

Temperament and early stuttering development

Temperament and early stuttering development: Cross-sectional findings from a community cohort.

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**Abstract**

**Purpose:** The purpose of this study was to ascertain if there is an association between stuttering severity and behaviors and the expression of temperament characteristics, including precursors of anxiety.

**Method:** We studied temperament characteristics of a prospectively recruited community cohort of stuttering children (N = 173) at ages 3, 4 and 6 years using the Short Temperament Scale.

**Results:** Six of 131 statistical tests of association between stuttering severity and behaviors and temperament traits were statistically significant at the 5% level, which was no more than expected by chance alone.

**Conclusion:** Based on parent responses to the Short Temperament Scale, preschoolers who exhibited different levels of stuttering severity and behaviors did not generally express temperament traits differently from one another. Stuttering severity and stuttering behaviors were not associated with the precursors of anxiety. Overall, taking multiple testing into consideration, results show little evidence of association between stuttering severity and temperament up to 4 years of age or between stuttering behaviors and temperament up to 6 years of age.

**Keywords:** Stuttering, Severity, Behaviors, Temperament, Anxiety, Children

## Temperament and early stuttering development

Temperament refers to the way a person responds to and interacts with the environment. Temperament is stable and genetically determined (Buss & Plomin, 1984; Costa & McCrae, 2001; Goldsmith, 1996; Rothbart, Derryberry & Hershey, 2000; Saudino, 2005). The expression of temperament traits varies, however, between individuals as personality traits. Between 20% and 60% of the variation in personality is explained by an individual's biological underpinnings, including genetic predisposition (Saudino, 2005; Goldsmith, Buss & Lemery, 1997; Loehlin, 1992; McCrae, et al, 2000). The remaining 40–80% of variation is accounted for by environmental factors (Buss & Plomin, 1984; Costa & McCrae, 2001; Saudino, 2005; Caspi, 1998; Kagan, Reznick, Clarke, Snidman & Garcia-Coll, 1984; Rothbart & Bates, 1998; Rothbart & Derryberry, 1981). In studies of temperament and early childhood stuttering, the temperament measures used are commonly based on the model devised by Thomas and Chess (1977). This model includes nine dimensions of temperament: activity level, rhythmicity, adaptability, attention span/persistence, threshold of responsiveness, intensity of reaction, quality of mood, distractibility, and approach.

In recent years three reviews have been published describing the inconclusive nature of the literature about the relationship between stuttering and temperament (Kefalianos, Onslow, Block, Menzies & Reilly, 2012; Conture, Kelly & Walden, 2013; Alm, 2014). Kefalianos et al (2012) highlighted that there has been some independent replication of findings. Compared to controls, stuttering children have lower *adaptability*, lower *attention span/persistence*, more negative *quality of mood* and higher *activity levels*. Alm (2014) asserted that as a group, children who stutter are not characterised by temperament traits which signal the onset of anxiety, but he also reported that “a subgroup of children who stutter tends to show somewhat elevated traits of inattention and hyperactivity-impulsivity” (p.18). This latter review raises two important issues about the current state of the literature in this field. First, published studies have yielded small effect sizes when reporting temperament

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differences between stuttering and control children. Second, the shape of the distribution of the temperament score in each group has not been reported in most studies. In those studies where the distributions have been plotted, the majority of scores overlap. Alm (2014) highlights that this suggests that, at best, only a small subgroup of children who stutter present with temperament anomalies that exceed those of their nonstuttering counterparts.

Recently we reported that preschool stuttering children recruited to our community-ascertained cohort did not have different temperaments from control children (Kefalianos, Onslow, Ukoumunne, Block & Reilly, 2014). This finding indicated that although temperament is not associated with stuttering onset there may be an association between temperament and the nature of stuttering development. One proposed hypothesis is that the degree of emotional reactivity and regulation a child exhibits influences stuttering severity and sustains its development during the early course of the disorder (Kraft, Ambrose & Chon, 2014; Jones, Choi, Conture & Walden, 2014). A second hypothesis is that stuttering severity may be associated with a child's risk of developing anxiety-related personality traits later in childhood, past the time of stuttering onset. Langevin, Packman and Onslow (2009) observed stuttering preschool children interacting with their peers at kindergarten and found that negative peer responses occurred contingent on stuttering moments. There are also parent reports available that are consistent with this observational study (Bloodstein, 1960; Boey et al, 2009; Langevin, Packman & Onslow, 2010; Yairi, 1983). Arguably, more severe and therefore more overt stuttering moments may be more likely to incur these negative responses. It is therefore possible that the expression of temperament traits as personality later during childhood can be influenced by such early negative conditioning experiences. Both these possibilities prompt a hypothesis that there is a relationship between stuttering severity and temperament at some time during childhood.

