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FACULDADE DE MEDICINA
PROGRAMA DE PÓS-GRADUAÇÃO EM PSIQUIATRIA E CIÊNCIAS DO COMPORTAMENTO

TESE DE DOUTORADO

TEMPERAMENTO E COMPORTAMENTOS POSITIVOS DE CRIANÇAS E ADOLESCENTES E SUAS RELAÇÕES COM DESFECHOS ESCOLARES

Maurício Scopel Hoffmann

Orientador: Prof. Dr. Giovanni Abrahão Salum Júnior

Porto Alegre, Dezembro de 2017

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Tese apresentada ao Programa de Pós-Graduação em Psiquiatria e Ciências do Comportamento como requisito parcial para obtenção do título de Doutor.

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G: How do you know all that?

S: I read about it. In a very old book.

G: You know all that from staring at marks on a paper?

S: Yes.

G: You are like a wizard!

(Diálogo entre Sam e Gilly*, Game of Thrones*, temporada 3, episódio 9*)*

Dedicado aos que trabalharam e participaram da coorte de alto risco para transtornos mentais do Instituto Nacional de Psiquiatria do Desenvolvimento para Infância e Adolescência.

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SUMÁRIO

ABREVIATURAS E SIGLAS

CFA: Análise fatorial confirmatória.

CFI: Índice de ajuste comparativo.

EATQ-R: *Early Adolescence Temperament Questionnaire revised*.

YSI: *Youth Strenghts Inventory*.

SDQ: *Strengths and Difficulties Questionnaire*.

QI: Quociente de Inteligência.

RMSEA: *Root mean square error of approximation*.

TDE: Teste de desempenho escolar.

TLI: Índice de Tucker Lewis.

WLSMV: *Weighted least square with diagonal weight matrix with standard errors and mean- and variance-adjusted chi-square test statistics estimator*.

RESUMO

Nas ultimas décadas, os desafios educacionais foram sendo modificados. Na medida que se consegue colocar a maioria dos jovens na escola, a ênfase pela quantidade da educação ofertada passa a ser por entender fatores associados a melhor qualidade educacional. A partir de meados do século XX, as habilidades cognitivas, como a inteligência, foram intensamente estudadas em sua relação com a educação. Mais recentemente, habilidades socioemocionais (não cognitivas) têm sido associadas com a promoção de maiores níveis educacionais que impactam nos níveis socioeconômicos, oriundos de melhoria das habilidades para o mercado de trabalho. Porém, não há clara definição do que poderiam ser as habilidades socioemocionais, sendo na maioria das vezes associadas a traços do funcionamento individual, como personalidade, temperamento ou até mesmo autoestima e baixos níveis de sintomas de transtornos mentais. Os artigos desta tese são relacionados a este tema, enquanto buscam avaliar a associação de medida unidimensional de comportamentos positivos em relação a aprendizagem e rendimento escolar (artigo #1), avaliar a estrutura de medidas multidimensionais de temperamento (artigo #2) e a relação dessas medidas com desfechos educacionais (artigo #3). Esses artigos utilizaram dados de um grande estudo comunitário realizado no Brasil, nas cidades de Porto Alegre e São Paulo – a Coorte de Alto Risco para Transtornos Psiquiátricos. O primeiro artigo avalia a distinção de sintomas mentais e traços gerais de comportamentos positivos e a modificação da associação deletéria de baixa inteligência e altos níveis de sintomas mentais em aprendizagem e rendimento escolar por habilidades positivas do comportamento. Este estudo avança no entendimento de que atributos positivos do comportamento de crianças e adolescentes são um construto distinto de sintomas de transtornos mentais e tem associações independentes com menor nível de problemas de aprendizagem e melhor rendimento acadêmico. Além disso, este estudo demonstra que os efeitos negativos de baixa inteligência e altos níveis de sintomas mentais na aprendizagem e rendimento acadêmico podem ser tamponadas por altos níveis de

atributos positivos do comportamento. No segundo artigo é analisado um modelo de temperamento no qual inclui, além de dimensões clássicas, um fator de autoavaliação negativa, juntamente com suas associações a grupos de psicopatologias não comórbidas. Dentre os resultados, menor controle de esforço esteve associado com diversas categorias diagnósticas. De maneira específica, foi encontrado maior nível de autoavaliação negativa nos sujeitos pertencentes ao grupo diagnostico que inclui transtornos emocionais, bem como menor nível de timidez nos sujeitos com transtorno de déficit de atenção e hiperatividade e maior nível de extroversão nos sujeitos com transtorno de conduta e de oposição e desafio. Esse estudo avança no sentido de apontar que autorrelato em sujeitos com determinados diagnósticos podem sofrer influência de uma maior tendência de se avaliarem negativamente, bem como é possível distinguir diagnósticos agrupados classicamente em transtornos externalizantes, através do temperamento. O terceiro artigo avalia as associações principais, independentes e interativas de dimensões do temperamento com desfechos escolares distintos. Neste estudo, demonstrou-se que o controle de esforço é associado à menor índice de eventos escolares negativos (suspensão, repetência e evasão escolar), bem como melhor rendimento escolar e habilidade de leitura e escrita. Esses efeitos foram independente da idade, sexo, nível socioeconômico, inteligência, sintomas mentais e outros temperamentos. No entanto, este estudo avança ao demonstrar que frustração e controle de esforço interagem para associarem-se a melhores níveis de habilidade de leitura. Especificamente, se o controle de esforço é baixo (ou frustração), níveis altos de frustração (ou controle de esforço) estão associados a melhor habilidade de leitura. Compreender as associações e distinções de medidas uni ou multidimensionais das habilidades não-cognitivas pode ser útil para a compreensão do papel destes construtos nas diferentes etapas do processo escolar, a fim de promover a elevação da qualidade educacional.

Palavras-chave: Educação, habilidades socioemocionais, temperamento, atributos positivos, transtorno mental, inteligência,

ABSTRACT

During the last decades, educational challenges have changed. As most of youths can be placed at school, the emphasis on studying educational supply shifted to the understanding of educational quality. From the mid-twentieth century, cognitive skills, such as intelligence, were intensely studied in their relationship with education. More recently, socioemotional (non-cognitive) skills have been associated with the promotion of higher educational levels that impact on socioeconomic levels, resulting from improved skills for the job market. However, there is no clear definition of what socioemotional skills could be and are most often associated with traits of individual functioning such as personality, temperament or even self-esteem and low levels of symptoms of mental disorders. The articles of this thesis are related to this theme, while evaluating the association of a single dimensional measure of positive attributes of behavior in relation to learning and school performance (article # 1), evaluating the structure of multidimensional measures of temperament (article # 2) and the relation of temperament measures with educational outcomes (article # 3). These articles use data from a large community study conducted in Brazil, in the cities of Porto Alegre and São Paulo - the High Risk Cohort for Psychiatric Disorders. The first article evaluates the distinction of mental symptoms and general traits of positive behaviors and modification of the deleterious association of low intelligence and high levels of psychopathology in learning and school performance by positive attributes of behavior. This study advances the understanding that positive attributes of the behavior of children and adolescents are a distinct construct of symptoms of mental disorders and have independent associations with low learning problems and better academic performance. In addition, this study demonstrates that the negative effects of low intelligence and high levels of psychopathology in learning and academic achievement may be buffered by high levels of positive attributes of behavior. The second article analyzes a model of temperament in which includes, besides classic dimensions, a negative self-evaluation factor, together with their associations to groups of non-overlapping

psychiatric diagnosis. Among the results, less effort control was associated with several diagnostic categories. Specifically, a higher level of negative self-evaluation was found in subjects belonging to the diagnostic group that included emotional disorders, as well as a lower level of shyness in subjects with attention deficit hyperactivity disorder and a higher level of extroversion in subjects with conduct disorder and of oppositional-defiant disorders. This study advances in the sense of pointing out that self-report in subjects with certain diagnoses may be influenced by a greater tendency to be evaluated negatively, as well as it is possible to distinguish diagnoses classically grouped as externalizing disorders, through temperament. The third article evaluates the main, independent and interactive associations of temperament dimensions with different school outcomes. In this study, effortful control was shown to be associated with a lower index of negative school events (suspension, repetition and dropout), as well as better school performance and reading and writing abilities. These effects were independent of age, gender, socioeconomic status, intelligence, mental symptoms and other temperaments. However, this study advances by demonstrating that frustration and effort control interact to associate with better levels of reading ability. Specifically, if effort control is low (or frustration), high levels of frustration (or effort control) are associated with better reading ability. Understanding the associations and distinctions of single or multidimensional measures of non-cognitive skills may be useful for understanding the role of these constructs in the different stages of the school process in order to promote the elevation of educational quality.

Keywords: Education, socioemotional skills, temperament, positive attributes, mental disorder, intelligence.

APRESENTAÇÃO

Este trabalho constitui-se na tese de doutorado intitulada “Temperamento e Comportamentos Positivos de Crianças e Adolescentes e Suas Relações com Desfechos Escolares”, apresentada ao Programa de Pós-Graduação em Psiquiatria e Ciências do Comportamento da Universidade Federal do Rio Grande do Sul, em 15 de dezembro de 2017.

Esta tese é parte integrante de um projeto de pesquisa amplo que visa avaliar trajetórias no desenvolvimento de crianças e adolescentes até a vida adulta, chamado “*Coorte de Alto Risco para Transtornos Psiquiátricos na Infância e Adolescência”*. Na fase inicial deste projeto, entre os anos de 2010 e 2011, foram triadas 8.012 famílias em escolas públicas de Porto Alegre e São Paulo, na qual foram selecionadas 2.511 jovens entre 6 e 14 anos e seus pais, para coletas fenotípicas, neuropsicológicas, genéticas, bioquímicas e de neuroimagem. Este projeto continua em andamento, atualmente conhecido como Projeto Conexão – Mentes do Futuro, e planeja sua segunda recoleta para este ano.

Os artigos que compõe esta tese puderam abordar questões dentro do tema de habilidades socioemocionais, transtornos mentais e desfechos educacionais, devido ao contexto escolar no qual se encontrou a presente amostra, bem como a multiplicidade de informações coletadas. De maneira breve, será apresentado abaixo razões que motivaram esta tese.

As habilidades cognitivas, especialmente e com maior força, a inteligência, apresentam alto valor preditivo para sucesso socioeconômico na vida adulta. Dentre os diversos motivos, a promoção de maiores níveis educacionais, tanto em rendimento quanto por anos escolares completados, é uma importante via para este efeito. Além disso, outras habilidades, como as sociais e emocionais, estão ligadas a estes desfechos positivos. Porém, diversas medidas tem sido utilizadas para inferir tais habilidades socioemocionais, dentre elas conceitos de personalidade, temperamento, identidade e autoestima, bem como sintomas de transtornos mentais. Assim, o conceito de habilidades socioemocionais torna-se múltiplo, enquanto envolve capacidade de se relacionar com outros, regular emoções, identificar-se positivamente frente a terceiros, entre outros. Cada um

destes conceitos tem validade própria e, possivelmente, sobreposição na captura do fenômeno das habilidades socioemocionais. Desta forma, este conceito está longe de ser homogêneo.

Neste sentido, o **primeiro artigo** desta tese visa explorar uma medida unidimensional de atributos positivos do comportamento de crianças e adolescentes, baseado em um instrumento reportado pelos pais, que avalia fundamentalmente diversos comportamentos positivos no comportamento. Neste estudo, procuramos avançar na distinção deste construto com os de sintomas mentais, utilizados na literatura como falta de habilidade socioemocional, bem como avançar no entendimento de como inteligência, sintomas mentais e atributos positivos do comportamento interagem para promover melhor aprendizado e rendimento escolar.

Personalidade e temperamento também são entendidos como habilidades socioemocionais. Refletem, respectivamente, as diferenças individuais e tendências básicas de sentir emoções, ter pensamentos ou se comportarem de determinadas maneiras. Ambos são conceitos multidimensionais. Porém, não há ainda um modelo estrutural definitivo que organize a hierarquia desses construtos. O **segundo estudo** explora a modelagem hierárquica do questionário autoaplicável para adolescentes jovens proposto por Mary Rothbart. Neste estudo, testa-se a hipótese da existência de um fator geral para o questionário de temperamento e que este fator geral está relacionado à autoavaliação. Ainda, testa-se a hipótese de que os fatores residuais representem medidas de temperamento não contaminadas por autoavaliação e estas estejam relacionadas a diferentes grupos de transtornos mentais.

O **terceiro estudo** utiliza o modelo de temperamento gerado no segundo estudo para avaliar as associações principais, independentes e interativas das dimensões de temperamento com desfechos escolares diversos. Neste estudo, avaliou-se eventos escolares negativos (suspensão, repetência e abandono escolar), rendimento escolar reportado pelos pais e testagem padronizada de habilidades de leitura e escrita. Devido a multiplicidade de dados coletados, este estudo, além de avaliar desfechos educacionais distintos, tem o objetivo de avaliar

os efeitos independentes do temperamento, ajustados para idade, sexo, nível socioeconômico, inteligência e sintomas mentais. Além disso, existe hipóteses na literatura de que as dimensões do temperamento podem interagir para associarem-se à desfechos educacionais, embora não demonstrada anteriormente. Portanto, este estudo também visa explorar se dimensões do temperamento podem modificar a associação de outra dimensão nos desfechos selecionados.

A tese a seguir está organizada da seguinte forma: Introdução, Objetivos, Artigo #1 (publicado no periódico *Journal of the American Academy of Child and Adolescent Psychiatry*), Artigo #2 (submetido ao periódico *Journal of Child Psychology and Psychiatry*), Artigo #3 (submetido ao periódico *Journal of adolescente Health*), Considerações finais e Conclusões. Anexo ao final da tese, encontram-se outras produções do autor durante o período de doutorado.

1. INTRODUÇÃO

A educação é um processo pelo qual habilidades e conhecimentos são transmitidos às pessoas (1). Está fortemente associada à riqueza dos países e é uma importante ferramenta para a redução da desigualdade social e para o crescimento econômico (2). O processo educacional pode ser entendido e medido por diversos índices, tanto na quantidade de educação ofertada, através da mensuração de anos de estudo completos, evasão escolar e repetência; quanto a qualidade do processo educacional, os quais acessam o aprendizado efetivo (p.ex., rendimento em testes escolares e testes padronizados) (3). Dentre os diversos fatores envolvidos na educação, podem ser citados os econômicos, sociais, políticos e individuais (4,5). Sobre os fatores individuais é que se dedica a presente tese.

Recentemente, as ciências econômicas ampliaram o entendimento do efeito de fatores individuais não cognitivos e seu papel como preditores de eventos na vida adulta, como taxa de emprego, renda, criminalidade, uso de drogas, bem estar, entre outros (6). De acordo com a teoria econômica da tecnologia da formação das capacidades, os seres humanos são formados por vetores de capacidades, sendo eles as habilidades cognitivas, não cognitivas e a reserva de saúde física de cada individuo (7,8). Estes fatores interagem para possibilitarem o desenvolvimento humano e dependem de quanto e de como o investimento é realizado em cada um destes, bem como, de se, após o investimento inicial, continuam a serem estimulados, para possibilitarem a manutenção e aquisição de novas capacidades (9). Assim, a teoria econômica converge com as teorias clássicas do desenvolvimento humano, demonstrando que o desenvolvimento é dado em estágios, no qual o aprendizado do estágio anterior possibilita a aquisição de novas habilidades no estágio posterior, bem como as habilidades cognitivas, não cognitivas e a saúde física podem impulsionar-se umas as outras (7,10).

1.1. Relação entre fatores cognitivos com educação

A relação entre habilidades cognitivas desenvolvidas na infância e desfechos na vida adulta são estudadas há algumas décadas (11–13). Cognição e inteligência são termos muitas vezes utilizados de forma intercambiável (11). Porém a cognição pode

ser entendida como o conjunto de processos mentais que levam à aquisição e à aplicação de conhecimentos dos mais variados tipos, como processamentos espaciais, memória, integração de informações, entre outros (14). Já a inteligência pode ser entendida como "*a capacidade de raciocinar, planejar, resolver problemas, pensar de forma abstrata, compreender ideias complexas, aprender rapidamente e aprender com a experiência*" (tradução livre de Gottfredson, 1997, (15). No intuito de mensurar a cognição, diversos testes foram propostos e ao longo do tempo e foi observada a maneira como os resultados dos diferentes testes variavam de modo similar, entre cada sujeito testado. Para isto, deu-se o nome de "*general cognitive ability – g*"(16,17). Portanto, em termos psicométricos, a inteligência é o mais alto grau hierárquico das habilidades cognitivas (13). Para os testes que vieram subsequentemente a estas observações, deu-se o nome de "quociente de inteligência – QI", no intuito de se ter uma medida geral da inteligência, que pode ser obtida através de diversos testes já validados (11,16). Os testes de Wechsler, com padronização para pré-escolares (WPPIS), crianças entre 6 e 16 anos (WISC) e adultos (WAIS), são frequentemente utilizados para extração do fator geral. Estas dimensões são compostas por testes de compreensão verbal, raciocínio perceptual, memória de trabalho e velocidade de processamento de informação (18,19). A forma breve do teste, utilizando apenas os testes de vocabulário (verbal) e cubos (execução) possui alta correlação com o teste completo (20).

A inteligência é uma habilidade com alta herdabilidade, mas que também é influenciada através de diversas condições, como estímulos ambientais, aleitamento materno, condição de saúde, educação e renda (12,21,22). As capacidades cognitivas tendem a apresentar estabilidade após a infância (13). Alguns pesquisadores advogam que dificilmente incentivos e estímulos dados ao indivíduo após este período poderão substituir o prejuízo da ausência ou insuficiência destes incentivos em períodos precoces na vida (7). Já outras pesquisas demonstram que algum ganho em inteligência pode ser alcançado em treinamento de adultos saudáveis, e a plasticidade da inteligência ainda é uma área a ser explorada (23,24). De qualquer maneira, a inteligência é uma capacidade humana influenciada por fatores muito precoces com consequências importantes na vida adulta, desde o nível educacional até mortalidade (11,22,25–27).

Especificamente para os fins da presente tese, torna-se relevante conhecer a influência da inteligência na educação. De fato, Alfred Binet desenvolveu os primeiros testes que culminaram por mensurar a inteligência, no intuito de predizer o rendimento escolar (27). Desde então, a inteligência se constitui no construto psicológico mais robusto em termos preditivos, especialmente para a predição de rendimento escolar geral (26,28). O rendimento escolar normalmente é mensurado por resultados de testes, tanto padronizados quanto não padronizados (28). Porém, há menor evidência para que a inteligência tenha algum papel em desfechos como abandono escolar (29), atribuindo a estes eventos a outros fatores, como motivação e persistência (27).

No entanto, a inteligência explica cerca de 25% da variância do rendimento escolar mensurado por testes de desempenho, sugerindo o papel de outros elementos não cognitivos (26,27,30). Além disso, fatores genéticos que se associam ao desempenho escolar refletem herdabilidade além da explicada pela inteligência (31). Assim, não somente a cognição, mas também as capacidades socioemocionais influenciam os desfechos da vida adulta (7).

1.2. Os fatores socioemocionais

As habilidades não cognitivas também são descritas como socioemocionais. O conceito de habilidade socioemocional foi mais amplamente divulgado por pesquisas do economista James Heckman e transitou entre um termo que abarcava motivação, autoestima, regulação emocional, capacidade de cooperar com terceiros, entre outros (12,30) até ser sinônimo com o conceito de traços de personalidade (32). Embora conceitos distintos, como a cognição social, empatia, identidade, autoestima e personalidade possam ser abarcados por um único termo, ainda não se conseguiu encontrar um fator geral ou alguma evidência de que estas habilidades sejam parte de um construto único, como no constructo da inteligência (16,30).

Um conceito relacionado, pouco expresso nas pesquisas do campo econômico, mas muito difundido na psicologia, é o conceito de temperamento. O temperamento pode ser entendido como a disposição básica que é subjacente e modula a expressão de atividade, reatividade, emoção e sociabilidade do sujeito, sendo esta disposição razoavelmente consistente no tempo (33). Dessa forma, os estudos do

temperamento são mais direcionados a fases mais precoces do desenvolvimento, enquanto a personalidade se dedica e se refere a fases mais posteriores, sendo a adolescência um período intermediário e de grandes transformações (33–35). Porém, a concepção moderna da interface temperamento-personalidade não mais simplifica o conceito de personalidade como sendo o produto da modulação ambiental do temperamento, mas a expressão de fases posteriores do desenvolvimento, que sofreram influencia ambientais em fases anteriores (33). De fato, a expressão gênica e remodelamento cortical ocorrem de maneira intensa na adolescência, de forma a sustentar novos repertórios comportamentais, capturados em parte pela personalidade (34,36,37).

No campo da personalidade, o modelo estrutural dos cinco fatores é o mais amplamente utilizado (38). Este modelo apresenta cinco traços, a saber o neuroticismo (ou estabilidade emocional), extroversão (propensão a buscar estímulos recompensadores), abertura a experiência (propensão à buscar estímulos abstratos e sensoriais), amabilidade (tendência a ser cooperativo nas relações sociais, altruísta e não agressivo) e conscienciosidade (capacidade de autocontrole, inibir impulsos e tenacidade). Estes traços do funcionamento são relacionados a diversos desfechos na vida adulta (32). Na medida em que se pode mensurar personalidade na infância, também são descritas associações entre personalidade e desfechos escolares. Dentre estes fatores, a conscienciosidade é o fator mais associado a anos de estudo completos (11) e ao aprendizado mensurado por desempenho escolar (39,40). O rendimento acadêmico também é predito por traços de amabilidade e abertura a experiência, o que pode informar que certo grau de propensão a cooperatividade e tendência a atrair-se por novos estímulos estéticos e intelectuais podem expor o indivíduo ao aprendizado (39–41). Além disso, a personalidade pode ter um papel diferente dependendo da idade, já que a amabilidade associa-se ao aprendizado de maneira mais importante antes dos seis anos e a conscienciosidade após esta idade (42).

Dentro dos modelos de temperamento, são utilizados os modelos de Thomas e Chess, Goldsmith, Plomin (43) e o de Cloninger (44). Porém o modelo adaptado para faixas etárias de Mary Rothbart tem sido o mais influente para estabelecer estudos sobre a estrutura do temperamento, bem como relacionar-se com o modelo

dos cinco fatores da personalidade (33,45,46), especialmente em etapas mais precoces do desenvolvimento.

1.2.1. Temperamento na adolescência

Dentre os modelos de temperamento mencionados acima, o modelo de Mary Rothbart (46) fundamenta-se no conceito das diferenças psicobiológicas individuais na reatividade e regulação da emoção, motivação e orientação da atenção.

Este modelo compreende três traços (hierarquicamente superiores ou de primeira ordem), a saber o controle de esforço (regulação), afetividade negativa e positiva/extroversão (reatividade) (47). O controle de esforço é o construto mais consolidado deste modelo, com frequente convergência de seus fatores em diversos estudos, os quais abarcam as dimensões de atenção, controle inibitório, nível de ativação (33,46). Este fator apresentam maior evidência em relação a desfechos educacionais, como aprendizado e engajamento escolar (48–52). Somadas, estas evidências sugerem que o controle de esforço na infância se relaciona ao desenvolvimento da conscienciosidade da vida adulta (33,46) e prediz melhor nível de aprendizado (independente de inteligência), potencializando anos completos de estudo (11,39).

