In this study, the early fixation on happy faces (measured by latency) and sustained attention (measured by dwell time) were associated with stronger BI-SA links. This finding aligns with the notion that children with BI might focus on emotionally salient stimuli, either to seek comfort (in the case of happy faces) or to avoid potentially threatening stimuli, which in turn may exacerbate social anxiety symptoms (Dodd et al., 2020). These results also suggest that attentional patterns, particularly those related to positive stimuli, may contribute to the perpetuation of BI, possibly by preventing children from engaging fully in ambiguous social situations.

Inhibitory control emerged as a significant moderator, particularly in the later developmental stage (T2-T3). Children with higher levels of inhibitory control showed a weaker relationship between BI and SA, suggesting that inhibitory control may serve as a protective factor in the development of SA among children with high BI (Fox et al., 2021). This aligns with previous research highlighting that children with better inhibitory control can manage their reactions to anxiety-provoking situations more effectively, reducing the likelihood of SA developing from BI (Gunther & Pérez-Edgar, 2021). The weaker BI-SA link at higher levels of inhibitory control further underscores the importance of this cognitive skill in moderating anxiety-related outcomes. Interestingly, this finding contrasts with the earlier marginal moderation effect (T1-T2), where inhibitory control had a weaker role, suggesting that as children age, inhibitory control becomes increasingly critical in shaping anxiety trajectories.

These results can be considered congruent with our results obtained concerning BI trajectory development, as they illustrate how the role of inhibitory control changes over time in relation to both the development of BI and the BI-SA relationship. In T2, higher inhibitory control is associated with higher levels of BI, which may indicate that in earlier stages, children with elevated BI use inhibitory control as a coping mechanism to manage anxiety. This heightened control, however, also strengthens the relationship between BI and SA, suggesting that rigid control over their responses might make these children more prone to SA, as they suppress impulses and avoid socially challenging situations. This pattern aligns with findings that suggest high inhibitory control can sometimes exacerbate internalizing symptoms, particularly in anxious children, by reinforcing avoidance strategies (White et al., 2011).

By T3, the role of inhibitory control shifts: higher inhibitory control is now associated with a weaker BI-SA relationship. This change may reflect a more adaptive development, where children with stronger inhibitory control are better able to regulate their emotional responses, thus reducing the strength of the link between BI and SA. As children grow older, inhibitory control might help them manage social stressors more effectively, allowing for better emotional regulation and reducing the persistence of anxiety symptoms (Lonigan & Vasey, 2009). This evolution in the role of inhibitory control suggests that while excessive control may act as a risk factor in early stages, it can become a protective mechanism as children develop, helping to mitigate the negative effects of BI on SA.

To understand how these cognitive variables are interconnected with each other, we also tested the possibility of cognitive variables, such as inhibitory control and cognitive flexibility, to moderate the impact that attentional bias has on the relationship between BI and SA. Our results indicated that when children displayed lower levels of inhibitory control, attentional biases (such as the latency to fixate on angry faces) had a stronger influence on the BI-SA relationship. This finding is consistent with previous research suggesting that children with poor inhibitory control may struggle to regulate their emotional responses, which exacerbates their anxiety levels (Lonigan & Vasey, 2009).

At T2, children with higher inhibitory control (indicated by faster reaction times) were less affected by initial vigilance to angry faces, suggesting that inhibitory control serves as a protective factor in managing attentional biases. This result is aligned with the idea that inhibitory control helps children regulate their attention to threatening stimuli, mitigating the risk of developing anxiety (Fox et al., 2005). Furthermore, by T3, children with lower inhibitory control remained more vulnerable to the effects of attentional biases, particularly in the context of angry-neutral face pairs. These findings support the role of inhibitory control as a buffer against the anxiogenic effects of attentional biases in children with BI.

Cognitive flexibility also played a key moderating role, particularly when children directed their initial vigilance toward nonsocial stimuli. Our results revealed a marginally significant interaction indicating that children with higher cognitive flexibility demonstrated a weaker association between BI and SA when their initial attention was directed to nonsocial stimuli. This suggests that cognitive flexibility enables children to manage and regulate their responses to environmental stimuli more effectively, reducing the impact of attentional biases on anxiety outcomes (Henderson et al., 2015).