By adolescence and adulthood, there is certainly a well-established association between stuttering and anxiety. To our knowledge, however, no research has examined the relationship between stuttering severity and anxiety in this population. Blood and Blood (2004) reported that adolescents with more severe stuttering have greater communication apprehension and perceive themselves to have poor communication competence. Adults with more severe stuttering also report lower educational achievement (O'Brian, Jones, Packman, Menzies & Onslow, 2011).

To date, reports of a relationship between stuttering severity and temperament have been inconclusive. Kraft et al (2014) studied preschool stuttering children with the Children's Behavior Questionnaire-Short Form (Putnam & Rothbart, 2006) and reported a significant correlation between the temperament dimension of "effortful control" and parent measures of stuttering severity. Ntourou, Conture, and Walden (2013) reported a relationship between emotion regulation behaviors and stuttering rate during a narrative. Several findings indicate that when preschoolers who stutter use reduced emotional regulation they produce fewer stuttering moments (Arnold, Conture, Key & Walden, 2011; Johnson, Walden, Conture & Karrass, 2010; Walden et al, 2012). Similarly, Choi, Conture, Walden, Lambert and Tumanova (2013) reported a positive relationship between behavioral inhibition and stuttering in preschoolers. Schwenk, Conture and Walden (2007) reported a "marginally significant" result for more distractible children to have more stuttering-like disfluencies.

Others have not reported associations between temperament and stuttering severity or behaviors. Eggers, De Nil and Van den Bergh, 2012 found no relationship between temperament and stuttering severity. Tumanova, Zebrowski, Throneburg and Kulak Kayikci (2011) found no association between children's levels of inhibitory control or their attentional abilities and the length of sound prolongations they produced.

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To date, nine studies have examined the relationship between temperament and stuttering severity or behaviors. Seven have reported that a relationship exists, although the nature of this relationship varies between studies, while two other studies have found no relationship. Hence the nature of this relationship remains inconclusive. Importantly, all previous studies have based findings on clinical cohorts and paid participants. Independent replication of findings using a community cohort of volunteers is required to establish the association between temperament and stuttering severity and behaviors definitively.

The present research sought to examine in a community cohort whether there is a cross-sectional relationship between:

- a) stuttering severity and temperament at each of 3 and 4 years of age; and
- b) stuttering severity and temperament at each of 3, 4 and 6 years of age.

## **Method**

### *Overview of the Early Language in Victoria Study*

Stuttering children were recruited from a prospective longitudinal cohort study of language development: the Early Language in Victoria Study (ELVS) (see Reilly et al, 2007; 2009 for details). Recruitment occurred in six of the 31 metropolitan Local Government Areas (LGAs) in Melbourne, Australia. Participating LGAs were selected by stratifying the 31 LGAs into three tiers according to Socio-Economic Indexes for Areas (SEIFA) scores which quantify social disadvantage. SEIFA scores were derived from the census-based SEIFA Index of Disadvantage developed by the Australian Bureau of Statistics (2001). The SEIFA Index of Disadvantage reflects factors such as high unemployment, low income and low educational attainment. The SEIFA scores are standardized to have a population mean of 1000 and standard deviation of 100. Lower scores reflect greater disadvantage. Two non-adjacent LGAs were then selected from each of the three tiers of SEIFA scores to ensure that a broad

socio-demographic range of advantaged-disadvantaged regions in Melbourne were captured (Reilly et al, 2009).