O afeto negativo abarca dimensões como medo, tristeza, frustração, raiva (46,53). O medo e a frustração são componentes da afetividade negativa, orientando duas facetas deste afeto, com motivações de evitação e aproximação comportamental respectivamente (47). Porém, também há evidências de que o medo pode se relacionar a baixos níveis de afetividade positiva na adolescência (54). A afetividade positiva/extroversão se refere à tendência a socialização, motivada pela recompensa a estímulos novos e excitantes, bem como níveis altos de atividade física, ao contrário de apresentar comportamento passivo, tímido e inibido (46). Incluem as dimensões de atividade, baixa timidez, prazer por novidades e atividades intensas, impulsividade e afiliação com terceiros (46). De maneira diferente de como ocorre na infância, a timidez na adolescência é carregada pelo fator de afetividade positiva (e não negativa), juntamente com extroversão e ativação (46,47).

Poucos estudos conseguem mensurar prospectivamente o temperamento com o mesmo instrumento, dificultando a avaliação de mudanças dos níveis do temperamento na adolescência (47). Porém, o auxílio da evidência dos estudos de personalidade pode ser útil neste entendimento, visto que a personalidade também captura mudanças psicobiológicas que se desenvolvem ao longo da vida (33). Neste sentido, pode-se observar que a correlação entre os fatores de temperamento e personalidade se torna mais robusta com o passar da idade, com intensas mudanças acontecendo ao final da adolescência até os 40 anos de idade, principalmente aumentando níveis de conscienciosidade e melhorando a estabilidade emocional após a adolescência (55,56). Isto coincide com os níveis baixos de autoestima encontrados neste período, os quais são os mais baixos no ciclo de vida humano (57,58).

Entretanto, não há um modelo estrutural definitivo que organize a hierarquia desses construtos de temperamento. No campo da personalidade, existem evidências de que os questionários autoaplicáveis apresentam um fator que informa a maneira como o individuo endossa os itens do instrumento, ou seja, relacionado à maneira como o sujeito se avalia (59,60). Porém, isso ainda não foi testado no campo do temperamento.

1.2.2. Estrutura fatorial do temperamento

A estrutura fatorial de um construto, especialmente psicológico, pode ser avaliado de maneira exploratória ou confirmatória (61,62). Nos estudos de temperamento e personalidade, os modelos teóricos são corriqueiramente testados através da analise confirmatória do modelo, utilizando os dados empíricos. Neste sentido, o modelo teórico de temperamento proposto por Mary Rothbart é estruturado utilizando três construtos hierarquicamente superiores, os quais são, como mencionados acima, o controle de esforço, a afetividade positiva e afetividade negativa. Estes construtos de primeira ordem influenciariam os construtos de segunda ordem (descritos acima), hierarquicamente inferiores e diretamente relacionados aos itens dos questionários (46,53).

Nos trabalhos que visam a testar esse modelo teórico, o construto de controle de esforço converge de maneira muito consistente entre os estudos, abarcando os fatores de atenção, regulação de atividade e controle inibitório (33). As dimensões que compõe os fatores de afetividade negativa e positiva nem sempre convergem nos modelos testados, mesmo quando realizados pelo mesmo grupo de pesquisa. Este é o exemplo da dimensão de medo, que em modelos utilizando questionário de temperamento para adolescentes (EATQ-R) pode tanto convergir para o fator de extroversão (54) quanto para o de afetividade negativa (47,53). Embora estes trabalhos tenham índices de ajuste de modelo aceitáveis, eles seguem a hipótese de que não há correlação entre as dimensões de segunda ordem (47,63) (por exemplo, correlação entre timidez e medo) ou de que a maneira como os itens são endossados não sofram influência da maneira como o sujeito pensa sobre si (64,65).

Modelos bifatorias têm sido utilizados no campo dos estudos da personalidade (59,60,64,66). O modelo bifatorial implica que existe um fator geral que influencia diretamente os itens endossados e os fatores residuais constituem os fatores específicos (67). No campo da personalidade, existem importantes evidências sobre a existência de um fator geral para os questionários de personalidade que traduzem a maneira como o sujeito se avalia no momento de preencher os itens do questionário (59,60,64), e, no caso de adultos, traduz um viés positivo de autoavaliação (66,68), que coincide com o período em que a autoestima começa a aumentar (58). Porém, estes modelos não são livres de críticas, já que o fator geral nos estudos de personalidade normalmente não explica a maior parte da variância dos modelos (69) – e, dessa forma, não sugere um fator geral robusto, como nos campos da psicopatologia e inteligência (17,70,71).

Modelos bifatoriais de temperamento começaram a ser testados, mas utilizando os tradicionais construtos de primeira ordem como fatores gerais e não explorando a possibilidade de um fator geral sobre todo o questionário (63). É possível que, no caso específico do temperamento, o modelo bifatorial consiga capturar, em seu fator geral, o viés de autoavaliação e os fatores residuais remanescentes consigam caracterizar, de forma não contaminada, as tendências individuais de regulação e reação dos sujeitos.

1.2.3. Temperamento e psicopatologia

Em relação à saúde mental, diversos modelos têm sido testados para avaliar a relação entre temperamento/personalidade e sintomas ou transtornos mentais, já que ambos são construtos que tentam capturar o funcionamento individual em comportamentos e emoções, muito embora o transtorno mental envolva também o sofrimento e prejuízo funcional. Esta relação tem ficado mais clara ao menos para os transtornos de personalidade, nos quais, parece haver um *continuum* de funcionamento, com o transtorno representando o extremo desadaptado do funcionamento dos traços normais de personalidade (72–74). Em relação a transtornos psiquiátricos, os achados mais frequentemente estudados são em relação ao neuroticismo e aos transtornos internalizantes, nos quais o neuroticismo apresenta-se como marcador de risco para transtornos depressivos e ansiosos, possivelmente devido a genes compartilhados (75–77). Em relação ao temperamento, evidências mais recentes apontam para o modelo de que o temperamento e suas modificações ao longo da adolescência se associam a riscos distintos para transtornos psiquiátricos, favorecendo o modelo da vulnerabilidade (78). Menor nível de controle de esforço está amplamente associado a transtornos externalizantes, como déficit de atenção e hiperatividade (79,80), bem como internalizantes, sendo o temperamento mais globalmente associado à transtornos mentais (63,78,81). Afeto negativo também se associa a transtornos mentais promovendo vulnerabilidade especialmente a transtornos internalizantes, como depressão e ansiedade (63,82,83). O aumento da frustração, em particular, pode aumentar o risco para quaisquer tipos de transtornos mentais após a adolescência (78). Extroversão ou afeto positivo também pode estar associado a transtornos externalizantes, na medida que modula a psicopatologia para esta manifestação comportamental (84).

1.3. Interação dos fatores em estudo

Os mecanismos que afetam os eventos do desenvolvimento infantil (neste caso, a vida escolar) e que possibilitam os desfechos na vida adulta (i.e., sucesso socioeconômico) são pouco compreendidos. Poucos estudos testam a possibilidade de interações entre essas capacidades, geralmente relatando apenas os efeitos principais ou ajustando os efeitos de uma capacidade pela outra (31,85–87). Portanto, os mecanismos de como as habilidades socioemocionais atuam com a cognição e saúde durante a infância, para promoverem os resultados na vida adulta, são pouco explorados. Se, por exemplo, há presença de interação, isso implica que os efeitos de habilidades socioemocionais dependem dos níveis de outro vetor de capacidade, como a inteligência. Ou seja, níveis altos de habilidades socioemocionais podem produzir maior efeito se os níveis de inteligência forem baixos (efeito antagonista ou de tamponamento) ou altos (efeito sinérgico) (88).

Os artigos da presente tese inserem-se dentro desse contexto. Compreender as associações e distinções de medidas uni ou multidimensionais das habilidades socioemocionais pode ser útil para entender papel destes construtos nas diferentes etapas do processo escolar, a fim de promover a elevação da qualidade educacional.

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3. OBJETIVOS

3.1. Objetivo geral

Investigar a relação de atributos positivos do comportamento e do temperamento com desfechos escolares.

3.2. Objetivos específicos

A. Relação de atributos positivos do comportamento com desfechos escolares (artigo #1)
    a. Avaliar a distinção entre atributos positivos e ausência de sintomas mentais;
    b. Investigar as associações principais e independentes dos atributos positivos em aprendizagem e rendimento acadêmico;
    c. Investigar a interação dos atributos positivos com sintomas mentais e inteligência nos desfechos de aprendizagem e rendimento acadêmico.
B. Modelo multidimensional de temperamento (artigo #2)
    a. Avaliar modelo correlacionado e bifatorial de temperamento, considerando o fator geral como fator de autoavaliação;
    b. Investigar validade do modelo com a caracterização fenotípica de grupos diagnósticos não sobrepostos com base no temperamento.
C. Relação de temperamento e desfechos educacionais (artigo #3)
    a. Investigar as associações principais do temperamento em eventos escolares negativos, aprendizagem e rendimento acadêmico;
    b. Ajustar as dimensões de temperamento para confundidores e avaliar associações ajustadas com desfechos escolares;
    c. Investigar interação entre dimensões de temperamento.

4. ARTIGO #1

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Positive attributes "buffers" the negative associations between low intelligence and high psychopathology with educational outcomes

Running title: Positive attributes and education.

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Summary

Objectives: This study examines the extent to which children's positive attributes are distinct from psychopathology. We also investigate whether positive attributes change or 'buffer' the impact of low intelligence and high psychopathology on negative educational outcomes.

Methods: In a community sample of 2,240 children (6-14 years of age), we investigated associations among positive attributes, psychopathology, intelligence, and negative educational outcomes. Negative educational outcomes were operationalized as learning problems and poor academic performance. We tested the discriminant validity of psychopathology vs. positive attributes using Confirmatory Factor Analysis (CFA) and Propensity Score Matching Analysis (PSM) and used generalized estimating equations (GEE) models to test main effects and interactions among predictors of educational outcomes.

Results: According to both CFA and PSM, positive attributes and psychiatric symptoms were distinct constructs. Positive attributes were associated with lower levels of negative educational outcomes, independent of intelligence and psychopathology. Positive attributes buffer the negative effects of lower intelligence on learning problems, and higher psychopathology on poor academic performance.

Conclusion: Children's positive attributes are associated with lower levels of negative school outcomes. Positive attributes act both independently and by modifying the negative effects of low intelligence and high psychiatric symptoms on educational outcomes. Subsequent research should test interventions designed to foster the development of positive attributes in children at high risk for educational problems.

INTRODUCTION

Educational attainment in childhood is a powerful predictor of economic success, health, and well-being later in life.[1–3] Both intelligence[4] and psychiatric symptoms[5,6] influence an individual's performance in educational settings. However, recent econometric studies also highlight the impact of positive attributes – such as being keen to learn, affectionate and caring – on educational attainment.[7–10] Whereas research has begun to examine the role of positive attributes on determining education outcomes[11,12] , major questions remain.

First, it is important to determine whether positive attributes are a distinct construct, separable from the absence of psychiatric symptoms.[11] Economic studies cannot answer this question because they do not include measures of psychopathology. The few available studies in psychiatry[11,12] support the independent contributions of positive attributes and psychiatric symptoms in predicting the subsequent development of psychiatric illness. However, the distinction between positive attributes and psychiatric symptoms has not been examined psychometrically.

Second, if positive attributes are indeed distinct from the absence of psychiatric symptoms, it is important to investigate interactions between these two constructs and intelligence in predicting educational outcomes. Consistent with economic theories of human development, evidence suggests that positive attributes and intelligence may interact in predicting educational outcomes, such as school graduation by age 30.[1,13] However, no studies investigate interactive effects between positive attributes and psychopathology on educational outcomes. Specifically, it is important to ascertain if positive attributes buffer the negative impact of low intelligence and high psychiatric symptoms on educational outcomes. If positive attributes have such buffering properties, then facilitating their emergence might improve outcomes in children who are at risk for adverse educational outcomes because of psychiatric symptoms or low intelligence.

Here we aim to investigate: (1) the discriminant validity of the constructs of positive attributes and psychiatric symptomatology in children; and (2) whether positive attributes are independently associated with educational outcomes and/or if they buffer associations between low intelligence and

negative educational outcomes, and between high psychiatric symptoms and negative educational outcomes. First, we predict that positive attributes are empirically discriminable from psychiatric symptoms. Second, we predict that positive attributes are associated with lower levels of negative educational outcomes independent of intelligence and psychopathology, and through interactions with low intelligence and high levels of psychiatric symptoms that buffer the impact of these two variables on negative educational outcomes.

METHODS

Participants

We used data from a large school-based community study that obtained psychological, genetic and neuroimaging data and was designed to investigate typical and atypical trajectories of psychopathology and cognition over development.[14] The ethics committee of the University of São Paulo approved the study. Written consent was obtained from parents of all research participants and verbal assent was obtained from the children.

The study included screening and assessment phases. The screening phase of the study included children from 57 public schools in São Paulo and Porto Alegre. In Brazil, on specified registration days, at least one caregiver is required to register each child for compulsory school attendance. All parents and children who presented at the selected schools were invited to participate. Families were eligible for the study if the children: (1) were registered by a biological parent capable of providing consent and information about the children's behavior; (2) were between 6-12 years of age; and (3) remained in the same school during the study period.

We screened 9,937 parents using the Family History Survey (FHS).[15] From this pool, we recruited two subgroups - one randomly selected (n=958) and one high-risk (n=1,524). Selection of the high-risk sample involved a risk-prioritization procedure designed to identify individuals with current symptoms and/or a family history of specific disorders.[14]

The assessment phase was performed in multiple visits, in the following order: home interview with parents (one visit), child assessment with a psychologist (one or two visits), child assessment with a speech therapist (one or two visits), and one hospital visit for imaging and blood collection.

From the total sample (N=2,512), missing data for intelligence and learning problems was handled using listwise deletion. Hence, a subset of 2,240 research participants (862 randomly selected and 1,378 high-risk) with complete intelligence measurements[16] were included in the present analysis. In this subsample, 1,987 research participants (783 randomly selected and 1,204 high-risk) had complete measurements of learning problems.[17] Subjects with missing intelligence data had lower mean age (9.53 vs. 10.37 [$F_{(1,2510)}$=81.28, p<0.001]) than included subjects, but did not differ on gender, socioeconomic status or psychiatric symptoms. Parent informants were mother (91.6%), father (4.4%) or both (4%).

Positive Attributes Measurement

To measure positive attributes in children and adolescents, we used the Youth Strength Inventory (YSI), a subscale of the Development and Well-Being Assessment (DAWBA).[11] The YSI is a 24-item scale, divided into two blocks of questions addressed to the caregiver. One block focuses on child characteristics, such as if he/she is “lively”, “easy going”, “grateful”, “responsible”, and has a “good sense of humour”. The other block addresses the child’s actions that please others, such as “helps around the home”, “well behaved”, “keeps bedroom tidy”, “does homework without reminding”. Each question is answered, “No”, “A little”, or “A lot”. A confirmatory factor analysis (CFA) of YSI yielded a one-factor solution with adequate goodness-of-fit indices (i.e., Root Mean Square Error of Approximation (RMSEA) 0.057 (90% CI 0.055-0.059), Comparative Fit Index (CFI) 0.957, Tucker Lewis Index (TLI) 0.950, Chi-Square Test of model fit 2201.316 (p<0.001)). Composite YSI scores were derived from saved factor scores from the CFA model (Table S1, available online).

Intelligence Evaluation

For intelligence, we estimated IQ using the vocabulary and block design subtests of the Weschler Intelligence Scale for Children, 3rd edition – WISC-III,[18] using the Tellegen and Briggs method[19] and Brazilian norms.[16,20]

Psychiatric Evaluation

Psychiatric symptoms were evaluated as a continuous variable, using the Strengths and Difficulties Questionnaire (SDQ).[21] SDQ is a 25-item questionnaire which provides five scores of behavioral and emotional symptoms. For the purposes of this study, we excluded “peer relationships problems” from the SDQ total because of the conceptual overlap among this variable, psychiatric symptoms, and positive attributes. The resulting measure, the SDQ composite (SDQc), includes “emotional symptoms”, “inattention/hyperactivity” and “conduct problems”.

Psychiatric diagnosis was assessed using the Brazilian Portuguese version[23] of the Development and Well-Being Assessment (DAWBA).[22] This structured interview was administered to biological parents by trained lay interviewers and scored by trained psychiatrists who were supervised by a senior child psychiatrist[14]. For the purposes of the propensity score matching (PSM) analysis we used the DAWBA broad category of ‘Any Psychiatric Diagnosis’.

There were low Pearson’s correlations between YSI and IQ ($r=0.105$; $p<0.001$) and between SDQ and IQ ($r=-0.146$; $p=<0.001$). There was a moderate correlation between YSI and SDQc ($r=-0.560$; $p=<0.001$).

Educational Evaluations

Educational evaluations consisted of direct measurement of learning problems in children and by the caregiver’s report of the child’s performance in academic subjects.

Specifically, learning problems were measured by participants' scores on the School Performance Test ("Teste de Desempenho Escolar" - TDE).[17] The TDE is comprised of two subtests, decoding (recognition of words isolated from context) and writing (isolated words in dictation). A previous TDE study from our group used Latent Class Analysis (LCA) to identify a cluster of children (18.5% of the sample) with poor decoding and writing skills.[24] Here, we used membership in this cluster to identify children with learning problems.

Academic performance was measured using Child Behavior Checklist for ages 6-18 (CBCL-school),[25] completed by the caregiver. The academic subjects assessed were Portuguese or literature, history or social studies, English or Spanish, mathematics, biology, sciences, geography, and computer studies. Each subject was scored as failing, below average, average, and above average. The CFA of CBCL-school using one-factor solution resulted in adequate goodness-of-fit indices (i.e., RMSEA 0.056 (90% CI 0.048-0.065), CFI 0.997, TLI 0.996, Chi-Square Test of model fit 49787.4 ($p<0.001$)). The composite CBCL-school (academic performance) scores were derived from saved factor scores from the CFA model (Table S2, available online).

Statistical Analysis

We performed a stepwise analysis. We used two analytic methods to test the first hypothesis. First, we performed a CFA to investigate if YSI and SDQc items load onto one or two latent factors. Specifically, we fitted a one factor, two factors, second order and bifactor models. (For CFA methods and results, see Supplementary Material, available online). Second, we used a LCA to identify groups differing on level of positive attributes. We then used propensity score matching (PSM) to test if children differing only in positive attributes (and not on psychiatric diagnosis, symptoms, medication, IQ, age, gender, siblings, socioeconomic status or parents' psychiatric diagnosis) differ on school outcomes. Specifically, after propensity score matching, generalized estimating equations (GEE) models were used to test between-group differences in school outcomes. Since school outcomes might vary among the 57 schools, we controlled for cluster effects (random-effects) in all statistical tests. The LCA and PSM methods and results are detailed in Supplementary Material, available online.

We tested the second hypothesis using univariate models that included one independent variable at a time (i.e., YSI, IQ, SDQc); followed by bivariate models that included YSI and IQ or SDQc in the same model without the interaction term and finally a full model that included the main effects of YSI and IQ or SDQc and the interaction term (i.e., YSI*IQ and YSI*SDQc). To facilitate interpretation, IQ, positive attributes and psychiatric symptom scores were transformed into standardized units (z-scores), regressing out the effects of age and gender (using Studentized residuals). Again, study hypotheses were tested using GEE models in SPSS 17 (SPSS Inc, Chicago, Illinois, USA). We used binary logistic and linear regression models for learning problems and poor academic performance respectively. Therefore, model estimates (OR and β) reflect the outcome additive increase for changing one standardized unit of the predictors. Interactions were represented graphically using regression surfaces implemented in R (plot3D package[26]). We used marginal effects implemented in Stata version 13 (StataCorp, College Station, Texas, USA) to test the significance of the continuous interactions. Marginal effects represent the change in linear prediction (linear regression) and probability (logistic regression) of an outcome for a one IQ or SDQc standardized unit change when YSI is held constant at different values (-3.5 to 3.5, with 0.5 unit increases). For logistic regression, results were transformed from chances into probabilities to facilitate interpretation. For marginal effects analysis, we used the inverse levels of IQ (IQ * (-1)). For post-hoc power analyses of the main models, see Supplementary Material.

RESULTS

Hypothesis 1: Positive attributes are empirically discriminable from psychiatric symptoms.

CFA indicated that the model with two correlated factors showed the best fit indices over the other models (one factor, second order and bifactor models). The model with two correlated factors ('psychiatric symptoms' and 'positive attributes') showed acceptable goodness-of-fit across indices: RMSEA 0.061 (90% CI 0.059-0.062), CFI 0.903, TLI 0.895, Chi-Square Test of model fit 66086.108 ($p<0.001$) as the model with one factor provided an unacceptable fit to the data according to two out of three fit indexes: RMSEA 0.077 (CI90% 0.076 – 0.079), CFI 0.842, TLI 0.830, Chi-Square Test of model fit 11012.799, df=689, $p<0.001$. Chi-Square Test for Difference Testing one-dimensional vs. correlated two factor models showed advantages of the two-factor correlated model over the one-factor model ($\chi^2=667.338$, df=1, $p<0.0001$). Second-order and bifactor models did not converge.

An item-level inspection of information curves from the CFA of the two-factor correlated model showed that YSI and SDQc provide information in different areas of a common metric (*i.e.*, YSI is better at discriminating among typically developing children, while SDQc is better at discriminating among atypically developing children). Specifically, the mean threshold of SDQc items was -0.19, whereas the mean threshold of YSI items was 0.83 (Figure S1, available online).

LCA indicated that the sample is divided into high (63.2%) and low (36.8%) positive attributes classes (Figure S2, available online). PSM procedures were able to generate two groups differing only in positive attributes levels (Figure S3, available online). As predicted, compared to the low YSI group, the high YSI group had lower means on the scale measuring poor academic performance ($\beta=0.72$; 95% CI [0.65-0.79]; $p<0.001$). Contrary to our predictions, YSI was not associated with a lower chance of having learning problems (OR=0.98; 95% CI [0.73-1.30], p=0.88).

Hypothesis 2: Positive attributes are associated with lower levels of negative educational

outcomes independent of intelligence and psychopathology, and through interactions with low intelligence and high levels of psychiatric symptoms that buffer the impact of these two variables on negative educational outcomes.