Additionally, cognitive flexibility moderated the BI-SA relationship during late stages of attention, specifically in relation to Happy-Neutral stimuli at T2. Children with greater cognitive flexibility exhibited a reduced association between BI and SA when their late attention was focused on happy faces. This finding suggests that cognitive flexibility may act as a protective factor, helping children with high BI to regulate their attention to positive social cues more effectively, thereby reducing the risk of developing SA (White et al., 2017). These results underscore the importance of targeting cognitive flexibility in interventions aimed at mitigating the progression of SA in children with high BI.

Overall, our findings suggest that attentional biases toward social and nonsocial stimuli play a critical role in the relationship between BI and SA. However, well-developed executive functions, particularly inhibitory control and cognitive flexibility, significantly moderate this relationship. Children with greater inhibitory control and cognitive flexibility are better able to manage attentional biases, which may mitigate the impact of their attentional biases on anxiety outcomes (Dennis & Chen, 2007; Lonigan & Vasey, 2009). These findings have important implications, and future research should explore the long-term effects of enhancing inhibitory control and cognitive flexibility on the development of SA in children with high BI.

In conclusion, this study offers valuable insights into the developmental trajectory of BI in children and its relationship with SA. Our longitudinal analysis reveals a general, though small, linear decrease in BI over time, with significant individual variability influenced by factors such as birth order and parental characteristics, particularly paternal BI, SA, and overprotection. While early bidirectional associations between BI and SA were observed, the influence of SA on BI diminished over time, emphasizing the central role of BI in predicting later SA symptoms.

Cognitive and emotional factors, such as cognitive flexibility, inhibitory control, and emotional regulation, play crucial roles in moderating and mediating the progression from BI to SA. Notably, emotional regulation emerged as a key mediator in the later stages of development (T2 to T3), while cognitive flexibility, inhibitory control, and attentional bias were significant moderators of the BI-SA relationship. These findings highlight the complex interaction between cognitive and emotional processes in shaping BI and its evolution into SA, suggesting that early interventions focusing on these factors could be pivotal in mitigating the development of anxiety-related disorders in children.

Ultimately, the study underscores the importance of considering both familial and individual factors in understanding BI's developmental trajectory, offering new perspectives on how early childhood traits influence later social and emotional outcomes.

While this study provides valuable insights, it is important to acknowledge its limitations, particularly the reliance on parent and self-reports for most variables. Notably, critical variables such as attentional bias, emotional regulation (T2), cognitive flexibility, and inhibitory control were assessed independently, mitigating concerns about shared method variance. Future research should adopt a multimethod approach to further minimize potential biases. For example, incorporating psychophysiological methods, such as EEG to measure brain activity or galvanic skin responses to assess stress reactivity, could provide objective data that complement subjective reports.

On the other hand, some of the measures used to assess the children were modified between assessment periods, which may have influenced our results and made comparisons between time points more challenging. Additionally, several of our findings only reached marginal significance, and therefore should be interpreted with caution. It is essential that future studies replicate these results to confirm and strengthen our conclusions.

These findings significantly contribute to the expanding literature on the determinants of BI during early childhood. Moving forward, investigations should delve into the complex interactions between these studied variables across more extended periods, exploring how changes in parental characteristics, sibling dynamics, and child competencies collectively influence BI trajectories.

In summary, our study enriches the understanding of the dynamic influences on BI's developmental trajectory in children. By identifying the role of both familial and individual factors in BI development, we offer new insights into the complex interaction of environmental, cognitive, and emotional factors in shaping BI. These findings underscore the importance of a holistic approach in research and interventions targeting BI, considering the evolving influence of parental, sibling, and individual child factors over time.

CHAPTER FIVE

GENERAL DISCUSSION

This thesis aimed to improve understanding of Behavioral Inhibition (BI) development and stability of its impact on the SA aetiology in children. To this end, our *first objective* was to adapt measures for Portuguese children, addressing the lack of comprehensive and valid instruments for assessing BI. We adapted two robust BI measures for the Portuguese context: a parent and teacher report and an observational measure. Based on previous research, the BIQ (Bishop et al., 2003) and Lab-TAB (Goldsmith et al., 1993) are among the most reliable tools for assessing BI. Our results confirm that both measures are reliable and valid for the Portuguese population and the specific age group studied.