Within the six selected LGAs, children were recruited through referrals from Maternal and Child Health Nurses at infants' routine 8-month visit across a 4-month period, referrals from Maternal and Child Health Nurses Hearing Screening Sessions attended by infants at 7-9 months, and advertisements in suburban and metropolitan newspapers.

Children were excluded if they were: diagnosed with a disability (syndrome, medical illness, significant vision or hearing impairment) or other significant physical or intellectual disability or their parents were unable to speak and understand English at an adequate level to complete parent-report questionnaires.

Parents in the ELVS study completed questionnaires at recruitment (8 months) and at each subsequent birthday between 1 year and 7 years of age.

### ***Recruitment for nested study of stuttering***

All of the ELVS participants who completed the 2-year-old parent report questionnaire were sent a recruitment pack inviting them to participate in the nested study of stuttering. Recruitment packs contained an invitation to the stuttering study, a fridge magnet which included a checklist of speech behaviors which typify stuttering (see Appendix, Figure A1) and an "opt-out" letter. Of the 1,910 children recruited to ELVS, 1,619 (85% of original ELVS cohort) consented and were recruited to the nested stuttering study. Of these 1,619 participants, 218 children were diagnosed with autism spectrum disorder and/or delayed language skills. These children were excluded from the current study as research has shown that such children express temperament traits differently from typically developing children (Adamek et al, 2011; Beitchman et al, 1996; Bolton, Golding, Emond & Steer, 2012; Fortenberry, Grist, McCord, 2011; Paul & James, 1990; Paul & Kellogg, 1997; Prior, Bavin, Cini, Eadie & Reilly, 2011; Prior et al, 2008).

Parents recruited to the nested stuttering study were instructed to contact the research team if their child started to exhibit any of the behaviors described on the fridge magnet (Reilly et al, 2009). Reminder letters were sent every 4 months asking parents to monitor their child's speech and contact the research team if they observed any of the behaviors. When a parent contacted the research team, a speech-language pathologist (SLP) ascertained by telephone interview whether the speech behaviors described by the parent resembled stuttering. In instances where they thought the child was stuttering, the SLP scheduled a home visit to confirm the presence of stuttering. At this visit, the SLP interviewed the parent about stuttering onset and speech behaviors being exhibited by the child. Following this, the parent and child were video-recorded in a play session. At the conclusion of the play session, the SLP and parent completed a Stuttering Severity Scale scored from 1 to 10, where 1 = no stuttering, 2 = extremely mild stuttering and 10 = extremely severe stuttering. The child was confirmed as stuttering when both the SLP and parent scored 2 or more on this scale during the play session. In total, 173 children were confirmed as stuttering by age 4 years and comprise the sample analyzed in this paper.

All of these children were offered 12 subsequent consecutive monthly home visits. At each of these home visits, the parent completed a brief questionnaire about their child's stuttering (Disfluency Questionnaire). Parents also participated in a 25-minute play session with their child at each home visit. At the end of the play session they were asked to complete the Stuttering Severity Scale. Both of these measures are discussed in detail below.

### ***Measures***

#### *Stuttering Severity Scale*

The stuttering severity scale is a 10-point scale, where a score of 1 represents no stuttering, a score of 2 represents extremely mild stuttering and a score of 10 represents extremely severe stuttering. The rater is required to assign a score from 1 to 10, which

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quantifies the severity of the stuttering exhibited by their child. As described in the previous section, parents were introduced to the Stuttering Severity Scale by a SLP during their initial home visit when the parent and SLP each rated the child's stuttering. Parents were told that the score allocated needed to reflect their child's average stuttering severity during the play session. Additionally, parents were asked to rate their child's speech on average for the past week using the stuttering severity scale.

During each of the 12 subsequent consecutive monthly home visits parents provided a severity rating for their child's stuttering that day and over the past week. For the current study, the parent rating for the past week was taken from the monthly questionnaire completed immediately prior to the corresponding annual questionnaire containing the STS. We therefore obtained stuttering severity data from the monthly questionnaires and temperament data from the annual questionnaire to examine the relationship between stuttering severity and the expression of temperament traits.