Positive attributes and intelligence

First we analyzed the associations of IQ and YSI on each outcome variable (Table 1). In both univariate and bivariate models, higher YSI and IQ were associated with lower chances of learning problems and lower levels of poor academic performance. For poor academic performance, the associations with IQ and YSI were independent of each other (Table 1, Model 3). For learning problems, there was a significant interaction between YSI and IQ, such that the association of intelligence on learning problems is moderated by children's positive attributes (Table 1, Model 3 and Figure 1A). Marginal effect analysis revealed that decreasing levels of IQ were significantly associated with higher probabilities of learning problems for individuals with YSI lower than 1.5 z-score, but not for those with YSI equal or higher than 1.5 z-score (Figure 1B). The strength of the association between levels of intelligence and learning problems decreases as a function of increasing levels of positive attributes. For example, at a YSI of -3.5 z score, the probability of learning problems increases 17.90% (95%CI 10.46% to 25.33%, $p<0.001$) for each IQ standardized unit decrease. At a YSI of 1 z-score, the probability of learning problems increases 4.21% (95%CI 1.50 to 6.93, $p=0.002$) for each IQ standardized unit decrease (Figure 1B). Importantly, when the YSI is ≥ 1.5 z-score, the associations between IQ and learning problems are non-significant (Figure 1B), suggesting that high levels of positive attributes buffer the negative impact of low intelligence on learning problems.

TABLE 1

FIGURE 1

Positive attributes and psychiatric symptoms

Lastly, we investigated the effect of psychiatric symptoms (SDQc) on school outcomes, again in univariate and bivariate models with child positive attributes (YSI) (Table 2). In the univariate model, higher SDQc were associated with higher levels of negative educational outcomes (Table 2, Model 1). In the bivariate models, both YSI and SDQc were significantly associated with learning problems and academic performance (Table 2, Model 2). For learning problems, associations with SDQc and YSI were independent (Table 2, Model 3). However, for poor academic performance, there was a significant interaction between YSI and SDQc, revealing that the association of psychiatric symptoms on performance in academic subjects is moderated by children's positive attributes (Table 2, Model 3 and Figure 2A). Marginal effect analysis revealed that increasing levels of psychiatric symptoms was significantly associated with poorer academic performance, for children and adolescents with YSI lower than 1.5 z-score, but not for those with YSI equal or higher than 1.5 z-score (Figure 2B). The strength of the association between levels of psychiatric symptoms and poor academic performance decreases as a function of increasing levels of positive attributes. For example, at a YSI of -3.5 z score, linear prediction of poor academic performance increases 0.403 z-score (95%CI 0.272 to 0.534, $p<0.001$) for each SDQc standardized unit increase. At a YSI of -1 z score, linear prediction of poor academic performance increases 0.115 z-score (95%CI 0.033 to 0.197, $p=0.007$) for each SDQc standardized unit increase (Figure 2B). At YSI $\geq$ 1.5 z score, the association between SDQc and poor academic performance is non-significant, suggesting that high levels of positive attributes buffer the negative impact of psychiatric symptoms on academic performance (Figure 2B).

TABLE 2

FIGURE 2

As a post-hoc analysis, we ran a second CFA for YSI, excluding items that could overlap with school outcomes ("keen to learn", "good at school work", "does homework without needing to be reminded"). A good model fit remained (RMSEA 0.057, 90% CI 0.055-0.060; CFI 0.961; TLI 0.955; Chi-Square Test of model fit 1681.197, $p<0.001$). We re-ran all the regressions using YSI scores

without school items and found the same main effects and interactions described above. Also, for each model, three-way interactive models among YSI, SDQc and IQ were non-significant, as were interactions with gender.

DISCUSSION

In this school-based community sample, we first used two analytic approaches to investigate the validity of the children's positive attributes construct. In particular, we were interested in ascertaining the extent to which positive attributes and psychiatric symptoms are distinct constructs. First, confirmatory factor analysis showed that a model with two correlated factors (positive attributes and psychiatric symptoms) fit better than a unidimensional model. Second, propensity score analysis showed that, even after matching participants for psychiatric symptoms, psychiatric disorders, intelligence, and other potential confounders, children with low positive attributes had worse performance in academic subjects than those with high positive attributes. Finally, we found that positive attributes are associated with better educational outcomes both independent of intelligence and psychiatric symptoms, and by buffering associations among low intelligence, high levels of psychiatric symptoms, and negative educational outcomes.

Consistent with other studies,[11,12] our results suggests that positive attributes in children are not merely the absence of psychopathology. Whereas the measurement of psychiatric symptoms might characterize developmental disruptions in children with high levels of psychopathology, the measurement of positive attributes might improve the characterization of behavioral and emotional variability within the normal range, adding incremental health risk prediction.[11,27] This may explain why positive attributes can predict the risk for later psychiatric disorders in healthy children, beyond predictions based on baseline psychiatric symptoms.[11]Additionally, our PSM results revealed that, in groups matched on other relevant characteristics, children high in positive attributes have better academic performance than those low in positive attributes . This is consistent with Krapohl and colleagues,[28] who found that academic performance was predicted not only by intelligence, but also by

personality traits and well-being. Hence, the CFA and PSM analyses supported the validity of the positive attributes construct by improving behavioral characterization and prediction of academic performance.

Most studies examine the predictive value of one variable alone, either positive attributes,[11,12,29,30] intelligence[4,31] or psychiatric symptoms,[32,33] without investigating interactions. In agreement with previous studies, we found that intelligence, psychiatric symptoms and positive attributes did, indeed, have independent associations with educational outcome. However, our study indicates that these variables also interact. Previous studies suggest that early interventions designed to improve noncognitive abilities in disadvantaged children impact on IQ briefly, but have longer-lasting effects on school attainment and employment.[33] Our results suggest that these lasting effects may result from the impact of noncognitive abilities (*i.e.*, positive attributes) on learning. Specifically, based on our findings, it is reasonable to hypothesize that children with low IQ would show particularly marked benefit from early interventions that increase positive attributes, since the impact of low IQ on learning problems is buffered by positive attributes. Also, an association between high positive attributes and lower psychiatric symptoms has been reported,[11] and interventions that improve such noncognitive skills in childhood appear to be associated with decreased psychiatric symptoms later in life.[33,35] While our results are consistent with these previous studies, our study also reveals that, with respect to academic performance, the positive effects of noncognitive abilities might be particularly important in highly symptomatic children, as well as in those with low intelligence. This is especially important given that mental health in adolescence predicts later educational and occupational attainment, rather than background economic and educational status[36].

The interactions that we observed among positive attributes, intelligence and psychiatric symptoms are consistent with developmental theories that focus on adaptive human characteristics.[37] In particular, Heckman's theory of human skills formation[1,7,38] is well-suited to explain the present findings, since it predicts interactions among cognitive skills, noncognitive skills and health.[38] As we observed, positive attributes interact with intelligence and psychiatric symptoms to impact on school learning and performance in children and adolescents, suggesting mechanisms by which these variables can affect on adult outcomes, including educational attainment, employment, crime and

health.[1] The interactions found in our study further suggest that remediation of single domain deficits in a developing child could be important not only for that specific domain, but to potentiate other facets of behavioral function. Considering Vidal-Ribas[11] work and ours, it is plausible to suggest a "noncognitive reserve mechanism" through which positive attributes decrease the odds of developing psychopathology and educational impairments, similar to the "cognitive reserve hypothesis" which proposes that cognitive function acts as a buffer against the development of psychopathology.[31]

Some limitations need to be considered in order to interpret our findings properly. *First*, since this is a cross-sectional study, the possibility of reverse causality (*i.e.,* school factors influencing positive attributes, intelligence and symptoms) cannot be ruled out. However, a previous longitudinal study on positive attributes[11] reported larger effects for positive attributes on psychopathology than those reported here. *Second*, although propensity score matching minimizes the role of potential confounding factors, unobserved variables might introduce residual confounding effects on the associations between YSI and school outcomes and decrease the effect size of positive attributes on reported associations. *Third*, apart from learning problems, which were measured by a standardized test, other child characteristics and outcomes were assessed by parental report, which may have led to effect overestimation. Further studies should include other sources of information such as school reports, test scores, and teacher reports. *Fourth*, this study was carried in a community sample of a single country and the results may not generalize to other cultures.

Taken together, our study provides further validity for the positive attributes construct and suggests that positive attributes may interact with intelligence to predict learning problems, and with psychiatric symptoms to predict academic performance. Importantly, the deleterious associations of psychiatric symptoms and low intelligence are buffered by children's positive attributes. Further studies should focus on understanding the mechanisms mediating these interactions, and on testing mechanistically-informed interventions designed to increase positive attributes, particularly in children with psychiatric symptoms and/or low intelligence.

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Table 1. Univariate, bivariate and interactive models of Positive Attributes and Intelligence on school outcomes

		Learning Problems[a]	**Poor Academic Performance**[a]
	z-score[b]	OR (LB – UB)	β (LB – UB)
Model 1 (Univariate)	YSI	0.78 *** (0.70 to 0.87)	-0.31*** (-0.34 to -0.27)
	IQ	0.60*** (0.52 to 0.68)	-0.22*** (-0.26 to -0.18)
Model 2 (Bivariate)	YSI	0.81*** (0.73 to 0.91)	-0.29*** (-0.32 to -0.25)
	IQ	0.61*** (0.53 to 0.70)	-0.19*** (-0.23 to -0.15)
Model 3 (Interactive)	YSI	0.86* (0.76 to 0.97)	-0.28*** (-0.32 to -0.25)
	IQ	0.62*** (0.55 to 0.71)	-0.19*** (-0.22 to -0.15)
	YSI*IQ	1.16* (1.02 to 1.32)	0.02 (-0.02 to 0.06)

Note: YSI = Youth Strengths Inventory; IQ = estimated intelligence quotient (defined in the text); OR = odds ratio; β = regression coefficient β; UB = upper bound; LB = lower bound. *p-value≤0.05; **p-value≤0.01; ***p-value≤0.001.

a. Outcomes defined in the text.

b. The 1st z-score was used as a reference for each independent variable. Estimates reflect the additive OR or β increase associated with changing one z-score.

Table 2. Univariate, bivariate and interactive models of Positive Attributes and Psychiatric Symptoms on school outcomes

		Learning Problems[a]	**Poor Academic Performance**[a]
	z-score[b]	OR (LB – UB)	β (LB – UB)
Model 1 (Univariate)	YSI	0.78 *** (0.70 to 0.87)	-0.31*** (-0.34 to -0.27)
	SDQc	1.27*** (1.14 to 1.42)	0.30*** (0.26 to 0.34)
Model 2 (Bivariate)	YSI	0.84* (0.73 to 0.96)	-0.20*** (-0.25 to -0.16)
	SDQc	1.15* (1.00 to 1.32)	0.19*** (0.14 to 0.23)
Model 3 (Interactive)	YSI	0.83** (0.72 to 0.95)	-0.20*** (-0.25 to -0.16)
	SDQc	1.18* (1.02 to 1.35)	0.18*** (0.14 to 0.22)
	YSI*SDQc	1.10 (0.98 to 1.24)	-0.06*** (-0.10 to -0.03)

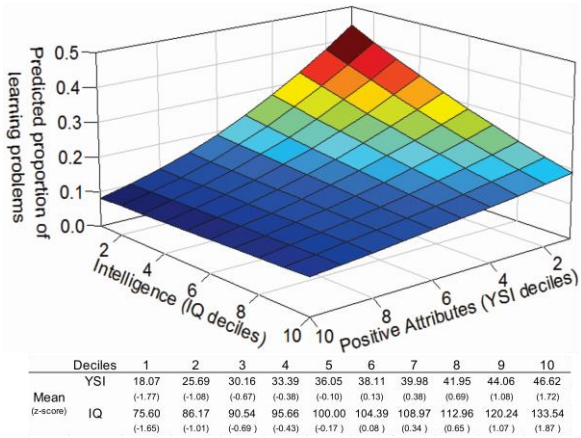
Note: YSI = Youth Strengths Inventory; SDQc = composite of Strengths and Difficulties Questionnaire (defined in the text); OR = odds ratio; β = regression coefficient β; UB = upper bound; LB = lower bound. *p-value≤0.05; **p-value≤0.01; ***p-value≤0.001.

a. Outcomes were defined in the text.

b. The 1st z-score was used as a reference for each independent variable. Estimates reflect the additive OR or β increase associated with changing one z-score.

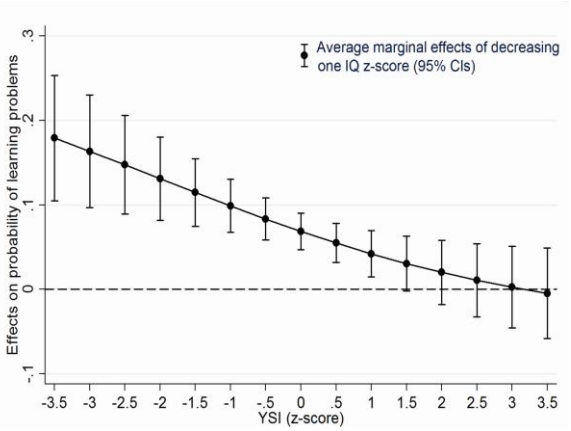
Figure 1 – Interaction and Marginal Effects of Intelligence and Positive Attributes on Learning Problems

A



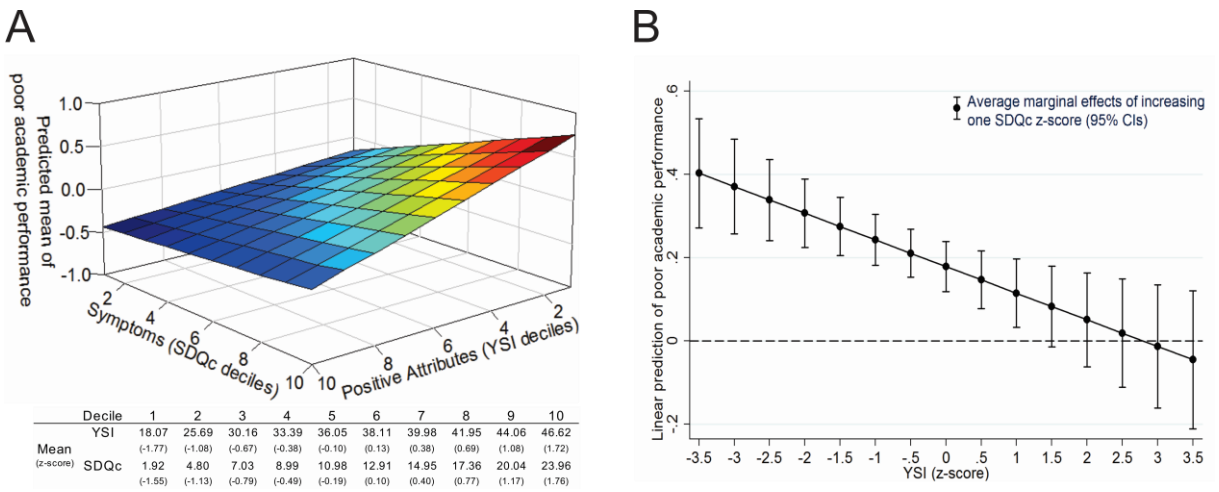
	Deciles	1	2	3	4	5	6	7	8	9	10
Mean (z-score)	YSI	18.07 (-1.77)	25.69 (-1.08)	30.16 (-0.67)	33.39 (-0.38)	36.05 (-0.10)	38.11 (0.13)	39.98 (0.38)	41.95 (0.69)	44.06 (1.08)	46.62 (1.72)
	IQ	75.60 (-1.65)	86.17 (-1.01)	90.54 (-0.69)	95.66 (-0.43)	100.00 (-0.17)	104.39 (0.08)	108.97 (0.34)	112.96 (0.65)	120.24 (1.07)	133.54 (1.87)

B



Note: (A) The y-axis represents the probability of learning problems by deciles of intelligence (x-axis) and positive attributes (z-axis). (B) The y-axis represents the probability of learning problems (defined in the text), quantified by the average marginal effect of decreasing one IQ z-scores (black dots with CIs) at each YSI z-scores (x-axis). CIs = Confidence Intervals; YSI = Youth Strengths Inventory; IQ = estimated Intelligence Quotient (defined in the text).

Figure 2 – Interaction and Marginal Effects of Psychiatric Symptoms and Positive Attributes on Poor Academic Performance



Note: (A) The y-axis represents the mean of poor academic performance by deciles of psychiatric symptoms (x-axis) and positive attributes (z-axis), (B) The y-axis represents the linear prediction of poor academic performance (defined in the text), quantified by the average marginal effect of increasing one SDQc z-score (black dots with CIs) at each YSI z-scores (x-axis). CIs = Confidence Intervals; YSI = Youth Strengths Inventory; SDQc = composite of Strengths and Difficulties Questionnaire (defined in the text).

Supplementary Material

Supplementary methods, analysis and results

Post-hoc power analysis

Post-hoc power analyses were conducted for our main outcomes. For our linear outcomes (academic performance), the observed power for the main effects of Youth Strengths Inventory (YSI) and Strengths and Difficulties Questionnaire composite (SDQc), and for their interaction, were >0.99, >0.99 and >0.95 respectively. For our binary outcome (learning problems), observed power for the main effects of YSI and SDQc, and for their interaction, were all >0.99.

Factor analysis from YSI and CBCL school items

For all confirmatory factor analysis (CFA), we used delta parameterization and weighted least square using a diagonal weight matrix with standard errors and mean- and variance-adjusted chi-square test statistics (WLSMV) estimators, using MPLUS 7.1 software (Muthén & Muthén, Los Angeles, California, USA). Model fit parameters were Chi Square Test of model fit, root mean square error of approximation (RMSEA), Comparative Fit Index (CFI) and Tucker Lewis Index (TLI). Values of RMSEA near or below 0.08 represent acceptable model fit, and values lower than 0.06 represent good-to-excellent model fit.[1] CFI and TLI values near or above 0.90 represent acceptable model fit, while values higher than 0.95 represent a good-to-excellent model fit. Nested models were tested using Chi-Square for Differences using the DIFFTEST option.

YSI

The YSI is a 24-item scale, divided into two blocks of questions addressed to the caregiver. One block focuses on characteristics of the child, such as if he/she is “lively”, “easy going”, “grateful”, “responsible”, and has a “good sense of humour”. The other block addresses the child’s actions that please others, such as “helps around the home”, “well behaved”, “keeps bedroom tidy”, “does homework without reminding” and others. All questions have three possible answers: “No”, “A little”, “A lot”. The CFA of YSI using a one-factor solution resulted in adequate goodness-of-fit indexes in our sample, converging to a single factor denominated “positive attributes” (see main text). The composite YSI scores were derived from saved factor scores from the CFA model (Table S1).

CBCL-school items

For academic performance, the CFA of CBCL-school using one-factor solution resulted in adequate goodness-of-fit indexes in our sample (see main text). The composite CBCL-school (academic performance) scores were derived from saved factor scores from the CFA model (Table S2).

Testing if YSI and SDQc are overlapping constructs

CFA models including the YSI and SDQc was used to test whether the two scales assess the same underlying latent construct. The category threshold indicates the expected value of the latent factor at which there is a $\geq$ 50% probability of endorsing a given category. The mean threshold for each item was computed as the item location on the severity continuum in order to inform the location of the latent trait in which items were more informative.

CFA models were run to test whether the two scales assess the same underlying latent construct. We fitted a one-factor model (all items loading into a general component), a correlated two-factor model with SDQc items loading onto a 'psychiatric symptoms' dimension and YSI items loading onto a 'positive attributes' dimension; a second-order model, with 'psychiatric symptoms' and 'positive attributes' loading onto one higher order factor; and a bifactor model, with all items loading into a general factor and residuals loading onto two specific factors – 'psychiatric symptoms' and 'positive attributes'. The model with one factor provided an unacceptable fit to the data according to two out of three fit indexes (see main text) and the model with two correlated factors ('psychiatric symptoms' and 'positive attributes') showed acceptable goodness-of-fit in practically all indices (see main text). Chi-Square Test for Difference Testing one-dimensional vs. correlated two factor models showed advantages of the two-factor correlated model over the one-factor model (χ^2=667.338, df=1, p<0.0001). Second-order and bifactor models were not identified.

An item-level inspection of information curves from CFA of the two-factor correlated model showed that YSI and SDQc provide information in different areas of a common metric (*i.e.*, YSI is better at discriminating among typically developing children, while SDQc is better at discriminating among atypically developing children). Specifically, the mean threshold of SDQc items was -0.19, whereas the mean threshold of YSI items was 0.83 (Figure S1).

Propensity Score Matching Methods

As a stringent test of discriminant validity, we used propensity score matching[2] to verify whether associations between a child's positive attributes and school outcomes are independent of intelligence, psychopathology, and other potential confounders. The analyses were conducted in R, using the PSM[3] and MatchIt[4] packages from R-project.

Before the propensity score matching (PSM) procedure, a latent class analysis (LCA) was performed to create empirically-derived groups with different levels of positive attributes (YSI score). This analysis was conducted in MPLUS 7.1 (Muthén & Muthén, Los Angeles, California, USA). A solution with two classes (FP=97, Loglikelihood=-44513.83, AIC=89221.66, IC=89787.02, ssaBIC=89478.82) showed a high entropy =0.925 and divided the sample into high positive attribute (63.2%) and low positive attribute (36.8%) classes (Figure S2). A solution with three classes showed an intermediate group with moderate level of positive attributes, while one with four classes showed

overlapping classes with no discrimination. A two-class solution was selected to maximize sample size and because of the higher entropy level.

We used the nearest neighbour method for the PSM analysis, with a caliper of 0.25, i.e., the largest allowable difference in propensity score for matched participants was 25%. Before and after matching, we used a measure of standardized bias to assess the balance of the covariates. Standardized differences of means <0.20 are acceptable and differences <0.10 are considered negligible.

The PSM procedure selected a total of 671 children with low positive attributes who were matched 1:1 with children with high positive attributes, as described in Methods. By this method, we were able to successfully reduce the magnitude of differences (standardized bias) between children with high and low positive attributes. The mean standardized bias for all covariates is shown in Figure S3.

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Supplementary Figure S1

Figure S1

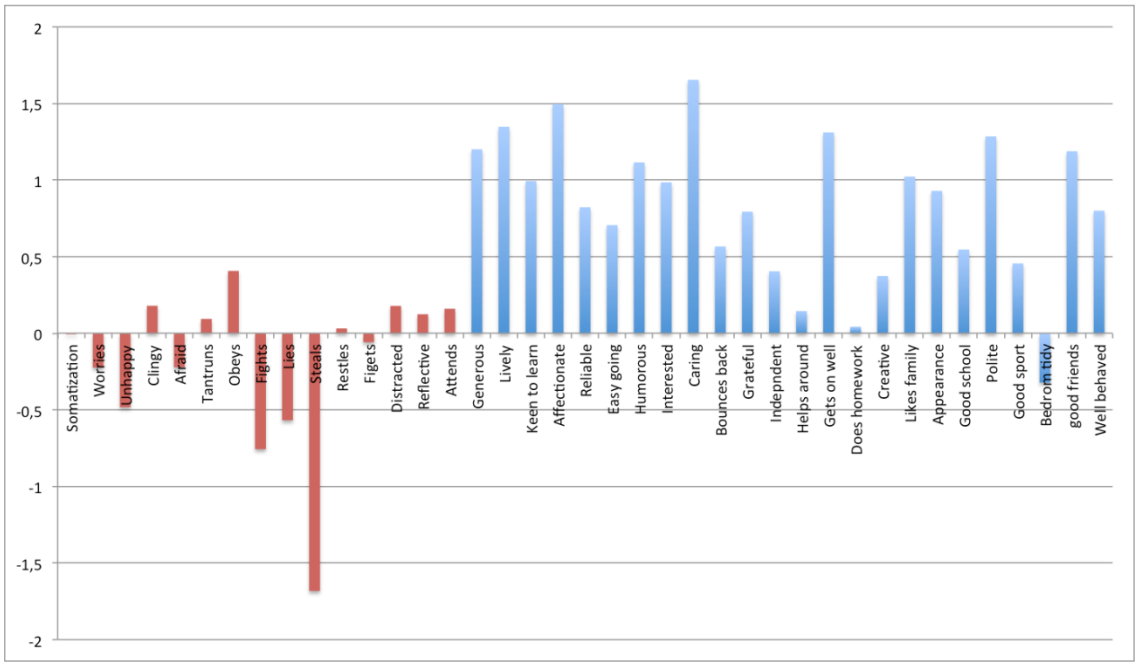

Figure S1: Standardized average thresholds of each item of the Strengths and Difficulties items (SDQc in red) and Youth Strengths Inventory items (YSI in blue).