Based on the BIQ, derived from parent and teacher reports, a six-factor structure emerged, all loading onto a higher-order BI factor, with an additional method factor to account for reversed items. There was obtained a good agreement between parents and teachers, and the instrument demonstrated good convergent validity and reliability (Fernandes et al., 2024). Lab-TAB, an observational method that provides a direct and more objective description of the child's functioning in different contexts, it has also been demonstrated to be a reliable measure (Faísca et al., 2021). Both measures demonstrated moderate convergence with each other as measures of BI.

By adapting both instruments, we managed to achieve our first objective and obtain two measures to assess BI in Portuguese children, thus filling the lack of validated instruments and allowing a multimethod assessment of a variable as important for the child's development as BI. The importance of a multimethod assessment cannot be understated, especially given the well-documented occurrence of informant discrepancies in children’s mental health research. Informant discrepancies—where different people provide varying reports on a child’s behavior—are a consistent finding in the literature (De Los Reyes & Kazdin, 2005). Recent studies suggest that these differences often reflect meaningful, domain-relevant information that provides a more nuanced understanding of the child's behavior (De Los Reyes et al., 2013). For instance, specific patterns of discrepancies between parent and teacher reports have been linked to poorer outcomes in internalizing disorders and are predictors of more severe future problems (De Los Reyes & Kazdin, 2005). Therefore, using a multimethod approach not only captures a more comprehensive view of BI but also helps in identifying at-risk children earlier, enhancing the effectiveness of interventions. This approach ensures that information gathered from different sources—parents, educators, and observational methods—contributes to a more accurate and holistic assessment of the child's emotional and behavioral development.

These first two studies (*first objective*) served as a foundation and facilitated progress towards the main objective of this thesis.

Our *second specific objective* was understanding the relation between BI and other proximal variables, such as parental factors (social anxiety and overprotection) and the impact in the child SA manifestation. Additionally, was considered the differential gender role of parents and children on child's SA.

Research in this area has long suggested a bidirectional relationship between child temperament and parental behavior. BI children may elicit overprotective or controlling responses from parents, while these same parental behaviors can further reinforce a child's inhibited tendencies (Ryan & Ollendick, 2018). These reciprocal dynamic highlights the complex interaction between child and parent in the development of emotional outcomes such SA. Considering this bidirectional influence, we aimed to investigate whether parental factors, particularly overprotection, mediate the relationship between BI and SA. However, our findings revealed that while BI has a direct effect on SA, parental variables, including overprotection, did not significantly mediate this relationship.

Regarding parental variables, specifically the transgenerational transmission of SA, the results illustrated different pathways, depending on the gender of both parents and children. While mothers' SA appears to have a direct effect on children's SA, regardless of gender, fathers' SA does not directly influence children's SA development. Considering parental overprotection, there was a significant indirect effect of the mothers' SA on the child's SA, mediated by overprotection, for both genders (although stronger for girls). Father's SA only has an indirect effect through overprotection for boys, with no association found for girls.

Finally, examining only the contribution of overprotection, the mother's overprotection levels appear to contribute significantly to the child's SA levels, regardless of gender. Father's overprotection only contributes to the boy's SA levels.

In summary, the contribution of parental dimensions to children's SA differs for mothers and fathers. The total contribution of mothers' SA is greater for their daughters' SA than for their sons, as part of this contribution is indirectly mediated by overprotective behaviors. For fathers, although their SA does not directly affect children's SA, it influences their overprotective behaviors towards both sons and daughters. However, only boys seem to exhibit SA symptoms in response to paternal overprotection. Thus, regarding the transmission of SA from parents to children, a gender-dependent mediation through overprotection was found, particularly in the Mother-Daughter and Father-Son dyads.

This study contributes significantly to the overall objective of understanding the development and stability of BI and their impact on the aetiology and maintenance of SA in children. Firstly, it confirms that BI in children has a significant positive effect on SA, regardless of gender. This finding emphasizes BI as a crucial factor in the development of SA, aligning with the goal of understanding the foundational elements of SA in children.