### *Disfluency Questionnaire*

The Disfluency Questionnaire was developed by Kloth, Janssen and Kraaimaat, (1989). The questionnaire contains a list of nine behaviors which typify stuttering. These behaviors include: sound repetitions, syllable repetitions, whole word repetitions, phrase repetitions, sound prolongations, blocks, fillers, word substitutions, and secondary/physical symptoms. The Disfluency Questionnaire uses a 5-point response scale which indicates how frequently the parent has observed their child produce the behavior listed: 1 = *never*, 2 = *rarely*, 3 = *sometimes*, 4 = *often* and 5 = *very often*. For each of the stuttering behaviors listed above, parents were required to assign the score from 1 to 5 that most accurately described how often they have observed their child produce each of the listed behaviors over the past week.

Parents completed the Disfluency Questionnaire at each of the 12 consecutive monthly home visits following stuttering onset. The Disfluency Questionnaire completed in the monthly questionnaire immediately prior to the corresponding annual questionnaire was used for the current study. At 6 years of age, parents completed the Disfluency Questionnaire as part of the annual questionnaire.

### *Short Temperament Scale*

The Short Temperament Scale was completed by parents around the time of their child's birthday at ages 2, 3, 4 and 6 years. There are two versions of the Short Temperament Scale: the Short Temperament Scale for Toddlers (STST) which measures six temperament dimensions of Australian infants aged up to 3.5 years (Approach, Distractibility, Rhythmicity, Reactivity, Cooperation and Persistence) and the Short Temperament Scale for Children (STSC) which measures four temperament dimensions of Australian children aged 3.5-8.3 years (Approach, Rhythmicity, Inflexibility and Persistence). Both versions have demonstrated validity (Prior, Sanson, Smart & Oberklaid, 2000). An overall Easy-Difficult score is also calculated to provide an overall measure of a child's temperament. All 30 items on each version are scored on a 6-point scale (1 to 6). Scores reflect how frequently parents observe their child exhibiting the behavior described in the item. *Approach (Sociability)* (STST - 5 items; STSC - 7 items) measures a child's response to new and unfamiliar people and situations. Specifically, items measure whether a child is more likely to approach these situations or exhibit signs of withdrawal and shyness. Higher scores (STST possible range 5 to 30; STSC possible range 7 to 42) indicate that the child is more withdrawn and shy. This temperament dimension has been identified as a precursor to the development of anxiety. *Distractibility* (STST - 4 items) measures 'the ease with which a child can be distracted or comforted when needed'. Higher scores (STST possible range 4 to 24) indicate that the child is *not* distractible. *Rhythmicity* (STST - 4 items; STSC - 7 items) measures the 'regularity and

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predictability' of physiologic functions such as sleeping patterns or times that the child gets hungry or requires toileting. A higher score (STST possible range 4 to 24; STSC possible range 7 to 42) indicates that the child is *less* rhythmic. *Reactivity* (STST - 8 items) measures the amount of energy a child exerts in response to a stimulus. A higher score (STST possible range 8 to 48) indicates that the child is more reactive and irritable. *Cooperation* (STST - 5 items) measures how easily a child adapts to routine activities throughout the day. A higher score (STST possible range 5 to 30) indicates that the child is *uncooperative*. *Persistence* (STST - 4 items; STSC - 7 items) measures a child's ability to focus on a task until it is completed. A higher score (STST possible range 4 to 24; STSC possible range 7 to 42) indicates that the child is *not* persistent. *Inflexibility* (STSC - 9 items) measures a child's 'difficulty in dealing with anger and frustration, and adjusting to challenges'. A higher score (STSC possible range 9 to 54) indicates that the child is inflexible. The overall *Easy-Difficult* score is calculated as the sum of the items spanning Approach, Reactivity and Cooperation for the STST and as the sum of the items spanning Approach, Inflexibility and Persistence for the STSC. A higher Easy-Difficult score (possible range 1 to 6) indicates that the child has a more *difficult* temperament which may be a precursor of anxiety.

Each version of the STS measures the temperament dimensions deemed to be most representative of Australian children at the corresponding ages. Different temperament dimensions are therefore measured within the STST and STSC. Consequently, some temperament dimensions were not measured at every age within the study. The complete STST was administered at age 3 years and the complete STSC was administered at ages 4 and 6 years as part of the annual ELVS assessment.