Supplementary Figure S2

Figure S2

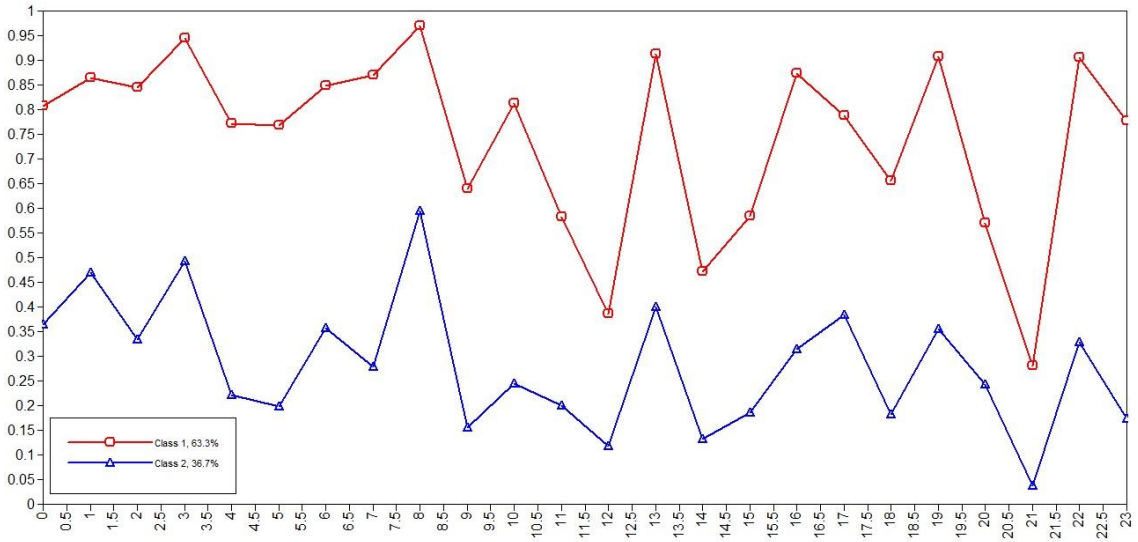

Figure S2: In red, Higher YSI score class, in blue, Lower YSI score class. Graph represents the chance of endorsement (Y axis) of each item of the YSI (X axis).

Supplementary Figure S3

Figure S3

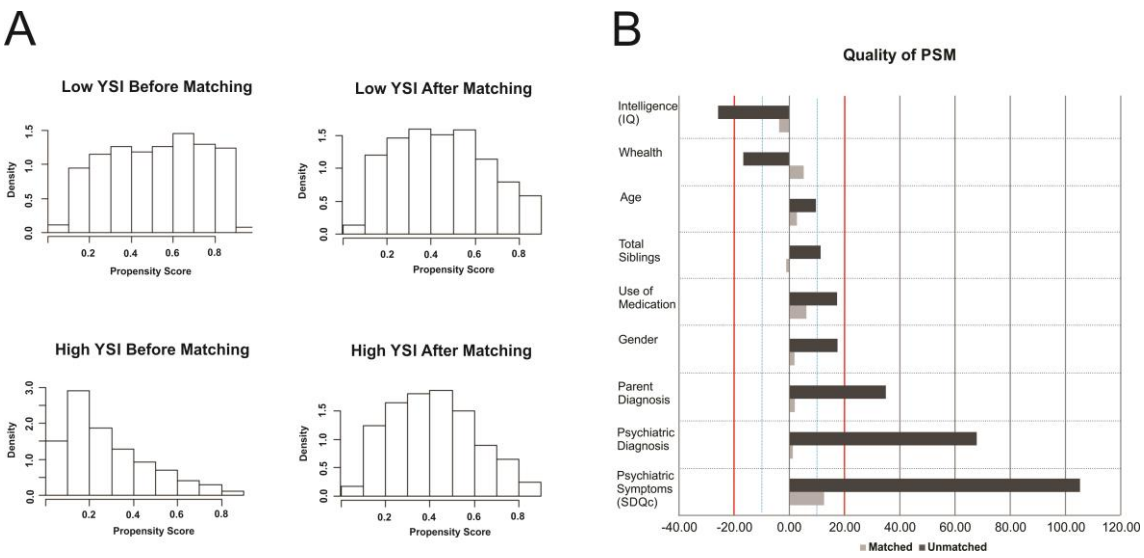

Figure S3: (A) Histograms of propensity score matching (PSM) of High YSI and Low YSI before and after matching and (B) standardized bias (%) of covariates before and after matching. Blue line represents 10% standardized bias limit; below the blue line was considered negligible. Red line represents 20% limit of standardized bias; below the red line was considered acceptable.

Supplementary Table S1

Table S1. Confirmatory Factor Analysis of Youth Strengths Inventory

	Factor Loadings	SE	Thresholds	
			B1	B2
Generous	0.598	0.019	-2.031	-0.371
Lively	0.620	0.019	-2.117	-0.579
Keen to learn	0.677	0.016	-1.581	-0.406
Affectionate	0.753	0.016	-2.222	-0.770
Reliable and responsible	0.740	0.013	-1.469	-0.176
Easy going	0.746	0.012	-1.264	-0.148
Good fun, good sense of humour	0.698	0.015	-1.796	-0.434
Interested in many things	0.759	0.013	-1.577	-0.393
Caring, kind-hearted	0.777	0.018	-2.343	-0.965
Bounces back quickly after setbacks	0.654	0.015	-1.229	0.096
Grateful, appreciative of what he gets	0.761	0.012	-1.324	-0.263
Independent	0.535	0.017	-0.954	0.145
Helps around the home	0.438	0.020	-0.852	0.563
Gets on well with the rest of the family	0.762	0.015	-2.024	-0.597
Does homework without needing to be reminded	0.514	0.018	-0.478	0.393
Creative activities: art, acting, music, making things	0.571	0.017	-0.903	0.156
Likes to be involved in family activities	0.740	0.014	-1.609	-0.436
Takes care of his appearance	0.577	0.019	-1.502	-0.357
Good at school work	0.618	0.016	-1.139	0.046
Polite	0.779	0.014	-2.031	-0.539
Good at sport	0.458	0.02	-1.036	0.125
Keep his bedroom tidy	0.53	0.018	-0.23	0.874
Good with friends	0.773	0.013	-1.871	-0.505
Well behaved	0.763	0.012	-1.46	-0.140

Note: Errors of the following item were correlated in the model: *Good at School* with *Keen to Learn* (r=0.278), *Does homework without need to be reminded* (r=0.399) and *Creative activities* (r=0.212). *Good fun/humour* with *Lively* (r=0.353). *Interested in many things* with *Keen to learn* (r=0.251). *Caring/Kind-hearted* with *Affectionate* (r=0.215) and *Generous* (r=0.204). *Keep his/her bedroom tidy* with *Helps around*(r=0.272) and *Does homework without need to be reminded* (r=0.208). *Well behaved* with *Polite* (r=0.178). *Affectionate* with *Generous* (r=0.223). *Creative activities* with *Does homework without need to be reminded* (r=0.249).

Supplementary Table S2

Table S2. Confirmatory Factor Analysis of Performance in Academic Subjects from Child Behaviour Checklist

	Factor Loadings	SE	Thresholds		
			B1	B2	B3
Portuguese/Literature	0.876	0.006	-1.421	-0.779	0.898
History/Social Studies	0.904	0.005	-1.563	-0.978	0.999
Mathematics	0.690	0.012	-1.484	-0.732	0.721
Science	0.887	0.005	-1.610	-1.023	0.978
Geography	0.928	0.004	-1.591	-1.034	1.034
English/Spanish	0.735	0.015	-1.484	-0.940	0.957
Computer course	0.662	0.024	-1.844	-1.429	0.696
Biology	0.888	0.015	-1.259	-0.891	1.091

Note: Errors of the following item were correlated in the model: *English/Spanish with Biology* (0.198), *Computer course with Biology* (0.170), *English/Spanish with Computer course* (0.202).

5. ARTIGO #2

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TEMPERAMENT AND MENTAL DISORDERS IN EARLY ADOLESCENTS

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Abbreviated title: Temperament and mental disorders in adolescents.

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Number of Figures: 1

Number of Tables: 2

Conflict of interest statement: MSH, PMP, GGM, JJM, ECM and GAS declare that they have no competing or potential conflicts of interest in relation to this work. RAB has received research grants from Janssen Cilag, Novartis, Roche in the last five years and the governmental funding research agencies: CAPES, CNPq and FAPESP; has been a forum consultant for Janssen, Novartis and Roche; and has participated in speaker bureaus for Ache, Janssen, Lundbeck and Novartis. LAR was on speakers' bureau and/or acted as consultant for Eli-Lilly, Janssen-Cilag, Medice, Novartis and Shire in the past three years, receives authorship royalties from Oxford Press and ArtMed, and has

received travel award from Shire and Novartis to attend the 2015 WFADHD and 2016 AACAP meetings, respectively. The ADHD Outpatient Programs chaired by him received unrestricted educational and research support from the following pharmaceutical companies in the past three years: Eli-Lilly, Janssen-Cilag, Novartis, and Shire.

Abstract

Background: Here, we aim to evaluate how adolescent temperament is associated with mental disorders. **Methods**: Temperament was evaluated a community sample of 1,540 adolescents (9-14 years of age), by the revised self-report Early Adolescence Temperament Questionnaire (EATQ-R). Confirmatory factor analyses were used to investigate the best empirical model of EAQT-R. Mental disorders were assessed by parental interview using the Development and Well-Being Behaviour Assessment (DAWBA). Participants were grouped into Typically Developing Comparisons (TDC; n=1,162), Phobic (n=66), Distress (n=64), Attention-Deficit/Hyperactivity Disorder (ADHD; n=92) and Disruptive Behaviour Disorders (DBD, n=39). **Results**: A bifactor model of EATQ-R with one general factor (representing negative self-evaluation) and five specific factors (effortful control, surgency, fear, frustration and shyness) presented the best fit to the data. The Distress group presented higher levels of negative self-evaluation and lower effortful control than TDC. ADHD had both lower effortful control and shyness. DBD had lower effortful control and higher surgency. Except from differences in effortful control, differences in levels of fear, shyness and surgency were driven by sex-imbalance between groups.

Conclusions: Negative self-evaluation impact adolescents' temperament assessment, specifically when investigating between-group differences related to distress disorders. Low levels of effortful control are linked transdiagnostically to several mental disorders.

Key words: EATQ-R, DAWBA, non-overlapping diagnosis, self-evaluation.

INTRODUCTION

Temperament is defined as individual constitutional differences of behaviour, feelings and self-regulation (Rothbart, 2007) and is known to influence development and mental health (Pine & Fox, 2015). Adolescence a transformative period across lifespan where several mental disorders firstly emerge (Kim-Cohen J et al., 2003; Paus, Keshavan, & Giedd, 2008). Therefore, understanding how individual differences in temperament during this sensitive period relate to mental disorders might help developing ways of preventing and treating those conditions early in life.

One of the most accepted ways of conceptualizing temperament across the lifespan is described by Mary Rothbart (Rothbart, 2007). According to her model, temperament is structured in three broad traits: effortful control (i.e., activation of responses, attentional focus or shifting and inhibitory control), negative affectivity (i.e., tendency to experience negative emotions such as fear and frustration) and extraversion/surgency (i.e., tendency to seek high positive emotions, low level of shyness and high impulsivity) (Nigg, 2016; Rothbart, 2007). Furthermore, she also categorized lower-order dimensions, such as attention and inhibition control, activity, fear, frustration, shyness and surgency (Rothbart, 2007).

Previous studies investigated the associations between early temperament (using Rothbart´s model) and future mental health (Blair & Razza, 2007; Caspi, Moffitt, Newman, & Silva, 1996; Martel, Gremillion, Roberts, Zastrow, & Tackett, 2014; Pine & Fox, 2015; Rabinovitz, O'Neill, Rajendran, & Halperin, 2016). However, research in adolescents is scarce, despite the high incidence of mental disorders during this period (Castellanos-Ryan et al., 2016; Paus et al., 2008). The available investigations, using dimensional measures of psychopathology, showed that low effortful control and high negative affectivity were associated with higher levels of general psychopathology and internalizing symptoms (Gulley, Hankin, & Young, 2016; Hankin et al., 2017; Snyder et al., 2015). On the other hand, at the diagnostic level, frustration and effortful control broadly predicted any mental disorder, while fear specifically predicted the internalizing disorders group (Laceulle, Ormel, Vollebergh, van Aken, & Nederhof, 2014).

The previous literature is limited in two important ways. *First*, the best unbiased way to measure temperament in adolescents is still open for debate. Specifically, adolescent changes in emotionality

and behaviour might influence the way that they evaluate and endorse items in temperament questionnaires (Anusic, Schimmack, Pinkus, & Lockwood, 2009; Davies, Connelly, Ones, & Birkland, 2015; Dunkel, van der Linden, Brown, & Mathes, 2016). Bifactor models have been used in personality research in order to address the potential biases from self-evaluation (Anusic et al., 2009; Davies et al., 2015). In these models, all items from a questionnaire load into a general factor and specific factors are modelled as residual variance from each indicator. Separating biases in negative self-evaluation from other factors might be a useful way to assess the relationship between self-evaluation, temperament and psychopathology. *Second*, mental disorders are often comorbid during adolescence. Therefore, it is often difficult to disentangle which mental disorder is linked to a particular temperament, especially in clinical samples. Moreover, clinical groups are frequently on medication and are highly affected by patterns of help seeking behaviour and health care access, and have significant levels of overall impairment. Conversely, few community studies have both diagnostic and temperament assessments to investigate differences in levels of temperament among classical diagnostic groups. Hence, a community sample has the advantage to detect subjects over the diagnostic threshold that might not yet be under health care. Besides, splitting the sample in non-overlapping diagnostic groups can be helpful in understanding specific clinical aspects that can be confounded by patterns of comorbidity.

Here we used baseline data from 1,540 young adolescents (9 to 14 years of age) from a large community sample from Brazil (Salum et al., 2015). *First*, we evaluate if a correlated five-factor or a bifactor model best describe the factor structure of the Early Adolescent Temperament Questionnaire – Revised (EATQ-R). *Second*, we evaluate the associations between temperament dimensions with broad non-overlapping mental diagnosis (Phobias, Distress, Attention-Deficit/Hyperactive and Disruptive Behaviour disorder groups) with a group of typically developing comparison adolescents. We hypothesize that a bifactor model will best explain temperament's structure with the general factor being a broad way in which an adolescent evaluate him/herself. Based on previous research (Davies et al., 2015; Orth, Robins, & Widaman, 2012), we also hypothesize that the general factor of the temperament model (i.e., self-evaluation) will be associated with Distress disorders and effortful control will be negatively associated with all diagnostic groups.

METHODS

Participants

Subjects from a large community sample from the Brazilian High Risk Cohort for Psychiatric Disorders participated in this study (Salum et al., 2015). The study was submitted and approved by the Ethical Committee of the University of São Paulo. Written informed consent was obtained from parents of all participants and verbal assent was obtained from the research subjects. Details about the cohort can be found elsewhere (Salum et al., 2015). Briefly, the screening phase of the study included children from public schools in São Paulo and Porto Alegre. The total sample includes children from 6 to 14 years of age (N=2,511). A subsample of youth from 9 to 14 years old participants that completed the temperament assessment (n=1,540) was included in this study. This age range was selected due to suit the validation of the instrument (Ellis & Rothbart, 2001). Except for being older, this subsample was identical from the total sample in sex ($\chi^2_{1,2296}$=0.806; *p*=0.369), socioeconomic status (t_{2294}=-0.810; *p*=0.418), intelligence (t_{2214}=0.204; *p*=0.771) and frequency of broad diagnostic groups measured by Development and Well-Being Assessment (DAWBA) ($\chi^2_{4,2127}$=4.924; *p*=0.295).

Psychiatric evaluation

Mental disorders were assessed using the Brazilian Portuguese version (Fleitlich-Bilyk & Goodman, 2004) of the Development and Well-Being Assessment (Goodman, Ford, Richards, Gatward, & Meltzer, 2000). This structured interview was administered to biological parents by trained lay interviewers and scored by trained psychiatrists who were supervised by a senior child psychiatrist (Salum et al., 2015). Diagnoses are related to diagnostic criteria from the Diagnostic and Statistical Manual of Mental Disorders, 4th edition.

For the purposes of this study we allocated each adolescent to one of five non-overlapping groups: 1) Typically Developing Comparisons (TDC; n = 1,162): subjects without any psychiatric disorder; 2) Phobic disorders (Phobic): subjects with separation anxiety disorder, social anxiety disorder, specific phobia, or agoraphobia (n = 66); 3) Distress disorders (Distress): subjects with

generalized anxiety disorder, depression (major or not otherwise specified), bipolar, obsessive-compulsive, tic, eating or posttraumatic stress disorder (n=64); 4) Attention-Deficit/Hyperactive disorder (ADHD): subjects with any ADHD subtype (n=92); or 5) Disruptive Behaviour Disorders (DBD): oppositional defiant disorder or conduct disorder (n=39). All subjects with other diagnosis (n=12) and subjects with comorbid disorders (belonging to more than one of abovementioned diagnostic group, n=105) were excluded from the main analyses. Comorbid group was used in a supplementary analysis.

These diagnostic groups were chosen on the basis of previous evidence on symptom structure (Blanco et al., 2015; Lahey, Van Hulle, Singh, Waldman, & Rathouz, 2011; Martel et al., 2017; Giovanni A. Salum et al., 2016; Watson, O'Hara, & Stuart, 2008). Most studies combine ADHD with DBD in externalizing disorders groups. Since temperament studies in ADHD have extensively reported effortful control deficits (Blair & Razza, 2007; Karalunas et al., 2014; Martel et al., 2014), we separated these diagnostic groups in order to evaluate specificity in between-group differences.

Temperament

Adolescent's temperament was assessed with the Brazilian-Portuguese self-report version of the EATQ-R (Ellis & Rothbart, 2001; Salum et al., 2015). This questionnaire is a 65-items Likert scale, ranging from 1 (always false) to 5 (always true), containing 12 subscales (4-7 items each). Five temperament factors were used, namely effortful control, fear, frustration, shyness and surgency (Laceulle et al., 2014; Rothbart, 2007).

To balance factors by the same sufficient number of items, four items per factor were selected, given shyness factor has only four items. Items were selecting by removing those with lower factor loadings in model testing. Effortful control is composed by three highly correlated dimensions of EATQ-R (activation, attention and inhibition) (Hankin et al., 2017; Laceulle et al., 2014; Snyder et al., 2015). To make a clinical interpretable analysis, we grouped four items of each of these dimensions, leaving effortful control with 12 items. We tested a correlated five dimensions and a bifactor model which allows specific factor fear to correlate with frustration, shyness and surgency, and shyness to

correlate with surgency, as suggested by previous literature (Ellis, 2002; Snyder et al., 2015). The empirically-derived factor model was used in the final analysis.

Socioeconomic status

Socioeconomic status (SES) was accessed with a standardized instrument validated in Brazil (ABEP, 2010). It is a composite score which includes the main caregiver's schooling and the number of items at home (colour TV, radio, VCR/DVD, refrigerator, freezer, washing machine, employed maid, bathroom and automobile).

Intelligence measurement

For intelligence, we estimated IQ using the vocabulary and block design subtests of the Weschler Intelligence Scale for Children, 3rd edition – WISC-III (Wechsler, 2002), using the Tellegen and Briggs method (Tellegen & Briggs, 1967) and Brazilian norms (Figueiredo, 2001; Nascimento & Figueiredo, 2002).

Statistical analysis

Confirmatory factor analysis (CFA) was performed in order to evaluate the best model that could better describe adolescent's temperament using EATQ-R. We used delta parameterization and weighted least square with diagonal weight matrix with standard errors and mean- and variance-adjusted chi-square test statistics (WLSMV) estimators. Model fit parameters were Chi Square Test of model fit, root mean square error of approximation (RMSEA), Comparative Fit Index (CFI) and Tucker Lewis Index (TLI). Values of RMSEA near or below 0.080 represent acceptable model fit, and values lower than 0.060 represent good-to-excellent model fit (Hu & Bentler, 1999). CFI and TLI values near or above 0.900 represent acceptable model fit, while values higher than 0.950 represent a good-to-excellent model fit. Factor scores for each factor were saved from the best model. All CFA were

performed using MPlus 7.4 software (Muthén & Muthén, Los Angeles, California, USA). Reliability coefficient for bifactor model was also calculated, as described in online supporting information.

After selecting the best factor model and extracting factor scores for each subject, we tested whereas diagnostic groups had differences in age, SES and IQ, using Analysis of Variance (ANOVA), and also had sex differences, using Chi-square statistic. ANOVA was used to test if temperament factor scores differentiate amongst non-overlapping groups of psychopathology. If diagnostic groups have differences in covariates, adjusted model for specific covariate was run using Analysis of Covariance (ANCOVA). Subjects with overlapping (n=105) or other (n=12) diagnosis were excluded from this analysis. Sidak post-hoc was applied to ANOVA and ANCOVA. All significance levels were set to be $p<0.05$.

Supplementary analysis was also run. Correlation between EATQ-R factors and age, SES and IQ was analysed with Pearson correlation test. Sex differences between EATQ-R factors was analysed with t-test. Differences between groups with subjects belonging within one or more than one psychiatric diagnostic group were tested. These analyses are described in online supporting information. Correlation, Chi-square, t-test, ANOVA and ANCOVA were run in SPSS® v.23.0.

RESULTS

EATQ-R factor structure

The correlated five factors model provided an unacceptable model fit (RMSEA 0.093 (90% CI 0.091 - 0.095), CFI 0.658, TLI 0.620 and Chi-Square Test of model fit 4866.351 ($p<0.001$)). However, the bifactor model presented good model fit indexes (RMSEA 0.050 (90% CI 0.047 - 0.052), CFI 0.909, TLI 0.891 and Chi-Square Test of model fit 1526.050 ($p<0.001$)). Frustration and fear (r=-0192, $p<0.001$), shyness and fear (r=0.628, $p<0.001$), surgency and fear (r=-0.783, $p<0.001$) and surgency and shyness (r=-0.596, $p<0.001$) were allowed to correlate.