Furthermore, the study provides valuable insights into the role of parental factors, such as SA and overprotection, in children's SA. It reveals that while BI directly influences SA, parental social anxiety and overprotection show complex, gender-dependent pathways. Previous studies also have shown that parents, both mothers and fathers, tend to interact differently with sons and daughters. For example, mothers are often more nurturing and protective with daughters, while fathers might encourage more independence in sons, aligning with traditional gender norms. This could explain why mothers' overprotection has a stronger effect on daughters, as girls are often socialized to be more emotionally expressive and sensitive to relational dynamics, making them more vulnerable to overprotective parenting (Möller et al., 2015). Conversely, fathers might exert influence differently, such as encouraging independence more with boys, which could explain the gender-specific pathways observed in this study.

The stronger influence of mothers’ SA on daughters may also reflect gender-specific modeling. Research by Edwards et al. (2010) suggests that children, especially daughters, are more likely to model the behaviors and emotional responses of same-gender parents. Mothers who exhibit high levels of SA may inadvertently model anxious behaviors that daughters replicate. This modeling could contribute to a stronger direct and indirect influence of maternal SA on daughters compared to sons.

The finding that fathers' SA only indirectly affects boys through overprotection aligns with the notion that fathers might play a more critical role in their sons' social and emotional development. According to Bögels and Phares (2008), fathers often influence the development of external behaviors such as social competence or withdrawal, particularly in boys. This may be why overprotection from fathers is more relevant for sons' SA, as boys may be more sensitive to paternal control in ways that impact their social interactions.

Finally, boys and girls may respond differently to overprotective parenting. Girls might be more resilient to paternal overprotection, particularly if it is not coupled with other emotional factors like SA. In contrast, boys might be more affected by paternal overprotection due to the social expectations placed on boys to be more independent and less emotionally expressive. Research suggests that boys may internalize the limitations imposed by overprotective fathers, leading to higher levels of social anxiety (Van Zalk et al., 2011).

In conclusion, the gendered pathways observed in this study reflect broader societal and familial patterns of interaction, where boys and girls may be differentially affected by parental SA and overprotection. These findings underscore the importance of considering gender and both parents, highlighting the need for gender-sensitive approaches in understanding and addressing SA in children.

Furthermore, these results have a significant contribution by providing empirical support for the theoretical model of SA proposed by Spence and Rapee (2016), demonstrating that distal factors such as BI significantly impact SA. Environmental factors, particularly parental influence differentiated by the parents' gender, also play a prominent role in the development of SA. However, our study does not support a relationship between BI and environmental factors, suggesting that BI may have a more direct role in SA or that other factors more internal to the child, such as cognitive processes, may exert a greater influence on the progression from BI to SA.

For that purpose, in our *third and main objective*, we aimed to understand the evolution of BI through a longitudinal study and assess whether the development of executive functions (inhibitory control and cognitive flexibility), attentional bias, and emotional regulation influences the long-term impact of BI on SA. To achieve this, we conducted a three-year prospective study to explore the causal relationships between these variables and SA.

Findings provide important insights into the developmental trajectory of BI and its role in predisposing children to SA. Following this, we will first discuss the results pertaining to the developmental trajectory of BI observed in our study. This analysis will shed light on how BI evolves over time and the factors influencing its stability and change.

First, we observed a linear decline in BI over time that is commonly observed in developmental studies and can be interpreted as part of the typical maturation process. As children grow older, their exposure to a wider range of social situations, along with cognitive and emotional development, generally leads to a decrease in inhibited behaviors. This trend is considered a normal aspect of social and emotional development, where children gradually become more comfortable in novel or socially challenging situations (Rubin et al., 2009).

However, although most children experience a natural reduction in BI, certain factors act as either barriers or facilitators in this process. The factors that either accelerate or slow down this decline in BI are crucial for understanding individual differences in BI trajectories. For instance, BI trait has been consistently linked with parental influence, attentional biases, executive functions, and emotional regulation capacities. Our study findings confirm that children with elevated BI often have parents, particularly fathers, who also exhibit traits of SA and BI. This is expected and supported by previous research showing that parental SA and overprotective behaviors reinforce a child’s inhibited responses, preventing them from developing coping strategies to handle anxiety-provoking situations (Murray et al., 2009).