### ***Statistical analysis***

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Characteristics for the 173 stuttering children were summarized using means and standard deviations for continuous variables and percentages for categorical variables (see Table 1). Cross-sectional relationships were examined between temperament and stuttering severity at each of 3 and 4 years of age and between temperament and different stuttering behaviors at each of 3, 4 and 6 years of age. For example, we examined the relationship between stuttering severity at 3 years and temperament at 3 years.

Temperament was measured at the 3, 4 and 6 year old annual assessments as part of the main ELVS study but stuttering severity was only measured in the 12 monthly visits following onset. Therefore temperament was only examined in relation to stuttering severity at each of ages 3 years and 4 years as all stuttering participants were recruited by 4 years. The age at which a child contributed data for this analysis was determined by the age of stuttering onset, because stuttering severity data were only provided during the 12 months following onset. The stuttering severity report that was closest to the annual assessment was used. The same approach was used to analyze temperament in relation to stuttering behaviors at each of ages 3 and 4 years, but in addition their relationship was also examined at 6 years because the Stuttering Disfluency Questionnaire was distributed via questionnaire at this age. We considered pooling data across the different ages into a single analysis when examining the cross-sectional association between temperament and stuttering but decided against this as the temperament measure for some specific dimensions changes between 3 and 4 years of age. Separate analyses of the association between temperament and stuttering are conducted at each age. Only a subset the 173 eligible stuttering children were included in any given analysis as not all children provided data on stuttering severity/behaviours and temperament and not all children stuttered by 3 years, the age at which the cross-sectional relationships of interest were first examined.

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Temperament was analyzed as a continuous outcome (dependent variable). The stuttering severity variable (predictor) was categorised into three groups: participants whose parents assigned a severity rating of 2 (extremely mild stuttering), a severity rating of 3 (mild stuttering) and a severity rating of 4 or higher (moderate-severe stuttering). Being a community cohort, the majority of participants exhibited extremely mild stuttering severity levels. Given this, participants were categorised in a manner to create groups of similar size. The stuttering behaviors (predictors) of the children were dichotomized into participants who never exhibited the behavior (i.e., had scored 1) versus those who exhibited the behavior irrespective of frequency (i.e., had scored 2 to 5).

STATA statistical software was used to clean and analyse the data. We conducted a range of checks to make sure only plausible values were inputted for the study variables. We examined relationships between variables to check for consistency. Analysis of variance was used to compare mean temperament scores across the three stuttering severity groups at ages 3 and 4 years. Two sample (independent groups) *t*-tests were used to compare the mean temperament scores between those who did and those who did not exhibit specific stuttering behaviors at ages 3, 4 and 6 years. Multiple linear regression was used to adjust the comparisons between those who did and did not exhibit specific stuttering behaviors for biological, environmental and demographic variables previously identified as significantly associated with the expression of temperament traits in this cohort: gender, twinning, premature birth, birth weight, birth order, family history of communication difficulties, socioeconomic status, maternal education level, maternal mental health, expressive language skills measured at 2 years of age. In the results section, we focus on the adjusted analyses as the results were similar to the unadjusted analyses whilst also accounting for potential confounding variables. Altogether 131 statistical tests were carried; 12 examining stuttering

severity in relation to temperament and 119 examining stuttering behaviors in relation to temperament.

## Results

Table 1 presents biological, environmental and demographic information about the stuttering participants collected when they were recruited to ELVS at age 8 months. All participants were stuttering at the time the analyses were conducted. Of the 173 participants: 9 (5.2%) recovered within 12 months, 118 (68.2%) did not recover within 12 months and 46 (26.6%) provided insufficient information to be classified on recovery status.