The general factor loaded higher on inversed items of positive-oriented constructs (effortful control and surgency) and on items from negative-oriented constructs (fear, frustration and shyness)

suggesting a (negative) self-evaluation factor, since the broad factor significantly correlated with the negative valence self-perception items (Table 1). Reliability indices for bifactor model can be found in supporting information (Table S1).

[TABLE 1 HERE]

Associations of Temperament and Psychopathology

Mean levels of temperament dimensions differ among broad non-overlapping diagnostic groups for negative self-evaluation ($F_{4,1418}$=2.747; p=0.027), effortful control ($F_{4,1418}$=10.736; p<0.001), fear ($F_{4,1418}$=3.769; p=0.005), shyness ($F_{4,1418}$=4.173; p=0.002) and surgency ($F_{4,1418}$=3.562; p=0.007). Frustration did not have significant mean factor score differences on diagnostic groups. Post-hoc analysis indicates that the Distress group had higher levels of negative self-evaluation and lower effortful control as compared with TDC. ADHD had lower effortful control and shyness when compared with TDC and Phobic groups. Moreover, DBD had lower effortful control and higher surgency compared with TDC and Phobic groups, as well as less fear compared with Phobic and Distress groups (Table 2 and Figure 1).

[FIGURE 1 HERE]

Broad diagnostic groups did not differ on age ($F_{4,1418}$=1.590; p=0.174), intelligence ($F_{4,1417}$=1.750; p=0.137) and SES ($F_{4,1418}$=2.056; p=0.084), but as expected, female sex had higher frequency of Distress (6.1% vs. 3.0%; $\chi^2_{4,1423}$=15.836; p=0.003) and males had higher frequency of DBD (3.6% vs. 1.8%; $\chi^2_{4,1423}$=15.836; p=0.003).

Due to this sex imbalance in diagnostic groups, we also conducted ANCOVA adjusting for between group differences in sex (Table 2). Adjusted mean levels of temperament dimensions differ among broad non-overlapping diagnostic groups for effortful control ($F_{4,1418}$=10.521; p<0.001), fear ($F_{4,1418}$=2.584; p=0.036), shyness ($F_{4,1418}$=3.316; p=0.010) and surgency ($F_{4,1418}$=2.585; p=0.036), but not negative self-evaluation ($F_{4,1418}$=2.106, p=0.078) and frustration ($F_{4,1418}$=1.146, p=0.333). Post-hoc analysis revealed that adjusted negative self-evaluation was still higher for Distress group. Adjusted effortful control was still lower in Distress, ADHD and DBD groups. Between group differences in levels of fear, shyness and surgency were not significant in comparison with TDC.

[TABLE 2 HERE]

DISCUSSION

In the present study we tested temperament models and investigate its dimensions among non-overlapping psychiatric diagnostic groups in young adolescents. Consistent with our first hypothesis, we found that a bifactor model better fit the data from self-reported EATQ-R, in which the general factor indicate a particular psychometric feature, which represents negative self-evaluation. The remaining specific factors were specifically associated with broad non-overlapping diagnostic groups, partially confirming our second hypothesis. Compared with TDC, Distress disorders were characterized by high negative-self-evaluation and low effortful control. ADHD had lower effortful control and lower shyness. DBD had lower effortful control and higher surgency. In addition, Phobic disorders were characterized by differences in effortful control, fear, shyness and surgency compared with ADHD and DBD groups, but not with TDC. Except from differences in effortful control, differences in levels of fear, shyness and surgency were driven by sex-imbalance between groups.

We found that a bifactor model better explain EATQ-R factor structure, with a general factor that influences how self-reported items are endorsed. In adults, studies showed that personality inventories can generate a general factor which represents positively-oriented self-evaluation (Anusic et al., 2009; Davies et al., 2015). We have found a general factor with positive loads in negatively constructed items (symptoms and difficulties) and negative loads in positive items (assets and attributes). This can be a negative self-evaluation factor, which is similar to adult personality research (Anusic et al., 2009; Davies et al., 2015; Dunkel et al., 2016). Our finding support previous studies showing that self-esteem tends to reach its lower levels in adolescence (Orth et al., 2012; Robins & Trzesniewski, 2005). It is possible that, by applying bifactor models to adolescent self-reports, we might be able to capture a factor that is not related to temperament itself (Davies et al., 2015; Şimşek, 2012).

Added to this, the general factor from our empirically-derived model was associated exclusively with the Distress disorders group, which includes depression and generalized anxiety disorders. This is important because it is well-known that those disorders are associated with negative self-evaluation and self-esteem (Sowislo & Orth, 2013). One possibility is that attention bias (Salum et

al., 2013) and interpretative bias (Cristea, Kok, & Cuijpers, 2015; Hallion & Ruscio, 2011) influence the way temperament questionnaires are answered in subjects with Distress disorders, which could be captured by our bifactor approach. Youth might be focusing only in the negative aspects of their temperament or they interpret their overall personal characteristics as negative. As our analysis showed, this is due to the high prevalence of girls in the Distress group. This is particularly relevant given sex was also implicated as related to other cognitive biases related to internalizing disorders (Montagner et al., 2016).

Effortful control was associated with a broad range of diagnostic groups, independently of sex-imbalance, which reinforce the pervasive importance of regulation ability in broad psychopathology (Beauchaine & Thayer, 2015; Laceulle, Ormel, Vollebergh, van Aken, & Nederhof, 2014; Nigg, 2016; Snyder et al., 2015). Deficient effortful control was also prominent in comorbid groups (see online supporting information), which is in accordance to the view that high rates of comorbidity might be related to shared factors such as the ones conceptualized by temperament research (Lahey et al., 2011; Martel et al., 2014). Phobic group was the only group that was not impaired in effortful control. This is consistent with other studies that demonstrated that phobic patients were not impaired in executive attention using cognitive tasks (Mogg et al., 2015).

Previous studies have successfully predicted ADHD from early temperament, specially assessing effortful control deficits, but also have pointed to affective temperament alterations (Einziger et al., 2017; Karalunas et al., 2014; Martel et al., 2014; Pine & Fox, 2015; Rabinovitz et al., 2016; Snyder et al., 2015). Our present findings suggest that aside effortful control, ADHD is also characterized by low shyness in young adolescents. DBD however are frequently grouped in externalizing disorders groups (Castellanos-Ryan et al., 2016; Laceulle et al., 2014; Snyder, Young, & Hankin, 2017). In the present study, since we separate ADHD from DBD, some differences among those disorders could be found and DBD showed higher surgency and lower fear aside lower effortful control, which leads to a clearer definition of externalizing behaviour (Castellanos-Ryan et al., 2016; Krueger, McGue, & Iacono, 2001). The possibility of using non-overlapping groups in a community sample presents an opportunity to disentangle constitutional differences of behaviour and feelings between ADHD and DBD, which are very comorbid in clinical samples. However, these differences were driven by sex-imbalance, which naturally occur in these groups. Therefore, we kept our non-

adjusted analysis as primary to show that for typical samples those differences in temperament will be evident, thought driven by sex imbalance.

This study must be understood within its limitations. *First*, due to its cross-sectional design, the degree that self-reported temperament assessment captures psychopathological phenomena cannot be estimated. We minimized possible information bias by having different sources for temperament and diagnosis. *Second*, differences within diagnostic groups might be found in larger samples. However, we used four diagnostic categories which have high correlation in previous studies (Blanco et al., 2015; Lahey et al., 2011; Martel et al., 2017; Salum et al., 2016; Watson et al., 2008) and expanded previous analysis on young adolescents (Laceulle, Ormel, Vollebergh, van Aken, & Nederhof, 2014). *Third*, excluding comorbid disorders can also represent the exclusion of subjects more severely compromised by mental disorders. However, subjects within each broad diagnostic group were allowed to have more than one diagnosis within the broad group but not overlapping with other diagnostic group. Supplementary analysis was also performed to evaluate those subjects with diagnosis in more than one group to complementary evaluate temperaments association in more severely ill subjects.

CONCLUSION

This study represents another step to understand the relationship between adolescent temperament and mental disorders. We have showed for the first time, temperament's association with distinct and clinically relevant groups of mental disorders, including disentanglement of ADHD and DBD groups. We have also showed that the use of bifactor models might shed light on the role of self-evaluation when answering temperament questionnaires. The empirically-derived negative self-evaluation factor have higher mean levels on Distress disorders, which is in accordance with previous evidence of attention and interpretation biases in depression and anxiety. Effortful control was low in every group except in phobias. ADHD is also exclusively characterized by low shyness and DBD by high surgency. Future prospective studies in adolescence might shed light on the trajectory from temperament to mental illness.

Supporting information

Additional Supporting Information may be found in the online version of this article:

Table S1 - Reliability indices for bifactor model indices from EATQ-R in young adolescents.

Table S2 - Temperament correlation on age, SES, IQ and gender mean difference.

Table S3 - Temperament mean according to each non-overlapping psychiatric diagnostic groups.

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Key points

- Bifactor models might be a useful method to assess temperament dimensions in a way it is uncontaminated from overall negative self-evaluation bias.
- Most adolescents with mental disorders have low effortful control, except those with phobic disorders
- ADHD had lower levels of shyness as DBD has higher levels of surgency, when compared with typical development adolescents.
- Temperament differences found in ADHD and DBD groups might be the phenotypical expression of sex-imbalance of these diagnostic groups.

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Table 1 – Bifactor model indices from EATQ-R in young adolescents (n=1,540)

	General Factor	Effortful Control	Fear	Frustration	Shyness	Surgency
Hard time finishing things - R	-0.373	0.393				
I get started tasks right away	0.213	0.573				
Finish my homework before due	0.116	0.490				
Start working on projects just before due - R	-0.267	0.555				
It is easy for me concentrate	0.076	0.458				
I find it hard to shift focus - R	-0.453	0.213				
Pay close attention when someone talk	0.161	0.557				
I tend to get distracted - R	-0.416	0.434				
It is easy for me to stop doing something	0.026	0.349				
It is hard for me to stop doing something - R	-0.427	0.376				
It's easy for me to keep a secret	0.075	0.386				
I can stick with my plans and goals	0.215	0.417				
I get frightened riding in speed	0.362		0.513			
I worry about getting into trouble	0.374		0.231			
I am nervous with bullies	0.427		0.504			
I feel scared in dark rooms	0.445		0.346			
It bothers me busy phone calls	0.489			0.089		
Upsets me if parents won't let me do stuff	0.450			0.513		
Irritates me when I stop doing something	0.485			0.483		
Frustrates me if people interrupt me	0.499			0.231		
I feel shy with kids of the opposite sex	0.460				0.419	
I feel shy about meeting new people	0.436				0.523	
I am shy	0.329				0.549	
I am not shy – R	0.098				0.456	
Running fast scares me - R	-0.165					0.546
I would not be afraid to try a risky sport	0.134					0.266
I wouldn't be afraid to try climbing	0.167					0.399
I enjoy going crowded places	0.275					0.275

Note: Bifactor Model in which fear correlates with frustration, shyness and surgency, and shyness correlate with surgency; EATQ-R, Early Adolescent Temperament Questionnaire; R, reversed item scoring; RMSEA, Root Mean Square Error of Approximation; CFI, Comparative Fit Index; TLI, Tucker Lewis Index; Model χ^2, Chi Square Test of Model Fit.

Table 2 - Temperament mean according to each non-overlapping psychiatric diagnostic groups

	TDC		Only Phobic		Only Distress		Only ADHD		Only DBD	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
ANOVA model										
Negative self-evaluation	-0.031	0.831	0.037	0.816	0.315[a]	0.889	-0.067	0.922	-0.064	0.929
Effortful control	0.095	0.847	0.079	0.771	-0.230[a]	0.673	-0.338[a;b]	0.767	-0.414[a;b]	0.730
Fear	0.008	0.741	0.175	0.735	0.162	0.694	-0.132	0.777	-0.278[b;c]	0.863
Frustration	0.001	0.619	-0.162	0.619	-0.006	0.578	0.011	0.650	-0.049	0.668
Shyness	0.014	0.772	0.202	0.770	0.097	0.739	-0.222[a;b]	0.764	-0.224	0.868
Surgency	-0.009	0.725	-0.173	0.766	-0.066	0.741	0.109	0.756	0.328[a;b]	0.795
ANCOVA model adjusted by sex										
Negative self-evaluation	-0.031	0.831	0.029	0.816	0.275[a]	0.889	-0.047	0.922	-0.250	0.929
Effortful control	0.095	0.847	0.075	0.771	-0.250[a]	0.673	-0.328[a;b]	0.767	-0.395[a;b]	0.730
Fear	0.008	0.741	0.164	0.735	0.108	0.694	-0.105	0.777	-0.225	0.863
Frustration	0.000	0.619	-0.163	0.619	-0.012	0.578	0.014	0.650	-0.043	0.668
Shyness	0.014	0.772	0.193	0.770	0.053	0.739	-0.200[b]	0.764	-0.180	0.868
Surgency	-0.009	0.725	-0.161	0.766	-0.010	0.741	0.081	0.756	0.272[b]	0.795

Note: TDC, Typically developing comparisons; Phobic, Phobic disorders group (separation anxiety disorder, social anxiety disorder, specific phobia, or agoraphobia, n=66); Distress, Distress disorders group (generalized anxiety disorder, depression (major or not otherwise specified), bipolar, obsessive-compulsive, tic, eating or posttraumatic stress disorder, n=64); ADHD, Attention-Deficit/Hyperactive disorder group (any ADHD subtype, n=92); DBD, Oppositional defiant disorder or Conduct disorder group (n=39). All subjects with co-morbid or other conditions were excluded from the diagnostic analyses (n=117); SD, Standard Deviation.

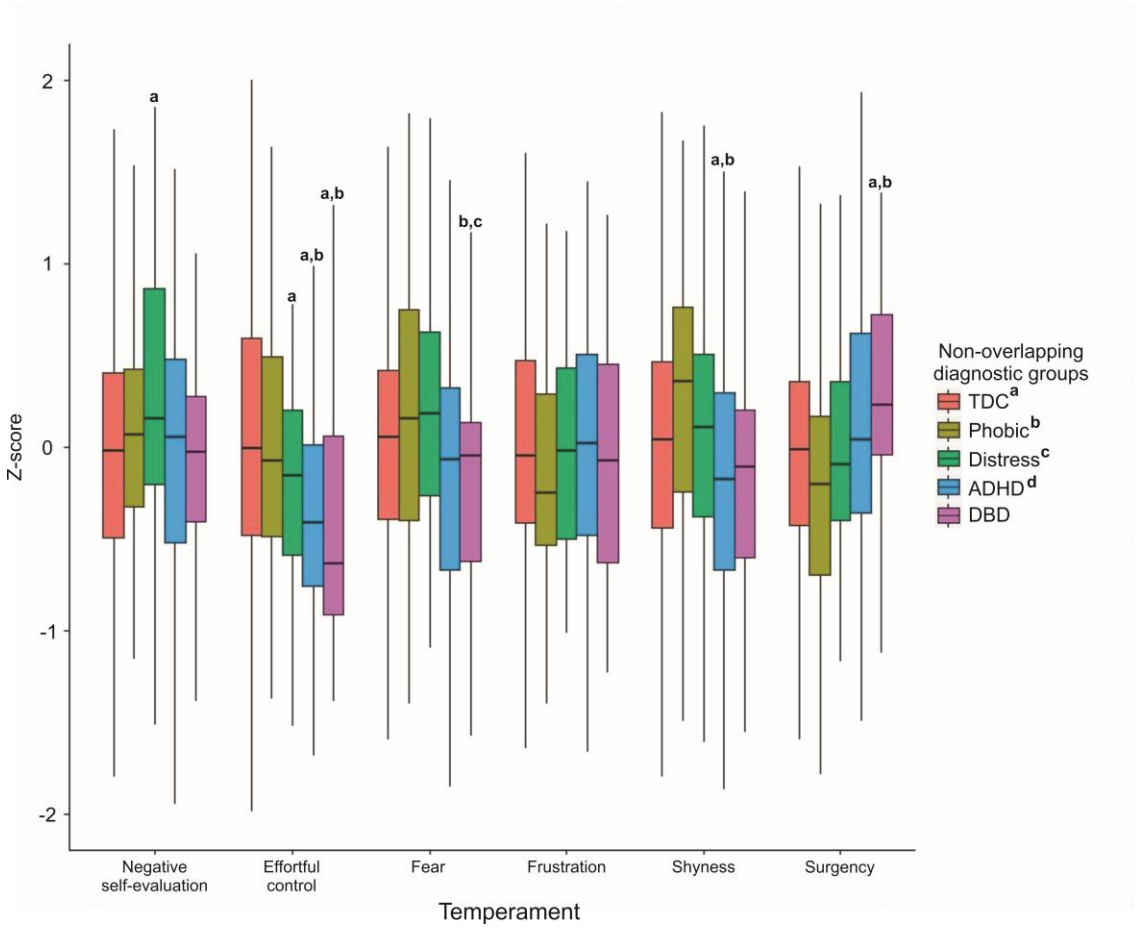
- a, p_{Sidak}<0.05 comparing with TDC;

- b, p_{Sidak}<0.05 comparing with Phobic;

- c, p_{Sidak}<0.05 comparing with Distress;

- d, p_{Sidak}<0.05 comparing with ADHD.

Figure 1 – Temperament levels by non-overlapping diagnostic groups in young adolescents



Note: TDC, Typically developing comparisons; Phobic, Phobic disorders group (separation anxiety disorder, social anxiety disorder, specific phobia, or agoraphobia, n=66); Distress, Distress disorders group (generalized anxiety disorder, depression (major or not otherwise specified), bipolar, obsessive-compulsive, tic, eating or posttraumatic stress disorder, n=64); ADHD, Attention-Deficit/Hyperactive disorder group (any ADHD subtype, n=92); DBD, Oppositional defiant disorder or Conduct disorder group (n=39). All subjects with co-morbid or other conditions were excluded from the diagnostic analyses (n=117).

- a, p_{Sidak}<0.05 comparing with TDC;

- b, p_{Sidak}<0.05 comparing with Phobic;

- c, p_{Sidak}<0.05 comparing with Distress;

- d, p_{Sidak}<0.05 comparing with ADHD.

Supporting Information

Temperament's modelling statistics

As described in the main text, here we used the Early Adolescent Temperament Questionnaire (EATQ-R) (Ellis & Rothbart, 2001; Salum et al., 2015). We tested a correlated five dimensions and a bifactor model which allows specific factor fear to correlate with frustration, shyness and surgency, and shyness to correlate with surgency, as suggested by previous literature (Ellis, 2002; Snyder et al., 2015).

In order to assess the reliability in bifactor models, we considered five indexes. (1) The percent of explained common variance (ECV), an unidimensionality index, defined as the ratio of variance explained by the general factor divided by the variance explained by the general plus the specific factors (Reise, 2012), which is interpreted in conjunction with (2) the percentage of uncontaminated correlations (PUC). (3) Lucke's omega (Lucke, 2005) (ω, a model-based reliability estimate, analogous to alpha coefficient, but appropriate for congeneric tests (varying factor loadings). (4) Hierarchical omega coefficient (Rodriguez, Reise, & Haviland, 2016) (ωH, which judges the degree to which composite scale scores are interpretable as measure of a single common factor; and (5) the omega subscale(Rodriguez et al., 2016) (ωS, reliability estimate for a residualized subscale, an index that controls for that part of the reliability due to the general factor (i.e., indicating the reliability of subscale score remaining once the effects of the general factor are removed). Values of ω, ωH and ωS coefficients vary between 0 and 1, where higher scores indicate greater reliability.

Correlation of temperament with age, SES, IQ and sex differences

Pearson correlation was used to test correlation between EATQ-R dimensions (bifactor model) and age, intelligence (IQ, defined in the main text) and socioeconomic status (SES, defined in the main text). T-test was applied to analyse temperament differences between sex (results expressed as differences between females and males).

Temperament differences in groups with and without overlapping diagnosis

Differences between groups of subjects belonging within one or more than one psychiatric diagnostic group were tested using ANOVA, including Typically Developing Comparisons (TDC; n=1,162), group with subjects belonging to only one broad diagnostic group (n=261) and a group of

subjects with overlapping diagnostic group (n=105). Diagnostic groups are defined in the main text. Post-hoc was run using Sidak test to analyse pairwise comparisons and adjusting p-values.

Results

The bifactor model provided the best empirically-derived fit indices, as described in the main text. Hence, we calculated reliability indices for this model. General factor does not explain common variance strongly, nor did ω and ωS indices assign high reliability level for specific dimensions. Negative phrasing of negative and reversed items of positive constructs had higher loadings from the general factor. All results and reliability indices for this model are in Table S1.

Correlations between negative self-evaluation and temperament dimensions with age, SES and IQ were mild. Sex differences emerged for all dimensions with exception of frustration (Table S2). Our data match with previous meta-analytic evidence in which negative affectivity (i.e., frustration) is no different between sex, and girls have higher effortful control, shyness, fear and lower surgency than boys (Else-Quest, Hyde, Goldsmith, & Van Hulle, 2006).

Results from a supplementary ANOVA conducted to explore the differences in subjects with and without overlapping diagnosis are depicted in Table S3. Subjects belonging to two or more diagnostic group had higher levels of negative self-evaluation ($F_{2,1525}$=4.226; p=0.015) in comparison with TDC (z-score mean difference=0.232; p_{Sidak}=0.022). Both groups, with a single diagnostic group (z-score mean difference=-0.313; p_{Sidak}<0.001) and with two or more diagnostic group (z-score mean difference=-0.508; p_{Sidak}<0.001), had lower effortful control ($F_{2,1525}$=29.263; p<0.001), but differences between single and comorbid diagnosis were not statistically significant.

Table S1 – Reliability indices for bifactor model indices from EATQ-R in young adolescents (n=1,540)

	General Factor	Effortful Control	Fear	Frustration	Shyness	Surgency
Reliability						
ECV(%)	37.9					
PUC(%)	76.2					
ω	0.737	0.695	0.508	0.497	0.523	0.503
ωH	0.237					
ωS		0.420	0.064	0.044	0.092	0.056

Note: Bifactor Model in which fear correlates with frustration, shyness and surgency, and shyness correlate with surgency; EATQ-R, Early Adolescent Temperament Questionnaire; R, reversed item scoring; ECV, Explained Common Variance; PUC, percentage of uncontaminated correlations; ω, Lucke's omega; ωH, hierarchical omega coefficient; ωS, omega subscale.

Table S2 - Temperament correlation on age, SES, IQ and gender mean difference

	Pearson correlation coefficients			Mean difference (T-test)
	Age	SES	IQ	Standardized Difference (female - male)
Negative self-evaluation	-0.006	-0.111***	-0.091***	0.248***
Effortful control	-0.037	0.019	0.113***	0.128**
Fear	-0.136***	-0.067*	-0.084**	0.309****
Frustration	0.097***	0.038	0.012	0.022
Shyness	-0.032	-0.057	-0.101**	0.247***
Surgency	0.121***	0.046	0.096***	-0.318***

Note: Simple correlation was performed for age. SES and IQ. Female and male differences were tested using t-test (none significant). SES, socio-economic status (defined in the main text); IQ, intelligence quotient (defined in the main text). *. p<0.05; **. p<0.01; ***. p<0.001.