The effect of parental SA and behavior play a significant role in the development of BI, with fathers in particular appearing to have a more substantial long-term impact. This may be explained by the role of paternal involvement in modern families. Fathers are increasingly taking on active caregiving roles, and their anxiety may model avoidant or fearful behaviors in children, particularly in boys (Bögels & Phares, 2008). Additionally, firstborn or only children were found to display higher levels of BI, which aligns with the literature suggesting that these children may receive more attention and protection from parents, potentially reinforcing inhibited behaviors (Ginsburg et al., 2005).

Another critical factor in understanding the developmental trajectory of BI is attentional bias, particularly how children with high BI focus on certain emotional stimuli. Our study reveals a nuanced progression of attentional bias in children with high BI, which shifts across time points. At the second assessment point (T2), children with high levels of BI show an early preference for positive emotional cues and avoidance of threat-related stimuli. This attentional preference was later followed by a shift towards a delayed fixation on angry faces. By the third assessment point (T3), these children initially seemed to prefer focusing on nonsocial stimuli, and later shifted their attention to happy faces.

The change between assessment moments may reflect a more internalized, avoidant strategy that limits their engagement with the social environment, which is a known marker of SA development (Bar-Haim et al., 2007). While the children with higher levels of BI initially attempted to avoid threatening faces but struggled with disengagement, by the final assessment point, the attentional bias no longer focused solely on threats but extended to all social stimuli. This shift may reflect the increasing salience of social threat as children age. As children become more aware of social norms and expectations, especially in the school environment, their sensitivity to potential social threats, such as disapproval or rejection (symbolized by angry faces), becomes heightened. This is in line with the maintenance model, which suggests that initially, children with BI may avoid threatening stimuli to reduce immediate distress (Pérez-Edgar et al., 2010). However, as social pressures intensify with age, especially in late childhood, children whose BI remains high, may also be more vulnerable to these changes because they have not developed sufficient coping mechanisms to disengage from threatening cues. Their attentional systems may thus prioritize detecting potential social threats (angry faces) to prevent negative social interactions, a process that reinforces anxiety and social avoidance behaviors over time (Fox et al., 2005).

In summary, attentional biases appear to evolve alongside the developmental trajectory of BI, reflecting an adaptive strategy in early stages. Initially, children with high BI tend to avoid threatening stimuli, such as angry faces, while focusing more on positive or non-social cues. This attentional pattern likely serves as a self-regulation mechanism to mitigate distress in unfamiliar social contexts (Pérez-Edgar et al., 2010).

Over time, however, as children maintain elevated levels of BI, this attentional avoidance may solidify into a more entrenched pattern, potentially reinforcing inhibited behaviors. In particular, the shift towards increased fixation on neutral or non-social stimuli at later stages (T3) may indicate a growing disengagement from social interactions, which can contribute to the persistence of BI (Fox et al., 2005).

Cognitive flexibility and inhibitory control further complicate the trajectory of BI. Children with high BI who also display higher cognitive flexibility, which is generally considered adaptive, present a paradox. These children seem to navigate social environments more adeptly, but this flexibility may also increase their awareness of social expectations and potential social failures, thus exacerbating discomfort (White et al., 2011). Conversely, lower inhibitory control observed in later assessments indicates that these children may struggle with self-regulation, leading to difficulty in suppressing inhibited responses to social stimuli over time.

Interestingly, children in the Stable BI group, who exhibited consistently high BI over time, initially showed better emotional regulation and inhibitory control at earlier time points but later struggled with these skills. This decline may be attributed to the cumulative stress of persistent inhibition, which may deplete emotional and cognitive resources over time (Fox et al., 2005). This is further illustrated by the shift in attentional bias towards angry faces at later stages and preference to nonsocial stimulus, suggesting that prolonged BI sensitizes children to threat, making emotional regulation more challenging as they grow older (Kiel & Buss, 2014).