**Table 1.** Characteristics of stuttering participants at recruitment

Characteristics	Statistics
Gender	
Boys, %	58.4
Twin birth, %	5.2
Premature birth, %	2.9
Birth weight in kg, mean (SD)	3.5 (0.5)
Birth order	
First child, %	51.4
Second child or more, %	48.6
Family history	
No problem, %	76.3
Speech/language/reading problems only, %	14.5
Family history of stuttering, %	9.2
*SEIFA disadvantage score, mean (SD)	1049 (45)
Mother's education level	
Did not complete secondary school, %	16.4
Completed secondary school, %	30.4
Degree/postgraduate qualification, %	53.2
Maternal mental health score, mean (SD)	3.1 (2.9)
**CSBS total score, mean (SD)	107.8 (15.4)
***CDI raw vocabulary score, mean (SD)	283.7 (154.4)

\*SEIFA: Socio-Economic Indexes for Areas (SEIFA) Index of Disadvantage

\*\*CSBS: Communication and Symbolic Behaviour Scales

\*\*\*CDI: MacArthur-Bates Communicative Development Inventory

Number of respondents ranges from 167 to 173

***Validation of parent-reported stuttering severity scores***

Parent severity scores were validated using 20 randomly selected 25-minute speech samples, provided by participants at 4 years of age. Parent and SLP stuttering severity scores were compared for each of the selected samples. “Reasonable agreement” was considered achieved when the parent and SLP scores differed by no more than one point on the 10-point scale. The parent and SLP assigned identical scores for 16 out of 20 samples. The SLP assigned a score of 2 for three of the samples which parents had assigned a score of 1. For the final sample, the SLP and parent severity scores differed by 2 points on the scale (the SLP scored 4 and the parent scored 2). The weighted Kappa statistic was 0.51 ( $p=0.002$ ) indicating moderate agreement (Landis & Koch, 1977).

***Relationship between temperament and stuttering severity***

We found no statistically significant differences at the 5% level based on a total of 12 tests across the stuttering severity groups for any temperament measure at 3 years or 4 years (see Appendix, Table A1). The sample sizes on which these analyses are based are presented in Table 2.

**Table 2.** Sample sizes for investigating relationships between temperament and stuttering severity and between temperament and stuttering behaviours at different ages

<b>Outcome</b>	<b>Predictor</b>	<b>Age</b>	<b>Sample size</b>
Temperament	Stuttering severity	3 years	77
Temperament	Stuttering severity	4 years	46
Temperament	Stuttering behaviours	3 years	102
Temperament	Stuttering behaviours	4 years	79
Temperament	Stuttering behaviours	6 years	29

### ***Relationship between temperament and stuttering behaviors***

Out of a total of 119 statistical tests to compare temperament between stuttering behavior groups only six significant differences were identified at the 5% level (see Appendix, Tables A2-A7). The sample sizes on which these analyses are based are presented in Table 2. At 3 years of age, children who produced part-word repetitions (N=42) were *less* cooperative adapting to routine activities and tasks (mean difference = 2.3; 95% CI: 0.4 to 4.1;  $p=0.02$ ) compared to children who did not produce part-word repetitions (N=60). Three-year-olds who produced secondary behaviors (N=11) had less regular physiologic functions (mean difference = 1.9; 95% CI: 0.1 to 3.6;  $p=0.04$ ) than children who did not produce secondary behaviors (N=91).

At 4 years of age, children who exhibited secondary behaviors (N=3) were reported to be more approaching in unfamiliar situations and with strangers (mean difference = 10.1; 95% CI: 2.8 to 17.5;  $p=0.01$ ) compared to children who did not exhibit secondary behaviors (N=75). Four-year-olds who exhibited sound prolongations (N=68) had less regular physiologic functions (mean difference = 3.6; 95% CI: 0.4 to 6.8;  $p=0.03$ ) than children who did not exhibit sound prolongations (N=11).

At 6 years of age, children who produced phrase repetitions (N=13) had more regular physiologic functions (mean difference = 4.0; 95% CI: 0.0 to 7.9;  $p=0.05$ ) than children who did not produce phrase repetitions (N=16). Finally, six-year-olds who produced blocks (N=7) had a more difficult temperament, a precursor of anxiety, compared to those who did not produce blocks (N=20) (mean difference = 12.4; 95% CI: 3.0 to 21.8;  $p=0.01$ ).