Table S3 - Temperament mean according to each non-overlapping psychiatric diagnostic groups

	TDC		One diagnostic group		Two or more diagnostic group	
	Mean	SD	Mean	SD	Mean	SD
Negative Self-evaluation	-0.031	0.831	0.053	0.898	0.202[a]	0.921
Effortful control	0.095	0.847	-0.218[a]	0.758	-0.412[a]	0.859
Fear	0.008	0.741	-0.004	0.777	-0.067	0.786
Frustration	0.001	0.619	-0.046	0.628	0.016	0.632
Shyness	0.014	0.772	-0.037	0.794	-0.074	0.842
Surgency	-0.009	0.725	0.028	0.775	0.066	0.728

Note: TDC, Typically developing comparisons; SD, standard deviation.

a, $p_{Sidak} < 0.05$ comparing with TDC;

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6. ARTIGO #3

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INDEPENDENT AND INTERACTIVE ASSOCIATIONS OF TEMPERAMENT DIMENSIONS WITH EDUCATIONAL OUTCOMES IN YOUNG ADOLESCENTS

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Implications and Contributions: Temperament dimensions were associated with distinct educational aspects. Effortful control has showed to have dominant role in predicting educational outcomes. Additionally, adolescents with low frustration and low effortful control at the same time are associated with poor reading ability, but not if frustration or effortful control is high.

Abbreviations:

- CBCL-school: School items from Child Behavioral Checklist.
- CFA: Confirmatory factor analysis.
- CFI: Comparative Fit Index.
- EATQ-R: Early Adolescence Temperament Questionnaire revised.
- IQ: estimated intelligence quotient.
- RMSEA: Root mean square error of approximation.
- SDQc: Strength and Difficulties Questionnaire composite score including emotional, hyperactivity and conduct symptoms.
- SES: Socioeconomic status.
- TDE: School Performance Test.
- TLI: Tucker Lewis Index.
- WLSMV: Weighted least square with diagonal weight matrix with standard errors and mean- and variance-adjusted chi-square test statistics estimator.

ABSTRACT

Purpose: The aim of this study is to examine the independent and interactive associations among temperament dimensions with educational outcomes in young adolescents.

Methods: Participants were 1,540 adolescents (9-14 years of age) from a community-based study. Temperament was empirically derived from factor analysis, based on adolescents' reports to the Early Adolescence Temperament Questionnaire. Educational outcomes were measured by the cumulative number of negative school events (suspension, repetition and dropout), parent reports on overall academic performance as well as by reading and writing standardized tests. First, we used mixed effects models to test associations of temperament dimensions with education independent from age, sex, socioeconomic status, intelligence, co-occurring psychiatric symptoms. Second, we tested whether associations with educational outcomes are independent from co-occurring temperament dimensions and tested interactions among temperament dimensions.

Results: High effortful control, fear and shyness were independently associated with better educational outcomes; whereas high levels of frustration and surgency were independently associated with worse educational outcomes. When adjusting from co-occurring temperament traits only effortful control predicted educational outcomes. Also, we observed an interaction between effortful control and frustration, such that low frustration and low effortful control were a detrimental combination for reading abilities.

Conclusions: Temperament dimensions were distinctively associated with negative school events, academic performance, reading and writing abilities, above and beyond confounders. Effortful control has showed to have a dominant role in predicting educational outcomes. Our findings about the interaction between effortful control and frustration suggest their associations with reading abilities depend on the levels of each other.

Key words: Temperament; School; Reading; Writing; Intelligence; Socioeconomic status; Sex; Psychiatric symptoms.

Education is an essential part of the human capital to all societies.[1] The ability to read, write and obtain overall scholastic knowledge in adolescents is particularly important given that school dropout and other negative school events are frequent at this developmental stage, which can lead to strong downstream effects in an individual future accomplishments.[2,3] Previous research suggests education can be influenced by individual differences in reactivity and self-regulation of emotion, motivation and attention processes,[4] which can be conceptualized by Rothbart's psychobiological model[5] as dimensions of temperament. This model presented compatible convergence with personality models primarily used in adults.[4,6] Although research has begun to examine links between temperament and educational attainment in adolescents,[7] major questions remain.

First, educational success is determined by several factors, including co-occurring traits such as intelligence,[8] psychiatric symptoms[9] and also influenced by social support and socioeconomic status.[10] Studies aiming to investigate associations between education and temperament need to take individual differences of co-occurring traits when investigating independent effects. One needs to assess whether temperament adds predictive information about educational outcomes above and beyond the levels predicted by the aforementioned covariates.

Second, dimensions of temperament might not only be independently associated with educational outcomes, but can also modify the influence of each other on a given outcome.[7] The few studies that have tested interactions among temperament dimensions have revealed non-significant results.[3,11] In a previous study we showed that interactions between a unidimensional construct of positive attributes of behavior, psychopathology and intelligence,[12] are correlated with educational outcomes distinctively. These findings encourage approaching education in its multiple aspects, such as school attendance and learning, in order to explore interaction among temperament dimensions, a question still open to examination by the literature.

The present study aims to explore these questions. First, we evaluate the associations between temperament dimensions (effortful control, fear, frustration, shyness and surgency) with four educational outcomes: negative school events, academic performance, reading and writing abilities. Our analysis is adjusted for age, sex, socioeconomic status, intelligence and psychopathology. Second, we tested interactions among temperament dimensions for associations with educational outcomes. Our first hypothesis is that temperament dimensions are independently associated with multiple educational outcomes. Specifically, due to previously reported findings,[3,13–15] we expect strong

positive effect of effortful control. Our second hypothesis is that temperament dimensions are not independent from each other, and we hypothesize specifically that effortful control modifies the associations between fear and frustration with educational outcomes.

METHODS

Participants

For purpose of this study, we used data from the baseline of a large school-based community study - the High Risk Cohort study for Psychiatric Disorders.[16] The study was submitted and approved by the Ethical Committee of the University of São Paulo. Written informed consent was obtained from parents of all research participants and verbal assent was obtained from the research subjects. The assembled cohort included screening and assessment phases, as well as sociological, phenotypic, genetic and neuroimaging data, described in detail elsewhere.[16] The total sample includes children from 6 to 14 years of age (N = 2,512). For this specific report, all 9 to 14 years old participants (n = 1,540) were included in this data analysis, given the questionnaire was constructed to specifically characterize temperament in this age range. Except for being older, this subsample was identical from the total sample in sex ($\chi^2_{1,2296} = 0.806$; $p = 0.369$), socioeconomic status ($t_{2294} = -0.810$; $p = 0.418$), intelligence ($t_{2214}=0.204$; $p = 0.077$) and psychopathology measured by Strengths and Difficulties Questionnaire ($t_{2294} = -1.384$; $p = 0.167$). The final sample of 1540 was all attending public schools, 22 in the city of Porto Alegre (n = 808) and 36 schools in the city of São Paulo (n = 732).

Socioeconomic status

Socioeconomic status (SES) was assessed with a standardized instrument validated in Brazil[17]. It is a composite score, which includes the main caregiver's schooling and the number of items at home (color TV, radio, VCR/DVD, refrigerator, freezer, washing machine, employed maid, bathroom and automobile). SES was transformed in z-scores for each subject.

Intelligence measurement

For intelligence, we estimated IQ using the vocabulary and block design subtests of the Weschler Intelligence Scale for Children, 3rd edition – WISC-III,[18] using the Tellegen and Briggs method[19] and the Brazilian norms.[20] We used studentized residuals, adjusted for age, and represented as z-scores.

Psychiatric evaluation

Psychopathology was evaluated as a continuous variable (sum of items), using the Strengths and Difficulties Questionnaire (SDQ) reported by caregiver.[21] SDQ is a 25-item questionnaire which provides five scores of behavioral and emotional symptoms. For the purposes of this study, we included “emotional symptoms”, “inattention/hyperactivity” and “conduct problems” to generate a composite score (SDQc) that was already used and validated in our previous studies.[12] SDQc was transformed in z-scores for each subject.

Temperament

Young adolescent’s temperament was assessed with the Brazilian-Portuguese version of the revised Early Adolescent Temperament Questionnaire (EATQ-R),[16,22] administered by trained psychologists to the youths. This instrument is suited for 9 to 14 years old subjects. This questionnaire is a 65-items Likert scale, ranging from 1 (always false) to 5 (always true), containing 12 subscales (4-7 items each). The factor structure of EATQ-R was generated by confirmatory factor analysis and the best-fitting solution was a bifactor model with one general factor and five specific factors, described in detail elsewhere (Hoffmann, unpublished). This empirically-derived model is a bifactor model that captures a general factor reflecting self-evaluation,[23] and the five temperament dimensions namely effortful control, frustration, fear, shyness and surgency. This model presents the advantage to capture temperament dimensions in a way it decreases the effects of biases in self-evaluation. This model was the only model showing acceptable fit indexes.

School and educational outcomes

Negative school events consisted of caregiver's report of school suspension, repetition and dropout, each report counting as one negative school event. Each event received a score of 1 point that were summed to compute the negative school events composite.

Overall academic performance was measured by the caregiver report of the Child Behavior Checklist school items[12] (CBCL-school). The items were composed by assessment of Portuguese or literature, history or social studies, English or Spanish, mathematics, biology, sciences, geography, and computer studies performance. Each subject was scored as failing, below average, average, and above average. We performed a CFA of CBCL-school items, presenting a one-factor solution with an adequate goodness-of-fit indexes in our total sample, as reported in a previous study.[12] The composite CBCL-school (academic performance) scores were derived from saved factor scores from the CFA model.

Reading and writing ability were measured throughout participants' scores on the School Performance Test ("Teste de Desempenho Escolar" - TDE).[24] The TDE is comprised of two tests: the reading decode (recognition of 64 words isolated from context) and writing (isolated 34 words in dictation). Both provided excellent model fit indices for these two latent variables: TDE-read (RMSEA 0.009, 90% CI 0.006-0.011; CFI 0.997; TLI 0.997 and Chi-Square Test of model fit 2170.4, $p < 0.001$) and TDE-write (RMSEA 0.020, 90% CI 0.017-0.022; CFI 0.990; TLI 0.989 and Chi-Square Test of model fit 837.7, $p < 0.001$. Reading and writing abilities were derived from reading and writing saved factor scores. See statistical analysis section for references about CFA fit indexes.

Statistical analysis

All CFA used delta parameterization and weighted least square with diagonal weight matrix with standard errors and mean- and variance-adjusted chi-square test statistics (WLSMV) estimators. Model fit parameters were Chi Square Test of model fit, root mean square error of approximation (RMSEA), Comparative Fit Index (CFI) and Tucker Lewis Index (TLI). Values of RMSEA near or below 0.080 represent acceptable model fit, and values lower than 0.060 represent good-to-excellent model fit.[25] CFI and TLI values near or above 0.900 represent acceptable model fit, while values higher than 0.950 represent a good-to-excellent model fit. Factor scores for each factor were saved from the best

model. All CFA were performed using MPlus 7.4 software (Muthén & Muthén, Los Angeles, California, USA).

Multilevel regression models (clustered by school) were used to analyze univariate and multiple associations of temperament factors with negative school events (Poisson regression), academic performance, reading and writing abilities (linear regression). First, univariate regression models were performed using each temperament factor individually. Second, each temperament dimension was individually regressed in a multiple model with covariates (age, sex, SES, IQ and SDQc) to predict school and educational outcomes (Appendix A supplies regression coefficients for covariates). Third, multiple models using all temperament dimensions were performed to investigate their association with the same outcomes.

To test temperament interactive associations, multiple regressions including main effects and interaction terms of temperament dimensions were performed. We tested interactions among effortful control, frustration, fear, shyness and surgency, resulting in 10 models for each outcome (40 total tests). P-values of each interactive term (10 p-values/outcome) were adjusted using Benjamini-Hochberg method for multiple testing (p_{BH}).[26,27] The same procedure was applied for each outcome in univariate and multiple models (5 temperament p-values/outcome).

To further explore the significance of the continuous interactions, we used marginal effects estimation, which represent the effects on predicted levels of an educational outcome for one temperament standardized unit change when the other temperament dimension is held constant at different values (-2.0 to 2.0 standard deviations).

Data analyses were performed in R (version 3.4.0) using “lme4”[28] (Poisson regression) and “nlme” packages[29]. Interaction were graphically represented using R packages “interplot”[30] and “persp3D”.[31] Marginal effects were explored using STATA version 13 (StataCorp, College Station, TX).

RESULTS

Sample description

Description of predictors and outcomes for the final youth sample with complete temperament data (n=1,540) are described in Table 1.

Associations between temperament and education

To test our first hypothesis, we investigated the associations between each temperament dimension alone (univariate models in Table 2; Figure 1 in green), as well as adjusted by age, sex, SES, IQ and SDQc (multiple models in Table 2; Figure 1 in orange) for each of the four educational outcomes. Here we briefly summarized the results from the multiple regression models after adjustment for multiple testing.

First, effortful control was associated with all educational outcomes including a lower rate ratio for negative school events, higher academic performance, reading and writing abilities. *Second*, fear was associated with lower rate ratio of negative school events and associated with better reading ability. *Third*, frustration was associated with higher rate ratio of negative school events and lower academic performance. *Fourth*, shyness was associated with higher reading ability. *Lastly*, surgency was associated with higher rate ratio for negative school events and poorer reading and writing abilities. These results are in Table 2 and represented in Figure 1 (for complete estimates of multiple models covariates, please see Appendix A).

Adjusting for co-occurring temperament traits

We also performed a multiple analysis in which all temperament dimensions were included as predictors of each educational outcome (Table 2, multiple model with all temperament dimensions). Effortful control was associated with all outcome variables. Other dimensions did not present significant associations.

Interactions between temperament dimensions on education

To test our second hypothesis, we investigated interactions between temperament dimensions as previously described. After adjustment for multiple testing, the interaction of frustration with effortful control (β= -0.113, 95%CI= -0.188 – -0.037, p_{BH} = 0.035) for reading abilities was the only significant interaction (for complete interaction analysis results, please see Appendix B). This interaction means that the combination of low frustration and low levels of effortful control are disproportionally detrimental when looking into associations with reading abilities. A graphical example of the interaction of effortful control and frustration can be seen in Panel A of Figure 2. For comparison, a non-significant interaction is represented in Panel D of the same figure.

Marginal effect analysis revealed that increasing levels of effortful control were significantly associated with higher reading ability for individuals with frustration less than 1.0 z-score, but not for levels of frustration higher than this level (Table 3). In other words, the strength of the association between effortful control with reading ability approaches non-significance as a function of increasing levels of frustration. For example, at a frustration level of -1.5 z-score, an increase of one effortful control standardized unit enhance the linear prediction of reading ability in 0.295 (95% CI 0.163 – 0.427, $p < 0.001$). At a frustration level of 0.5 z-score, the linear prediction of reading ability decreases to 0.069 (95% CI 0.012 – 0.126, $p < 0.05$) for each effortful control standardized unit increase (representation in Figure 2, Panel B). For purposes of comparison, a non-significant marginal effect of effortful control is depicted in Panel E of the same figure.

Conversely, marginal effect of increasing levels of frustration was associated with higher reading ability for individuals with effortful control lower 0.5 z-score. This shows that association of frustration with reading ability approaches to insignificance as a function of increasing levels of effortful control (Table 3). As an example, at an effortful control level of -1.5 z-score, an increase of one frustration standardized unit enhances the linear prediction of reading ability in 0.258 (95% CI 0.121 – 0.395, $p < 0.001$). At activation level of 0.0 z-score, the linear prediction of reading ability drops to 0.089 (95% CI 0.019 – 0.159, $p < 0.05$) for the same frustration standardized unit increase (representation in Figure 2, Panel C). For purposes of comparison, a non-significant marginal effect of frustration is depicted in Panel F of the same figure.

DISCUSSION

Temperament dimensions predicted educational outcomes independently of possible confounders and co-occurring traits, such as age, sex, SES, intelligence and psychopathology. Specifically, effortful control, fear and shyness were associated with better outcomes and frustration and surgency with worse outcomes. Multiple models adjusting for co-occurring temperament traits revealed the prominent effects of effortful control in predicting educational outcomes. Furthermore, frustration modified the associations of effortful control with reading abilities and vice versa, in a way that the combination of both low levels of effortful control and low levels of frustration are detrimental when associated with the adolescent's reading abilities.

Effortful control has showed to be the most important temperament trait for different aspects of education, since it is independently associated with less negative school events and better academic performance, reading and writing abilities independently from other temperament traits. Other studies also found that effortful control was associated with math and reading abilities in young children,[14,32] and aspects such as attention in childhood have important effects on math and reading performance in late adolescence.[33] Moreover, previous studies suggested positive effects of effortful control at classroom participation, teacher-student relationships, grades and school absence.[13,34] Self-regulation in children has also been linked to better social relationships and academic achievement.[15] As long as conscientiousness can be related with effortful control,[35,36] this personality trait has also been associated with better academic performance in young children and earnings and employment in adulthood.[35,37] Thus, by studying early adolescence our study add information to the gap between childhood and adulthood. Effortful control also have independent effects on reading and writing abilities, a finding that has been showed in very young children regarding literacy.[14] We can see again the relevance of effortful control when modeled at the same time with other temperament dimensions.

Dimensions such as frustration and fear are also related with our selected educational outcomes. Frustration, anger and impulsivity in children are associated with lower grades, classroom participation and poor social relationships.[11,13,34] Personality research shows that high levels of agreeableness, in which frustration can be placed at the lower end of this trait,[38] are associated with higher or better education.[37] Therefore it is possible that frustration temperament is related with education by lowering the adolescent's tolerance to adverse events. It is however surprising that fear independently associates with lower risk ratio for suspensions, repetitions and dropouts and associates with higher reading ability. This might be relevant to keep the student on track with the same classmates and school. Indeed, our results also show modest deleterious associations of surgency in school events and reading and writing abilities, which has been previously shown.[39] However, it is possible that those associations might be due to variations in levels in effortful control, given multiple models revels that when all temperament traits are included in the same model, only effortful control predicted negative educational outcomes above and beyond variation in other temperament traits.

Also in agreement to our second hypothesis, some temperament dimensions interact with each other when associated with reading abilities. Although frustration is not associated with reading

abilities in models testing main effects, interactive models show its dependability with effortful control in order to be linked with the outcome. Our results reveal that subjects with low levels of frustration are associated with poor reading abilities, but not in subjects with high effortful control. On the other hand, subjects with low effortful control are associated with poor reading abilities, but not in subjects with high frustration. In other words, subjects low in both frustration and effortful control are associated with poor reading ability, but when either frustration or effortful control are high, the association with poor reading is non-significant. Frustration is related with approach behavior, especially in non-rewarding situations.[42] It is possible that a proneness to experience frustration can lead one to be motivated to approach a given task and low levels of this temperament dimension lead adolescents to avoid learning due to lack of motivation, specifically if they have low effortful control. The motivational aspect of this affective trait can be a positive target to be explored in subjects with lower diligence and tenacity provided by effortful control, given that the combination of low frustration and effortful control was detrimentally associated with reading abilities.

This study must be understood in light of its limitations. *First*, due to its cross-sectional design, causal interpretations are not adequate. *Second*, reports from a single source might not capture the full temperament phenomena. Further studies should investigate whether results are similar with the combination of differences sources of information. Nonetheless, an important strength of our study is that assessments on school outcomes were reported by parents or assessed by standardized tests, which decreases associations due to shared method variance. *Third*, we only tested two-way interactions and temperament can potentially interact in a more complex way. It might be relevant to mention that before adjustment for multiple testing, interactions of effortful control and frustration emerged for negative school events and writing abilities. Due to the exploratory nature of this study, this might be taken into account in further research. Also it is important to bear in mind that the majority of associations were not interactive.

This study represents another step toward understanding young adolescent's temperament and its importance to multiple educational outcomes, using a larger middle income country sample. Effortful control has an important role in educational outcomes, from school events to learning. Interactions between temperament dimensions can modify the associations of each other to promote higher abilities, specifically frustration and effortful control. This might reinforce options on educational policies, once alternatively of investing in training soft skills, schools could optimally use adolescent's

dispositional traits to tailor strategies for better educational outcomes. Future prospective studies using causal designs should be performed in order to further explore this issue.

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Table 1

Table 1 - Demographics, educational and temperament descriptions from the sample (n = 1,540)

	Mean	SD
Age (years)	10.7	1.37
SES (score)	20.2	4.92
IQ (score)	100.0	15.0
SDQc (score)	13.3	4.89
Academic measures (z-score)		
Academic Performance	-0.02	0.93
Reading ability	-0.15	0.85
Writing ability	-0.06	0.90
Temperament dimensions (z-score)		
Effortful control	0.01	0.85
Fear	0.00	0.74
Frustration	-0.01	0.62
Shyness	0.00	0.78
Surgency	0.00	0.73
	n	%
Sex (female)	733	47.6
Negative School Events (count)	474	30.8

Note: SES, socioeconomic status measured by ABEP score (described in methods section); IQ, Intelligence coefficient; SDQc, Strengths and difficulties Questionnaire composite (described in methods section). Age, sex, SES, IQ, SDQc and Negative school events are the sum of repetition, suspension or school dropout events. Remaining variables are described in their factors scores extracted from confirmatory factor analysis models (described in the text).

Table 2

Table 2 - Univariate and Multiple mixed effects models (clustered by school) of temperament dimensions and educational outcomes

	Negative School Events (count)			**Academic Performance (z-score)**			**Reading Skills (z-score)**			**Writing Skills (z-score)**		
	RR	LB	UB	β	LB	UB	β	LB	UB	β	LB	UB
Univariate												
Effortful control	0.75***	0.69	0.82	0.23***	0.18	0.29	0.11***	0.06	0.16	0.17***	0.12	0.22
Fear	0.83***	0.75	0.91	0.06	0.00	0.13	0.00	-0.05	0.06	0.01	-0.05	0.07
Frustration	1.22**	1.09	1.38	-0.09*	-0.16	-0.01	0.07	0.00	0.14	0.09	0.01	0.16
Shyness	0.94	0.86	1.04	0.01	-0.05	0.07	0.03	-0.03	0.08	0.03	-0.03	0.09
Surgency	1.17**	1.07	1.29	-0.06	-0.12	0.01	-0.01	-0.07	0.04	-0.03	-0.09	0.04
Multiple (one model for each temperament dimension adjusting for covariates)												
Effortful control	0.88*	0.81	0.96	0.16***	0.11	0.22	0.05*	0.01	0.10	0.09***	0.04	0.14
Fear	0.88*	0.80	0.97	0.07	0.00	0.13	0.06*	0.01	0.11	0.06	0.00	0.12
Frustration	1.17*	1.04	1.31	-0.09*	-0.16	-0.02	0.04	-0.02	0.10	0.04	-0.02	0.11
Shyness	0.94	0.85	1.03	0.02	-0.04	0.07	0.05*	0.00	0.11	0.05	0.00	0.10
Surgency	1.11*	1.00	1.23	-0.06	-0.12	0.01	-0.07*	-0.12	-0.01	-0.07*	-0.12	-0.01
Multiple (all temperament dimensions in the same model)												
Effortful control	0.77***	0.70	0.84	0.23***	0.17	0.28	0.11***	0.06	0.16	0.17***	0.12	0.23
Fear	0.79	0.55	1.14	-0.02	-0.26	0.21	-0.02	-0.23	0.20	-0.01	-0.24	0.22
Frustration	1.09	0.93	1.27	-0.08	-0.17	0.02	0.08	-0.01	0.17	0.10	0.00	0.20
Shyness	1.20	1.03	1.40	-0.06	-0.16	0.04	0.06	-0.03	0.15	0.05	-0.05	0.15
Surgency	1.06	0.76	1.48	-0.10	-0.32	0.11	-0.02	-0.18	0.22	0.01	-0.20	0.23

Note: Temperament units are z-scores. Multiple models with covariates include age, gender, standardized socio-economic status, standardized intelligence quotient (defined in methods section), Strengths and Difficulties Questionnaire composite of emotional, attentional/hyperactive and conduct problems (defined in methods section). Multiple models with all temperaments include all five temperament dimensions in the same model. RR, rate ratio; β, regression coefficient β; UB, 95% confidence interval upper bound; LB, 95% confidence interval lower bound. Outcomes were defined in methods section. p-values are adjusted using Benjamin-Hochberg method for multiple testing in each outcome. *, p<0.05; **, p<0.01; ***, p<0.001.