To summarize, our findings shed light on the key factors influencing the developmental course of BI, including parental roles, attentional patterns, and executive functions. Building on these insights, we now shift our focus to the second part of our objective: exploring the connection between BI and SA. The link between BI and SA is well-established in the literature, with BI serving as a key precursor for the development of SA (Clauss & Blackford, 2012). However, the progression from BI to SA is not inevitable, as individual cognitive, emotional, and attentional factors either exacerbate or mitigate this trajectory.

Our findings indicate that emotional regulation plays a critical mediating role in this relationship, particularly at later stages. Children who are better able to manage their emotions seem to buffer the impact of high BI on the development of SA (Eisenberg et al., 2004). This suggests that the ability to regulate emotions, especially in socially challenging situations, allows children to navigate potential stressors more effectively, reducing the likelihood that BI will manifest as SA. Over time, the development of emotional regulation skills may help children to reframe anxious thoughts and engage in more adaptive coping strategies, thus breaking the cycle between BI and SA (Thompson & Meyer, 2007).

Attentional bias also plays a significant moderating role in the BI-SA link. Children who focus on happy or non-threatening stimuli tend to show weaker associations between BI and SA, indicating that attentional avoidance of threat may be protective. However, as children age and their attention shift towards threatening stimuli, the risk of developing SA increases. This finding aligns with research by Lonigan et al. (2004), which suggests that attentional bias towards threat amplifies the anxiety-inducing effects of BI. Additionally, prolonged fixation on positive stimuli (e.g., happy faces) in earlier stages seems to weaken the BI-SA relationship, reinforcing the protective role of positive attentional bias.

Executive functions, particularly inhibitory control and cognitive flexibility, further moderate the BI-SA relationship. Inhibitory control initially helps to weaken the connection between BI and SA, as it allows children to suppress maladaptive responses to social stimuli. However, as social pressures increase, high inhibitory control may become maladaptive, as it sustains avoidance behaviors and reinforces anxiety (Derryberry & Rothbart, 1997). Cognitive flexibility, on the other hand, helps children adapt to changing social contexts, but when paired with high BI, it may increase the salience of social failure, heightening the risk of SA (White et al., 2011).

The moderated moderation effects further highlight the complexity of these relationships. Inhibitory control was found to reduce the impact of attentional biases on SA development, suggesting that children who can control their attention toward positive stimuli may be less vulnerable to the negative effects of BI. Additionally, cognitive flexibility acts as a crucial moderator, providing these children with tools to manage their biases and mitigate the risk of SA.

In particular, inhibitory control appears to buffer the impact of attentional biases on the development of SA in children with high BI. Contradictory findings are observed by White et al. (2011), which suggest that high levels of inhibitory control increased this risk for anxiety symptoms. One possible explanation for this discrepancy lies in the context of the tasks used to measure inhibitory control. While White et al. (2011) emphasize inhibitory control as a potential risk factor for children who may excessively suppress their emotional responses, leading to internalization, our study suggests that in cases where inhibitory control is employed to regulate attentional biases towards positive stimuli, it can act as a protective factor. This may imply that the role of inhibitory control is nuanced and context dependent. In situations where inhibitory control facilitates disengagement from threat-related cues and directs attention toward positive or neutral stimuli, it serves a protective function. Studies by White et al. (2010) have demonstrated that children who can better regulate their attention, especially toward positive stimuli, are less vulnerable to the anxiety-provoking effects of BI. This ability to exert control over attentional processes helps mitigate the influence of negative biases, suggesting that enhancing inhibitory control could be a key intervention point for preventing the progression from BI to SA. This emphasizes the importance of considering both the nature of the stimuli and the broader emotional context when assessing the effects of inhibitory control on anxiety development.

Cognitive flexibility also emerged as a critical moderator in this relationship. Dennis and Chen (2007) emphasized that cognitive flexibility allows children to shift their attention adaptively and avoid prolonged focus on negative or threatening stimuli. In children with high BI, this adaptability can reduce the risk of developing SA by helping them disengage from negative emotional cues. Moreover, Pérez-Edgar and Fox (2005) suggest that cognitive flexibility provides children with essential tools for adjusting their emotional responses, thereby decreasing their vulnerability to anxiety. Together, these executive functions—when well-developed—act as protective factors, reducing the likelihood that attentional biases will exacerbate SA symptoms. The combination of inhibitory control and cognitive flexibility is crucial in creating a more adaptive response to the internal challenges posed by BI, as highlighted by Lonigan et al. (2004).