### **Discussion**

Of 131 statistical tests of the relationship between temperament with stuttering severity and behaviors only six were significant at the 5% level. This is what might be

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expected by chance, that is if there is no true association in the population. The lack of consistency in the associations across child age adds further doubt to their salience. We are mindful of the potential limitation that the sample size for many of the comparisons was small and therefore the study was insufficiently powered to detect differences. Illustrating this, for many of the analyses the confidence intervals were too wide to rule out the possibility of relationships that would be considered important if they were real (see Appendix Tables A1 to A7). Given the large number of statistical tests conducted, however, overall, the results, taken at face value, provide little evidence of a relationship between temperament and features of stuttering up to 6 years of age. Another potential explanation for the null findings is that we conducted only cross-sectional analyses of the association between temperament and stuttering features. Effect of stuttering features on temperament or vice versa may be delayed or lagged limiting the ability of cross-sectional analyses to detect them.

We found little evidence of an association between anxiety-prone “difficult” or “approach” temperament traits and stuttering severity up to 4 years of age. This finding is consistent with previous studies, which have failed to find an association between stuttering severity and anxiety in adulthood. These findings have important clinical implications. While the potential catalysts of mental health problems for people who stutter may have their origins during the preschool years, such as negative peer reactions and child distress, there are no signs of these mental health problems developing during the preschool years in this community cohort. Our findings do not provide evidence to suggest that clinicians need to use temperament as a screener for signs of impending mental health problems when establishing the timing of intervention for individual stuttering children.

When investigating the relationship between stuttering behaviors and temperament up to 6 years of age only six of 119 statistical tests were significant at the 5% level. Earlier we

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described two possible explanations for the association between temperament and stuttering severity and behaviors: temperament as a factor which influences stuttering severity and temperament differences which emerge as a result of developmental influence over time. In our study, six year olds who produced phrase repetitions had more regular physiologic functions while those who produced blocks had a more difficult temperament, a precursor of anxiety. It may be argued that blocks are a more effortful behavior than repetitive behaviors; blocks may therefore be more likely to influence a child's communication experiences, promoting anxiety. Existence of this influence, however, is only supported by analyses in the later years of childhood and then only if one ignores the multiple statistical tests conducted.

## **Conclusion**

This is the first study to examine the relationship between stuttering severity, behaviors and temperament within a community cohort of children. Overall, our findings did not provide clear evidence of a relationship between stuttering severity or stuttering behaviors and temperament during the preschool years. The finding that 6 year olds who produced blocks exhibited temperament precursors of anxiety suggests a possible developmental influence. By 6 years of age, the preliminary signs of anxiety may manifest as a result of constant experience of effortful stuttering behaviors. However, given the small sample size and uncertainty with which the differences in temperament are estimated, these findings need to be replicated in studies with larger numbers of children who stutter before we can definitively conclude there is no salient association.

## **Acknowledgements**

The ELVS was funded by Australian National Health and Medical Research Council (NHMRC) grants 237106, 436958 and 436958. An additional NHMRC program grant, held by Professor Onslow and grants from the Murdoch Childrens Research Institute and the Faculty of Health Sciences at La Trobe University also supplemented funding for this project. Dr Ukoumunne is supported by the National Institute for Health Research (NIHR) Collaboration for Leadership in Applied Health Research and Care (CLAHRC) for the South West Peninsula at the Royal Devon and Exeter NHS Foundation Trust. The views expressed in this publication are those of the authors and not necessarily those of the NHS, the NIHR or the Department of Health in England. Ethical approval was obtained from the Royal Childrens Hospital Melbourne (23018) and La Trobe University Human Ethics Committee (03-32). This research was supported by the Victorian Government's Operational Infrastructure Support Program. We would also like to acknowledge the team of ELVS investigators, particularly Professor Ann Packman, Doctor Patricia Eadie and Professor Melissa Wake, and all of the participating children and parents of ELVS.