Table 3

Table 3 - Marginal effects of effortful control and frustration for fixed values of each interactive dimension on reading ability

Fixed z-score	Effortful Control			Fixed z-score	Frustration		
Frustration	β	LB	UB	Effortful Control	β	LB	UB
-2.0	0.351***	0.184	0.519	-2.0	0.314***	0.144	0.485
-1.5	0.295***	0.163	0.427	-1.5	0.258***	0.121	0.395
-1.0	0.238***	0.140	0.336	-1.0	0.202***	0.095	0.308
-0.5	0.182***	0.113	0.250	-0.5	0.145*	0.063	0.227
0.0	0.125***	0.075	0.176	0.0	0.089*	0.019	0.159
0.5	0.069*	0.012	0.126	0.5	0.032	-0.045	0.109
1.0	0.013	-0.070	0.095	1.0	-0.024	-0.123	0.075
1.5	-0.044	-0.159	0.071	1.5	-0.080	-0.209	0.048
2.0	-0.100	-0.250	0.050	2.0	-0.137	-0.298	0.025

Note: Marginal effects derived from interaction models of effortful control with frustration for reading ability. β, regression coefficient β; UB, 95% confidence interval upper bound; LB, 95% confidence interval lower bound. ***, $p<0.001$; *, $p<0.05$.

Figure 1: Univariate and Multiple models (adjusting for covariates) Of temperament dimensions and educational outcomes.

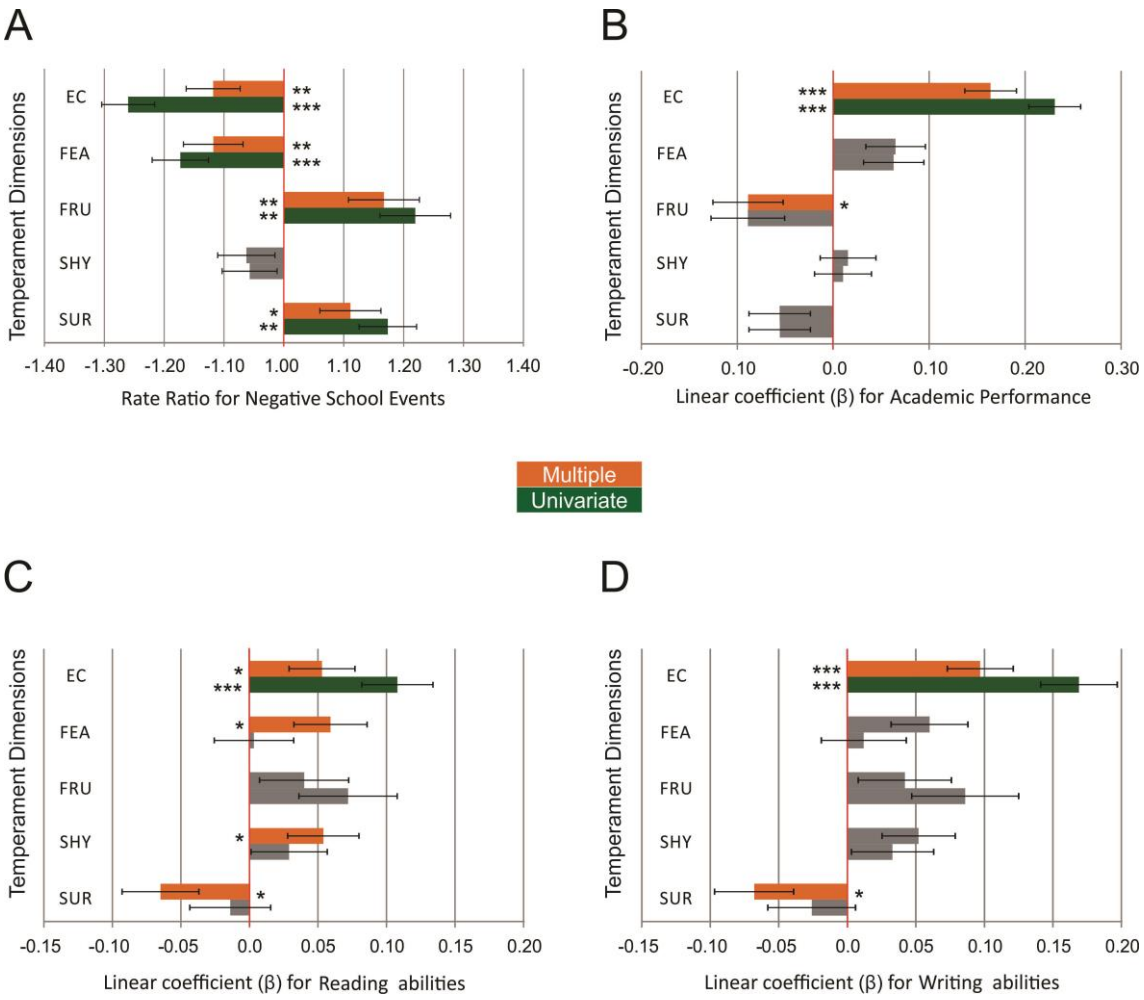


Figure 1 Univariate (p_{BH} < 0.05 in green) and Multiple (p_{BH} < 0.05 in orange) regression analysis of temperament factors and educational outcomes. Rate ratio for negative school events (A), linear coefficient for academic performance (B) and linear coefficient for reading (C) and writing abilities (D), with their respective standard errors. Multiple models include age, sex, socioeconomic status, intelligence and psychiatric symptoms as independent variables besides each temperament dimension. Gray bars represents p_{BH} > 0.05. Abbreviations: EC, effortful control; FRU, frustration; FEA, fear; SHY, shyness; SUR, surgency; *, p_{BH} <0.05; **, p_{BH} <0.01; ***, p_{BH} <0.001; $p_{BH,}$ p-value adjusted using Benjamini-Hochberg method for multiple testing.

Figure 2: Interaction between effortful control and frustration in reading ability (non-significant interaction depicted for comparison).

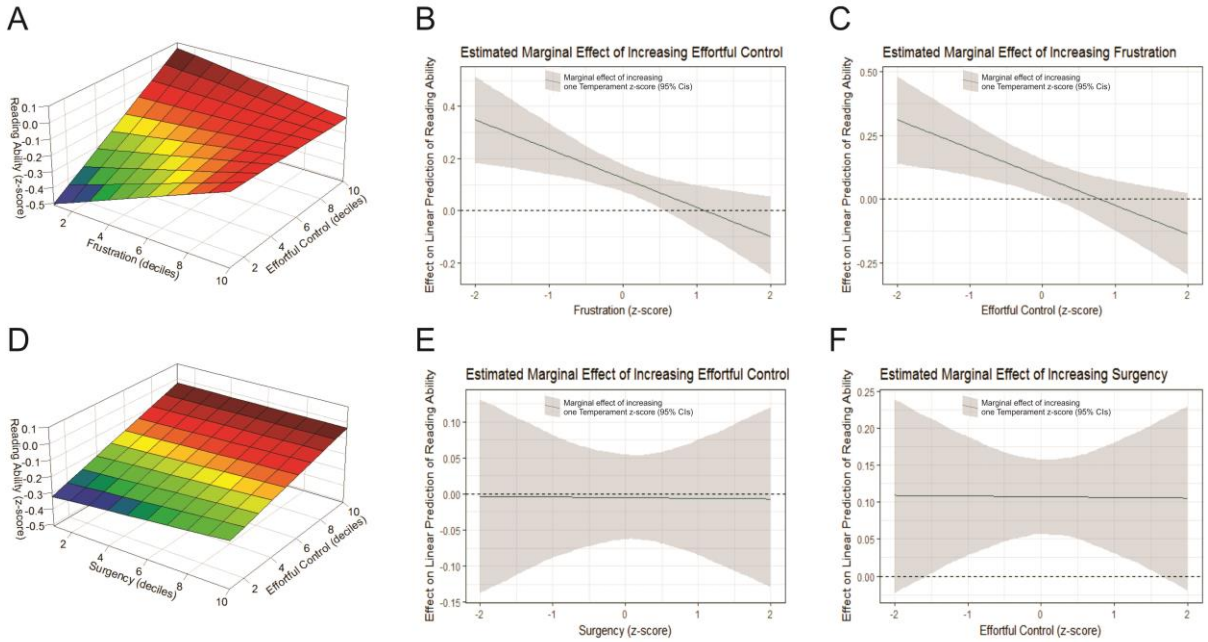


Figure 2- Graphical demonstration of significant and non-significant Interactions. Panels A-C represents the interactive relationship between effortful control and frustration on reading ability. Panels D-F represents the independent relationship between effortful control and surgency on reading ability. Panels A and D showed tridimensional plots depicting standardized performance in reading abilities (z-score) according to deciles of effortful control and frustration (A) or a temperament with no interactive association, such as surgency (D). Interactions were probed using marginal effects in two ways. First, average marginal effect of increasing one effortful control z-score on the predicted linear coefficient of reading abilities (y-axis) at different z-scores of frustration (B) and surgency (E) (x-axis). Second, average marginal effect of increasing one frustration (C) and surgency (F) z-score on the predicted linear coefficient of reading abilities (y-axis) at different z-scores of effortful control (x-axis). For purposes of comparison, surgency was used to depict a non-significant marginal effect.

APPENDIX

Appendix A: Complete multiple models containing each individual temperament plus covariates for each outcome are represented in Table A1.

Table A1 - Multiple mixed effects regression models (clustered by school) of temperament dimensions and educational outcomes, adjusted by covariates

	Negative School Events (count)			Academic Performance (z-score)			Reading Skills (z-score)			Writing Skills (z-score)		
	RR	LB	UB	β	LB	UB	β	LB	UB	β	LB	UB
Effortful control	0.88*	0.81	0.96	0.16***	0.11	0.22	0.05*	0.01	0.10	0.09***	0.04	0.14
Age (years)	1.37***	1.30	1.45	-0.01	-0.05	0.02	0.17***	0.14	0.20	0.20***	0.16	0.23
Gender (F/M)	0.67***	0.58	0.78	0.16***	0.07	0.25	0.06	-0.02	0.14	0.20***	0.12	0.28
SES (z-score)	0.88**	0.82	0.95	0.08**	0.03	0.12	0.06**	0.02	0.10	0.09***	0.05	0.14
IQ (z-score)	0.72**	0.67	0.78	0.17***	0.13	0.22	0.26***	0.22	0.30	0.32***	0.28	0.36
SDQc(z-score)	1.29***	1.19	1.39	-0.14***	-0.19	-0.10	-0.07***	-0.11	-0.03	-0.07***	-0.12	-0.03
Fear	0.88*	0.80	0.97	0.07	0.00	0.13	0.06*	0.01	0.11	0.06	0.00	0.12
Age (years)	1.37***	1.30	1.44	-0.01	-0.05	0.02	0.18***	0.15	0.21	0.20***	0.17	0.23
Gender (F/M)	0.68***	0.59	0.79	0.16***	0.07	0.25	0.05	-0.03	0.12	0.20***	0.10	0.27
SES (z-score)	0.88**	0.81	0.95	0.08**	0.03	0.12	0.06**	0.02	0.10	0.09***	0.05	0.14
IQ (z-score)	0.71***	0.65	0.76	0.20***	0.15	0.24	0.27***	0.23	0.31	0.33***	0.29	0.37
SDQc(z-score)	1.31***	1.22	1.41	-0.17***	-0.21	-0.12	-0.08***	-0.12	-0.04	-0.09***	-0.13	-0.05
Frustration	1.17*	1.04	1.31	-0.09*	-0.16	-0.02	0.04	-0.02	0.10	0.04	-0.02	0.11
Age (years)	1.37***	1.30	1.45	-0.01	-0.05	0.02	0.17***	0.14	0.20	0.19***	0.16	0.22
Gender (F/M)	0.66***	0.57	0.76	0.18***	0.09	0.27	0.06	-0.01	0.14	0.21***	0.13	0.29
SES (z-score)	0.88**	0.81	0.95	0.08**	0.03	0.12	0.06**	0.02	0.10	0.09***	0.05	0.13
IQ (z-score)	0.70***	0.65	0.76	0.19***	0.15	0.24	0.27***	0.22	0.31	0.33***	0.29	0.37
SDQc(z-score)	1.30***	1.22	1.41	-0.17***	-0.21	-0.12	-0.08***	-0.12	-0.04	-0.09***	-0.13	-0.05
Shyness	0.94	0.85	1.03	0.02	-0.04	0.07	0.05*	0.00	0.11	0.05	0.00	0.10
Age (years)	1.38***	1.31	1.46	-0.02	-0.05	0.02	0.17***	0.14	0.20	0.20***	0.16	0.23
Gender (F/M)	0.67***	0.58	0.77	0.18***	0.09	0.27	0.05	-0.03	0.13	0.20***	0.12	0.28
SES (z-score)	0.88**	0.82	0.95	0.08**	0.03	0.12	0.06**	0.02	0.10	0.09***	0.05	0.14
IQ (z-score)	0.71***	0.65	0.77	0.19***	0.15	0.24	0.27***	0.23	0.31	0.33***	0.29	0.37
SDQc(z-score)	1.31***	1.22	1.41	-0.17***	-0.21	-0.12	-0.08***	-0.12	-0.04	-0.09***	-0.13	-0.05
Surgency	1.11*	1.00	1.23	-0.06	-0.12	0.01	-0.07*	-0.12	-0.01	-0.07*	-0.12	-0.01
Age (years)	1.37***	1.30	1.45	-0.01	-0.05	0.02	0.18***	0.15	0.21	0.20***	0.17	0.23
Gender (F/M)	0.68***	0.59	0.79	0.16***	0.07	0.25	0.04	-0.04	0.12	0.19***	0.11	0.27
SES (z-score)	0.88**	0.82	0.95	0.08**	0.03	0.12	0.06**	0.02	0.10	0.09***	0.05	0.13
IQ (z-score)	0.71***	0.65	0.76	0.20***	0.15	0.24	0.27***	0.23	0.31	0.33***	0.29	0.38
SDQc(z-score)	1.31***	1.22	1.41	-0.17***	-0.21	-0.12	-0.08***	-0.12	-0.04	-0.09***	-0.13	-0.05

Note: Temperament units are z-scores. SES, standardized socio-economic status; IQ, standardized intelligence quotient (defined in the text); SDQc, Strengths and Difficulties Questionnaire composite of emotional, attentional/hyperactive and conduct problems (defined in the text); RR, rate ratio; β, regression coefficient β; UB, 95% confidence interval upper bound; LB, 95% confidence interval lower bound. Outcomes were defined in the text. p-values are adjusted using Benjamini-Hochberg method for multiple testing for each outcome. *, p<0.05; **, p<0.01; ***, p<0.001.

Appendix B: Complete interactive models results are described in Table B1.

Table B1 - Interactive mixed effects regression models (clustered by school) of temperament dimensions and educational outcomes

	Negative School Events (count)		Academic Performance (z-score)		Reading Skills (z-score)		Writing Skills (z-score)	
	RR	p-value (BH)	β	p-value (BH)	β	p-value (BH)	β	p-value (BH)
EC*Fear	1.04	0.559	-0.01	0.843	0.01	0.959	0.02	0.686
EC*Frustration	1.11	0.314	-0.07	0.570	-0.11*	0.035	-0.10	0.134
EC*Shyness	1.06	0.388	-0.02	0.674	-0.03	0.628	-0.02	0.686
EC*Surgency	0.99	0.783	0.01	0.848	0.00	0.984	0.01	0.790
Fear*Frustration	1.15	0.151	-0.03	0.726	-0.04	0.628	-0.05	0.596
Fear*Shyness	1.02	0.707	0.04	0.570	0.01	0.959	0.02	0.686
Fear*Surgency	0.98	0.707	-0.03	0.570	-0.01	0.959	-0.02	0.868
Frustration*Shyness	1.16	0.122	-0.07	0.570	-0.07	0.454	-0.09	0.214
Frustration*Surgency	0.84	0.122	0.06	0.570	0.05	0.628	0.06	0.596
Shyness*Surgency	0.96	0.559	-0.03	0.570	0.00	0.948	-0.01	0.790

Note: All interactive terms were adjusted for main effects. Temperament units are z-scores. EC, effortful control; RR, rate ratio; β, regression coefficient β; BH, p values adjusted usingBenjamini-Hochberg method for multiple testing for each outcome. Outcomes were defined in the text. *, p<0.05.

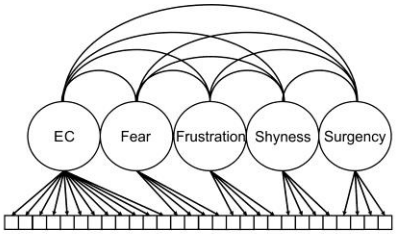
7. ANÁLISES COMPLEMENTARES

Outras análises foram realizadas ao longo da elaboração dos artigos para responder algumas perguntas durante a realização dos estudos. As perguntas foram as seguintes: 1) Quais outros modelos possíveis para o instrumento de temperamento utilizado? 2) Qual a correlação entre os atributos positivos do comportamento, mensurados pela YSI, e o modelo de temperamento?

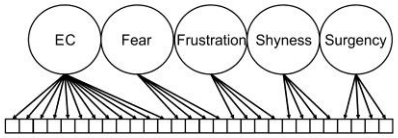
7.1. Modelos de temperamento utilizando o questionário EATQ-R

Sete modelos foram avaliados para testar a estrutura do EATQ-R, com base na literatura prévia, que incluíram modelo com fatores correlacionados, não correlacionados e modelos de segunda ordem, com o controle de esforço, afeto negativo e afeto positivo nos construtos hierarquicamente superiores (33,46,54). Além destes modelos clássicos, foram também avaliados modelos bifatoriais, com base na hipótese do fator geral representar um fator de autoavaliação, presente na análise de instrumentos de personalidade (59,60). Foram selecionados cinco fatores de temperamento, a saber o controle de esforço, medo, frustração, timidez e extroversão. O controle de esforço foi analisado modelando itens de três dimensões (atenção, controle inibitório e ativação) já que este construto apresenta alta convergência destas dimensões de forma sistemática (33,63,78,83). Os demais fatores foram modelados a partir de quarto itens de cada construto, já que o fator timidez apresenta somente quatro itens. Os itens com menor carga fatorial em cada tentativa de modelagem (do modelo bifatorial correlacionado) foram sendo excluídos em cada etapa da análise, a fim de se chegar aos itens mais informativos.

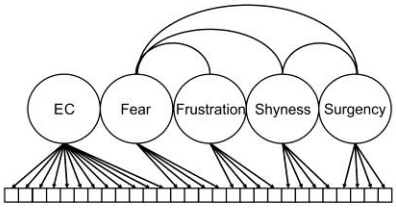
Os sete modelos testados foram: Cinco dimensões correlacionadas (CFD); cinco dimensões ortogonais (OFD); cinco dimensões parcialmente correlacionadas, na qual medo está correlacionado com frustração, timidez e extroversão, bem como timidez está relacionado com extroversão (FPCD); modelo de segunda ordem, com medo pertencente ao traço de afeto negativo (SOM1) e outro com o medo pertencente ao afeto positivo (SOM2); modelo bifatorial com cinco dimensões ortogonais (BM-OS) e outro modelo bifatorial no qual medo está correlacionado com frustração, timidez e extroversão, bem como timidez está relacionado com extroversão (BM-CS). Os modelos estão representados na figura complementar 1.



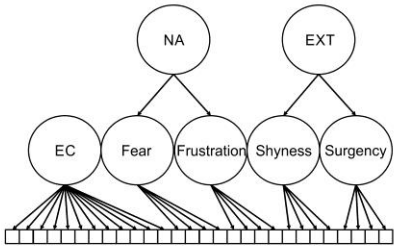
CFD - Correlated five dimensions



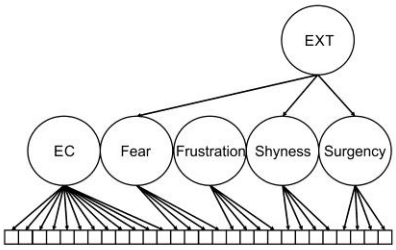
OFD - Orthogonal five dimensions



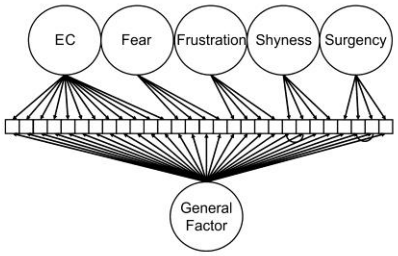
PCFD - Partially correlated five dimensions



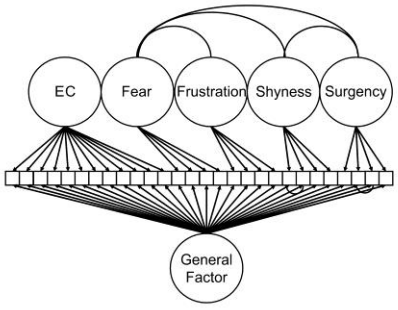
SOM1 - Second order model 1 (fear in negative affectivity higher order trait)



SOM2 - Second order model 2 (fear in extroversion higher order trait)



BM-OS - Bifactor model with orthogonal specific dimensions



BM-CS - Bifactor model with correlated specific dimensions

Nota: CFD, cinco dimensões correlacionadas; OFD, cinco dimensões ortogonais; PCFD, cinco dimensões parcialmente correlacionadas (medo correlacionado com frustração, timidez e extroversão); SOM1, modelo de segunda ordem no qual o medo é carregado pela afetividade negativa; SOM2, modelo de segunda ordem no qual o medo é carregado pelo fator de extroversão (primeira ordem); BM-OS, modelo bifatorial com cinco dimensões específicas ortogonais, BM-CS, modelo bifatorial no qual o medo se correlaciona com frustração, timidez e extroversão e timidez se correlaciona com extroversão.