In summary, the trajectory of high BI is influenced by a dynamic interaction of parental characteristics, attentional biases, executive functions, and emotional regulation skills. Children with high BI are more likely to have parents with SA, especially fathers, who model anxious behaviors and reinforce BI. Over time, these children shift their focus from positive to threatening stimuli, which, coupled with declining emotional regulation and inhibitory control, increases their vulnerability to developing SA. However, those with strong emotional regulation and cognitive flexibility are better equipped to manage these risks. The findings underscore the importance of early interventions targeting attentional biases, executive functions, and emotional regulation to mitigate the progression from BI to SA.

We believe this study has made some contribution to the understanding of the evolution of BI and its potential impact on SA. Specifically, we have provided scientific evidence supporting some of the speculative pathways proposed by Spence and Rapee (2016). However, despite the relevance and contributions of this work, there are some limitations to consider. Firstly, the inhibited temperament within our sample consistently displayed subclinical values, which made it challenging to draw definitive conclusions. Future studies would benefit from including clinical samples or groups with more varied levels of BI to determine whether these findings can be replicated in more robust samples.

Another limitation of our study was that the longitudinal study covers only a three-year period. Longer-term studies are needed to fully understand the developmental trajectories of BI and SA throughout childhood and adolescence. Also, certain measures were not repeated across all time points of the longitudinal study due to concerns that children might remember the tasks, which could influence their performance and potentially bias the data. As a result, we were required to use different measures at different time points, which may not have assessed the same constructs with identical precision. This variation in measures could have impacted the stability of the findings or contributed to less clear or consistent results. On the other hand, the instruments used are primarily based on parental reports, which may introduce response bias. Additional measures, such as self-reports from children or third-party evaluations, could complement the data and increase the validity of the results.

Although many avenues have been explored, we believe that research into SA is still a vast field to explore and work on. To this end, we hope to continue working and contributing scientifically to this topic, namely: contributing to a deeper understanding of the role of attentional bias in these children and understanding the role of parents' attentional bias in these children. Furthermore, many parent assessments relied primarily on self-reports. We think that using implicit measures, such as the Implicit Association Test, could provide valuable insights. Psychophysiological measures, like galvanic skin response alongside eye-tracking, may also help identify subtle differences between inhibited and non-inhibited or anxious and non-anxious individuals in response to threatening stimuli.

Despite these limitations, this thesis makes several important contributions to the understanding of BI and its role in the development of SA. First, it fills a crucial gap in the Portuguese context by validating two widely used measures (BIQ and Lab-TAB) for assessing BI in children, ensuring that future research and clinical interventions can more accurately evaluate this temperament trait. Second, this research adds depth to the current understanding of how attentional biases, inhibitory control, cognitive flexibility and emotional regulation interact to influence the developmental trajectory of BI. The findings support existing models of attentional bias in BI but also highlight how shifts in attentional focus over time—specifically the movement from avoidance of angry faces to fixation on social threat—signal a worsening of SA anxiety symptoms as children age. This nuanced view aligns with models of anxiety development (Pérez-Edgar et al., 2010), adding a layer of understanding about how these shifts occur and their potential for predicting SA onset. Third, the study underscores the significant role of parental influence, especially paternal SA and overprotection, in shaping the child's BI trajectory. These findings emphasize the importance of considering gender-specific pathways in the transmission of SA, supporting the notion that fathers may play a more substantial role in the emotional development of boys, while mothers have a stronger influence on daughters (Bögels & Phares, 2008; Edwards et al., 2010). Finally, this thesis contributes to the literature by challenging the conventional view of inhibitory control and cognitive flexibility as purely protective factors. The finding that inhibitory control may serve different functions depending on context—either buffering or exacerbating anxiety—offers a more complex understanding of how executive functions interact with attentional biases to moderate anxiety outcomes (White et al., 2011). This insight has important implications for interventions, suggesting that targeting both attentional and executive functions early in development may help prevent the progression from BI to SA.

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FCT
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