Para esta análise, foram realizadas análises confirmatórias fatoriais (CFA). Foi utilizado parametrização delta e o estimador WLSMV (*weighted least square with diagonal weight matrix with standard errors and mean- and variance-adjusted chi-square test statistics*). Os parâmetros de ajuste do modelo foram o teste Qui-quadrado do ajuste do modelo, erro quadrático médio aproximado (RMSEA), índice de ajuste comparativo (CFI) e índice de Tucker Lewis (TLI). Os valores de RMSEA próximos ou abaixo de 0,08 representam o ajuste aceitável do modelo, e os valores inferiores a 0,06 representam o ajuste do modelo bom a excelente (89). Os valores de CFI e TLI próximos ou superiores a 0,900 representam o ajuste aceitável do modelo, enquanto valores superiores a 0,950 representam um ajuste de modelo bom a excelente. Todas as CFAs foram realizadas usando o *software* MPlus 7.4 (Muthén & Muthén, Los Angeles, Califórnia, EUA).

Os resultados estão representados na tabela complementar 7.1 e demonstram o melhor ajuste para o modelo utilizado no artigo #2 (bifatorial com dimensões correlacionadas).

Tabela 7.1 – Indices de ajuste dos modelos fatoriais utilizando EATQ-R

Modelos	Indices de ajuste (WLSMV)				
	χ^2	*gl*	RMSEA [90% IC]	CFI	TLI
CFD	4866,351***	340	0,093 [0,091 - 0,095]	0,658	0,620
OFD	6460,203***	350	0,106 [0,104 - 0,109]	0,538	0,501
PCFD	5045,081***	346	0,094 [0,092 - 0,096]	0,645	0,612
SOM1	6153,257***	348	0,104 [0,102 - 0,106]	0,561	0,524
SOM2	5400,535***	348	0,097 [0,095 - 0,099]	0,618	0,585
BM-OS	2,065,726***	320	0,060 [0,057 - 0,062]	0,868	0,844
BM-CS	1526,050***	316	0,050 [0,047 - 0,052]	0,909	0,891

Nota: EATQ-R, *Early Adolescent Temperament Questionnaire*; WLSMV, *weighted least squares means and variance adjusted*; *gl*, graus de liberdade; RMSEA, *root mean square error of approximation*; IC, intervalo de confiança; CFI, *comparative fit index*; TLI , *Tucker–Lewis Index*; CFD, cinco dimensões correlacionadas; OFD, cinco dimensões ortogonais; PCFD, cinco dimensões parcialmente correlacionadas (medo correlacionado com frustração, timidez e extroversão); SOM1, modelo de segunda ordem no qual o medo é carregado pela afetividade negativa; SOM2, modelo de segunda ordem no qual o medo é carregado pelo fator de extroversão (primeira ordem); BM-OS, modelo bifatorial com cinco dimensões específicas ortogonais, BM-CS, modelo bifatorial no qual o medo se correlaciona com frustração, timidez e extroversão e timidez se correlaciona com extroversão.; ***, $p<0.001$.

7.2. Relação entre YSI e EATQ-R

Para explorar a relação da medida unidimensional de atributos positivos do comportamento (YSI) utilizada no artigo#1 e o modelo de temperamento utilizado nos demais artigos (utilizando o EATQ-R), foram realizadas análises a fim de modelar o YSI e as dimensões de temperamento, com a finalidade de avaliar se os atributos positivos do temperamento fazem parte do construto do temperamento ou se é uma medida diferente da capturada pelo EATQ-R. Esta análise possui uma limitação importante, pois as fontes de informação do YSI (relato dos pais) e EATQ-R (auto relato) são de fontes independentes e os resultados podem representar somente a diferença de fonte de informação e não o construto.

De qualquer forma, as seguintes análises utilizando correlação e CFA foram realizadas, com os parâmetros de ajuste para a CFA descritos na seção acima (7.1): Correlação de Pearson entre o escore fatorial da YSI e escores do modelo bifatorial do EATQ-R utilizado nos artigos #2 e #3. Modelagem utilizando CFA com as configurações 1) YSI e modelo bifatorial de EATQ-R em um modelo de dois fatores ortogonais para avaliar se os construtos (ou fontes de informação) não correlacionados explicam melhor os dados; 2) Mesmo modelo anterior de dois fatores, porém, com o YSI correlacionando-se com controle de esforço (avaliar se os dados são melhor explicados pela sobreposição destes dois fatores); 3) Atributos positivos carregando em todos os itens dos instrumentos YSI e EATQ-R em um modelo de um fator, modelando como se o temperamento estivesse sob o construto de atributos positivos; 4) YSI modelado como uma dimensão do temperamento, carregando para o fator geral e correlacionado com o controle de esforço.

A correlação entre o YSI é significativa somente para a dimensão de controle de esforço no modelo bifatorial da EATQ-R (0,211; $p<0,001$). Este achado pode ser interpretado de, pelo menos, três maneiras. Primeiro, estes podem ser um construto distinto devido à fraca correlação; segundo, um destes construtos não captura a total dimensão do construto latente e por isso o YSI e EATQ-R se correlacionam fracamente; ou, terceiro, a fonte de informação do construto latente permite uma fraca concordância e correlação entre YSI e controle de esforço. Nos modelos de CFA, o primeiro (modelo de dois fatores) demonstra um ajuste de bom a excelente (RMSEA 0,038 (IC90% 0,036-0,039); CFI 0,934; TLI 0,930 e teste de Qui-quadrado para ajuste do modelo de 4325,3 ($p<0,001$)). O segundo modelo (YSI correlacionado

ao controle de esforço) também apresenta índices de ajuste bons ou excelente (RMSEA 0,034 (IC90% 0,033-0,035); CFI 0,947; TLI 0,943 e teste de Qui-quadrado para ajuste do modelo de 3746,0 ($p<0,001$), correlação entre YSI e controle de esforço = 0,262; $p<0,001$). O terceiro modelo (atributos positivos carregando todos os itens dos instrumentos) não apresentou índices de ajuste aceitáveis (RMSEA 0,085 (IC90% 0,083-0,086); CFI 0,814; TLI 0,803 e teste de Qui-quadrado para ajuste do modelo de 8078,7 ($p<0,001$)). O quarto modelo (Bifatorial utilizando YSI como dimensão de temperamento) não apresentou convergência.

Esta análise possibilita concluir que ao menos em parte, os atributos positivos são correlacionados ao construto de controle de esforço (melhora do ajuste do modelo ao correlacionar YSI com controle de esforço) mas as limitações da fonte de informação não possibilitam avaliação definitiva deste aspecto.

8. CONSIDERAÇÕES FINAIS E CONCLUSÃO

Esta tese teve por objetivo investigar a relação de atributos positivos do comportamento e temperamento com desfechos escolares. Ampliando o que já existe na literatura, esta tese conseguiu avaliar desfechos escolares através de diferentes indicadores e ajustar para importantes variáveis associadas tanto com os preditores quanto desfechos nos modelos testados, bem como explorar interações de preditores.

Foi demonstrado que uma medida unidimensional de atributos positivos gerais do comportamentos de crianças e adolescentes prediz de maneira independente o aprendizado e rendimento acadêmico, bem como modifica positivamente o efeito da baixa inteligência e altos sintomas mentais nestes desfechos educacionais. Também foi demonstrado que o modelo bifatorial de temperamento pode apresentar um fator de autoavaliação negativa, que informa a maneira geral de como os adolescentes endossam os itens em instrumento de auto relato, e que as dimensões residuais de temperamento são preditivas para os desfechos educacionais. Em especial, o controle de esforço é o traço de temperamento mais fortemente associado a desfechos qualitativos e quantitativos na educação, bem como modifica o efeito da frustração em habilidade de leitura.

Estes resultados reforçam a importância da valorização do desenvolvimento de aspectos socioemocionais em crianças e adolescentes e além disso, de possível compensação de deficiências através do uso de potencialidades de traços distintos. Porém, a literatura ainda não é clara em relação a como modificar ou incentivar esses traços socioemocionais ou ainda se a relação entre esses traços e desfechos escolares é unidirecional. Passos futuros devem explorar a relação causal (habilidades socioemocionais causam os desfechos escolares ou a exposição a educação modifica os traços socioemocionais), através de estudos observacionais que possam utilizar técnicas de inferência causal, como o uso de variável instrumental em modelos de regressão, ou estudos experimentais que visem modificar níveis de habilidade e avaliar os impactos na educação, bem como a exposição diferencial em ambiente escolar e avaliação da modificação das diferenças individuais em comportamentos e emoções.

9. ANEXOS

9.1. Outros artigos publicados durante o período de doutorado.

9.1.1. Artigo anexo #1 (resumo)

Publicado no periódico ***Journal of Abnormal Psychology***

Journal of Abnormal Psychology
January 2017 – Volume 126 – Issue 1 – p 137-148
doi: 10.1037/abn0000205

A general psychopathology factor (p-factor) in children: Structural model analysis and external validation through familial risk and child global executive function

Michelle M. Martel, Pedro M. Pan, Maurício S. Hoffmann, Ary Gadelha, Maria C. do Rosário, Jair J. Mari, Gisele G. Manfro, Eurípedes C. Miguel, Tomás Paus, Rodrigo A. Bressan, Luis A. Rohde, Giovanni A. Salum

High rates of comorbidities and poor validity of disorder diagnostic criteria for mental disorders hamper advances in mental health research. Recent work suggests the utility of continuous cross-cutting dimensions, including general psychopathology and specific factors of externalizing and internalizing (e.g., distress and fear) syndromes. The current study evaluated the reliability of competing structural models of psychopathology and examined external validity of the best fitting model based on family risk and child global executive function (EF). A community sample of 8,012 families from Brazil with children aged 6 to 12 years completed structured interviews about the child and parental psychiatric syndromes, and a subsample of 2,395 children completed tasks assessing EF (i.e., working memory, inhibitory control and time-processing). Confirmatory factor analyses tested a series of structural models of psychopathology in both parents and children. The model with a general psychopathology factor (“p-factor”) with 3 specific factors (“fear,” “distress,” and “externalizing”) exhibited the best fit. The general p-factor accounted for most of the variance in all models, with little residual variance explained by each of the three specific factors. In addition, associations between child and parental factors were mainly significant for the p-factors and nonsignificant for the specific factors from the respective models. Likewise, the child p-factor – but not the specific factors - was significantly associated with global child EF. Overall, our results provide support for a latent overarching p-factor characterizing child psychopathology, supported by familial associations and child EF.

General Scientific Summary: An overarching general factor of child psychopathology was particularly prominent and strongly associated with parental mental disorders and a global measure of child executive function.

9.1.2. Artigo anexo #2 (resumo)

Publicado no periódico ***Revista Brasileira de Psiquiatria***

Revista Brasileira de Psiquiatria
April-June 2017 – Volume 39 – Issue 2 – p 118-125
doi: 10.1590/1516-4446-2016-2064

Specific and social fears in children and adolescents: separating normative fears from problem indicators and phobias

Paola P. Laporte,Pedro M. Pan, Mauricio S. Hoffmann, Lauren S. Wakschlag, Luis A. Rohde, Euripedes C. Miguel, Daniel S. Pine, Gisele G. Manfro, Giovanni A. Salum

Objective: To distinguish normative fears from problematic fears and phobias.
Methods: We investigated 2,512 children and adolescents from a large community school-based study, the High Risk Study for Psychiatric Disorders. Parent reports of 18 fears and psychiatric diagnosis were investigated. We used two analytical approaches: confirmatory factor analysis (CFA)/item response theory (IRT) and nonparametric receiver operating characteristic (ROC) curve.
Results: According to IRT and ROC analyses, social fears are more likely to indicate problems and phobias than specific fears. Most specific fears were normative when mild; all specific fears indicate problems when pervasive. In addition, the situational fear of toilets and people who look unusual were highly indicative of specific phobia. Among social fears, those not restricted to performance and fear of writing in front of others indicate problems when mild. All social fears indicate problems and are highly indicative of social phobia when pervasive.
Conclusion: These preliminary findings provide guidance for clinicians and researchers to determine the boundaries that separate normative fears from problem indicators in children and adolescents, and indicate a differential severity threshold for specific and social fears.

9.1.3. Artigo anexo #3 (resumo)

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Compulsory psychiatric treatment checklist: Instrument development and clinical application

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Instruments designed to evaluate the necessity of compulsory psychiatric treatment (CPT) are scarce to non-existent. We developed a 25-item Checklist (scoring 0 to 50) with four clusters (Legal, Danger, Historic and Cognitive), based on variables identified as relevant to compulsory treatment. The Compulsory Treatment Checklist (CTC) was filled with information on case (n=324) and control (n=251) subjects, evaluated under the Portuguese Mental Health Act (Law 36/98), in three hospitals. For internal validation, we used Confirmatory Factor Analysis (CFA), testing unidimensional and bifactor models. Multilevel logistic regression model (MLL) was used to predict the odds ratio (OR) for compulsory treatment based on the total scale score. Receiver Operating Characteristic analysis (ROC) was performed to predict compulsory treatment. CFA revealed the best fit indexes for the bifactor model, with all items loading on one General factor and the residual loading in the a priori predicted four specific factors. Reliability indexes were high for the General factor (88.4%), and low for specific factors (<5%), which demonstrate that CTC should not be performed in the subscales to access compulsory treatment. MLL reveals that for each item scored in the scale, it increases the OR by 1.26 for compulsory treatment (95%CI 1.21-1.31, p<0.001). Based on the total score, accuracy was 90%, and the best cut-off point of 23.5 detects compulsory treatment with a sensitivity of 75% and specificity of 93.6%. The CTC presents robust internal structure with a strong unidimensional characteristic, and a cut-off point for compulsory treatment of 23.5. The improved 20-item version of the CTC could represent an important instrument to improve clinical decision regarding CPT, and ultimately to improve mental health care of patients with severe psychiatric disorders.

9.1.4. Artigo anexo #4 (resumo)

Publicado no periódico ***Trends in Psychiatry and Psychotherapy***

Trends in Psychiatry and Psychotherapy
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Heat stroke during long-term clozapine treatment: should we be concerned about hot weather?

Hoffmann MS, Oliveira LM, Lobato MI, Belmonte-de-Abreu P.

Objective: To describe the case of a patient with schizophrenia on clozapine treatment who had an episode of heat stroke.
Case description: During a heat wave in January and February 2014, a patient with schizophrenia who was on treatment with clozapine was initially referred for differential diagnose between systemic infection and neuroleptic malignant syndrome, but was finally diagnosed with heat stroke and treated with control of body temperature and hydration.
Comments: This report aims to alert clinicians take this condition into consideration among other differential diagnoses, especially nowadays with the rise in global temperatures, and to highlight the need for accurate diagnosis of clinical events during pharmacological intervention, in order to improve treatment decisions and outcomes.

9.1.5. Apresentação em congresso #1 (resumo)

*Apresentado no **XIII Congresso Gaúcho de Psiquiatria da Associação de Psiquiatria do Rio Grande do Sul** (1º lugar no prêmio Professor Cyro Martins como melhor trabalho em psiquiatria clínica)*

NÃO BASTA SER INTELIGENTE: MODIFICAÇÃO DO EFEITO DA INTELIGÊNCIA POR TRAÇOS DE TEMPERAMENTO EM DESFECHOS ESCOLARES.

INTRODUÇÃO: A Inteligência é um dos fatores mais importantes pra o sucesso educacional, bem como traços do temperamento. Pouco se sabe se as associações desses fatores com a educação se dá de maneira independente ou interativa, ou seja, se o efeito de um fator depende do efeito do outro.
MATERIAIS E MÉTODOS: Foram analisados 1540 sujeitos entre 9 e 14 anos na linha de base da Coorte de Alto Risco para Transtornos Mentais, realizada em São Paulo e Porto Alegre em 57 escolas públicas. O temperamento foi mensurado através de um modelo fatorial utilizando itens da *Early Adolescent Temperament Questionnaire Revised* (EATQ-R) na qual foi encontrada uma solução bifatorial contendo Controle de Esforço, Medo, Frustração, Timidez e Extroversão. Inteligência foi analisada com o teste simplificado da escala Wechsler. Como desfechos, foram utilizados 1) contagem de repetência, suspensão e abandono escolar como eventos negativos (resultados em razão de taxa – RT), 2) rendimento acadêmico através de questionário aos pais por disciplina e testagem padronizada de aprendizagem de 3) escrita e 4) leitura. Foram realizadas regressões multinível (efeito randômico da escola) contendo cada traços de temperamento com termo de interação com Inteligência (6 modelos por desfecho). Análises de efeito marginal foram realizadas para explorar como as possíveis interações ocorrem.
RESULTADOS: Controle de Esforço (RT = 0,86; IC95% 0,78–0,94; p=0,001) e Frustração (RT = 1,19; IC95% 1,06–1,34; p=0,003) modificam o efeito da Inteligência para eventos escolares negativos. Frustração modifica o efeito da Inteligência para habilidade de leitura (β=-0,11; IC95% -0,17– -0,01; p=0.002). Análises de efeito marginal demonstram que a associação da Inteligência em diminuir as taxas de eventos negativos só ocorre quando os níveis de Controle de Esforço são maiores que -1,5 escores z e Frustração menores que 1,5 escores z. Inteligência se associa com melhor habilidade de leitura somente nos sujeitos com níveis de Frustração também menores que 1,5 escores z.
CONCLUSÃO: A Inteligência aumenta sua associação com menores taxas de eventos negativos quanto maior o nível de Controle de Esforço e menor a Frustração, bem como aumenta sua associação com habilidade de leitura quanto menor forem os níveis de Frustração.

Instituição de Fomento: CNPq, MRC e FAPESP.

9.2. Tabelas anexas

(instrumentos principais utilizados, validados em português)

9.2.1. Tabela anexa 1 - Escala de atributos positivos do comportamento (pertencente ao instrumento DAWBA)

[LER] *Já fiz várias perguntas sobre problemas e dificuldades. Agora eu gostaria de perguntar sobre os pontos positivos e as capacidades de* [Nome].

Parte 1 - As descrições a seguir servem para ele(a)?		Não	Um pouco	Muito
a)	Generoso(a)	0	1	2
b)	Animado(a)	0	1	2
c)	Tem vontade de aprender	0	1	2
d)	Afetuoso(a)	0	1	2
e)	Confiável e responsável	0	1	2
f)	Fácil de lidar	0	1	2
g)	Divertido(a), com senso de humor	0	1	2
h)	Interessado(a) em muitas coisas	0	1	2
i)	Carinhoso(a), bom coração	0	1	2
j)	Se algo dá errado, levanta a cabeça e segue em frente	0	1	2
k)	Agradecido(a), dá valor ao que recebe	0	1	2
l)	Independente	0	1	2
Parte 2 - Quais são as coisas que ele(a) faz que realmente lhe agradam?				
a)	Ajuda em casa	0	1	2
b)	Se dá bem com o resto da família	0	1	2
c)	Faz a lição de casa sem precisar ser lembrado	0	1	2
d)	Atividades criativas: artes, interpretação, ,música, trabalhos manuais	0	1	2
e)	Gosta de estar envolvido em atividades familiares	0	1	2
f)	Cuida da aparência	0	1	2
g)	Bom/boa com trabalhos escolares	0	1	2
h)	Educado(a)	0	1	2
i)	Bom/boa com esportes	0	1	2
j)	Mantém o quarto arrumado	0	1	2
k)	Bom/boa com amigos	0	1	2
l)	Bem comportado(a)	0	1	2

Nota: Este instrumento é parte do DAWBA, descrito por Goodman et al., 2000.

9.2.2. Tabela anexa 2 – Questionário de temperamento para adolescentes jovens (itens do *Early Adolescent Temperament Questionnaire*, versão brasileira)

Item	O quanto verdadeiro ou falso é cada afirmação para você? 1 Sempre ou quase sempre falso 2 Em geral é falso 3 Às vezes FALSO, às vezes VERDADEIRO 4 Em geral é verdadeiro 5 Sempre ou quase sempre verdadeiro
EQ7i	Tenho muita dificuldade em terminar as tarefas na data combinada *(no prazo).*
EQ30	Se eu tenho uma tarefa difícil para fazer, começo a fazer ela logo
EQ39	Eu termino as minhas tarefas antes da data combinada (limite/prazo).
EQ49i	Eu deixo para fazer o trabalho *(as tarefas)* depois até quase o prazo acabar *("deixo tudo para última hora").*
EQ1	Para mim, é realmente fácil me concentrar nas tarefas de casa (temas/lição/dever)
EQ34i	É difícil para mim trocar de um assunto (matéria/disciplina) para outro na escola (*Por exemplo: começar a entender a matéria de português, depois de sair de uma aula de matemática)*
EQ59	Eu presto muita atenção quando alguém me diz como fazer algo (*Ex.: quando alguém me ensina alguma coisa, ou me explica como eu devo fazer uma tarefa)*
EQ61i	Eu tenho tendência de parar no meio de uma tarefa, interromper o que eu estava fazendo e ir fazer outra coisa. (*Ex.: Começar a fazer o dever de casa e parar no meio para ver televisão ou jogar bola, sem terminar o dever)*
EQ14	Quando alguém me diz para parar de fazer alguma coisa que eu estou fazendo, é muito fácil para mim parar de fazer essa coisa.
EQ26i	Quanto mais eu tento parar de fazer algo que não devo, mais chance eu tenho de continuar fazendo isso (quando eu estou fazendo algo que eu sei que não devo, quanto mais eu tento parar, mais eu continuo fazendo)
EQ43	É fácil para mim guardar um segredo.
EQ63	Eu consigo me focar nos meus planos e objetivos *(dar prioridade para aquilo que eu planejei e dar prioridade para aquilo que eu quero no futuro)*
EQ32	Eu fico assustado quando ando de carro com uma pessoa que gosta de correr (na direção).
EQ40	Eu me preocupo com a possibilidade de entrar em confusão (Ex.: como entrar em uma briga sem querer).
EQ46	Eu tenho medo de garotos na escola que empurram as pessoas e atiram seus livros no chão.
EQ57	Eu fico com medo quando entro numa sala escura em casa.
EQ25	Fico incomodado quando tento fazer um telefonema/ligação e a linha de telefone está ocupada.
EQ36	Eu fico muito chateado quando quero fazer algo e os meus pais não deixam.
EQ47	Eu fico irritado quando tenho que parar de fazer alguma coisa que eu esteja gostando de fazer.
EQ62	Eu fico frustrado *(desapontado/chateado)* se as pessoas me interrompem quando estou falando.
EQ8	Eu me sinto envergonhado com crianças do sexo diferente do meu *(perto de meninas/perto de meninos)*
EQ15	Eu fico envergonhado quando tenho que conhecer pessoas novas
EQ45	Eu sou tímido *(envergonhado).*
EQ53i	Eu não sou tímido.
EQ28i	Descer rapidamente um morro alto de bicicleta me parece assustador.
EQ42	Não teria medo de praticar um esporte de risco, como mergulhar em alto mar.
EQ48	Eu não teria medo de tentar algo como escalar montanhas.
EQ52	Eu gosto de estar em locais *(lugares)* onde há grandes multidões e muita agitação. (*Ex.: como num shopping cheia, em uma praça cheia, etc.)*

Nota: Escala elaborada por Lesa K. Ellis e Mary K. Rothbart, 1999. Versão Portuguesa de Marina Carvalho, 2007.