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**Table A1.** Comparison of mean temperament scores between participants with different levels of stuttering severity at ages 3 and 4 years

Temperament dimension	Severity group	N	Mean (SD)	Crude mean difference estimate	Adjusted mean difference		
					estimate	95% CI	p value
<b>3 years</b>							
Approach	Extremely Mild	27	16.5 (3.0)				0.06
	Mild	25	18.1 (4.9)	1.6	2.2	-0.3 to 4.7	
	Moderate-Severe	25	15.8 (3.5)	-0.7	-0.6	-3.2 to 1.9	
Distractibility	Extremely Mild	27	15.5 (2.3)				0.98
	Mild	25	15.0 (2.2)	-0.4	0.0	-1.3 to 1.3	
	Moderate-Severe	25	14.8 (2.2)	-0.6	0.1	-1.2 to 1.4	
Rhythmicity	Extremely Mild	27	10.9 (2.3)				0.07
	Mild	25	10.9 (2.6)	-0.2	-0.3	-1.8 to 1.3	
	Moderate-Severe	25	11.9 (2.3)	1.1	1.4	-0.2 to 3.0	
Reactivity	Extremely Mild	27	28.0 (4.0)				0.35
	Mild	25	26.4 (3.9)	-1.6	-1.1	-3.4 to 1.2	
	Moderate-Severe	25	25.9 (4.5)	-2.1	-1.7	-4.1 to 0.7	
Cooperation	Extremely Mild	27	14.3 (3.7)				0.71
	Mild	25	14.8 (4.4)	0.4	0.5	-2.1 to 3.0	
	Moderate-Severe	25	13.1 (4.1)	-1.2	-0.6	-3.2 to 2.0	
Persistence	Extremely Mild	27	14.0 (2.4)				0.97
	Mild	25	14.6 (2.3)	0.6	0.1	-1.4 to 1.6	
	Moderate-Severe	25	14.5 (2.3)	0.5	-0.1	-1.6 to 1.4	
Easy-difficult	Extremely Mild	27	58.9 (6.1)				0.18
	Mild	25	59.3 (10.4)	0.4	1.5	-3.3 to 6.4	
	Moderate-Severe	25	54.8 (7.1)	-4.1	-2.9	-7.9 to 2.0	

**4 years**

Temperament and early stuttering development

Approach	Extremely Mild	20	20.5 (5.6)					0.87
	Mild	14	20.5 (6.3)	0.1	1.3	-3.8 to 6.4		
	Moderate-Severe	12	21.2 (4.4)	0.7	0.4	-4.1 to 5.0		
Rhythmicity	Extremely Mild	20	19.6 (4.7)					0.11
	Mild	14	17.3 (5.8)	-2.3	-0.5	-5.5 to 4.4		
	Moderate-Severe	12	15.4 (4.6)	-4.2	-4.7	-9.2 to -0.3		
Inflexibility	Extremely Mild	20	26.5 (7.1)					0.35
	Mild	14	27.1 (6.2)	0.6	3.4	-3.2 to 10.0		
	Moderate-Severe	12	24.7 (7.6)	-1.8	-2.3	-8.2 to 3.6		
Persistence	Extremely Mild	20	20.9 (4.7)					0.72
	Mild	14	20.2 (5.4)	-0.6	0.5	-4.4 to 5.5		
	Moderate-Severe	12	23.3 (3.2)	2.4	1.8	-2.7 to 6.3		
Easy-difficult	Extremely Mild	20	67.8 (13.4)					0.71
	Mild	14	67.9 (15.2)	0.1	5.2	-7.8 to 18.3		
	Moderate-Severe	12	69.1 (9.6)	1.3	-0.1	--11.8 to 11.7		

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Mean differences are shown between the mild and extremely mild stuttering groups and between the moderate-severe and extremely mild stuttering groups.

Temperament and early stuttering development

**Table A2.** Comparison of mean temperament scores between participants who produced sound repetitions and those who did not at ages 3, 4 and 6 years

Temperament Dimension	Sound Repetitions		No Sound Repetitions		Crude Mean Difference	Adjusted	
	N	Mean (SD)	N	Mean (SD)		Mean Difference (95% CI)	p-value
<b>3 years</b>	43		59				
Approach		16.2 (3.5)		17.7 (3.8)	-1.50	-1.60 (-3.3 to 0.1)	0.07
Distractibility		14.8 (2.0)		15.6 (2.6)	-0.82	-0.69 (-1.7 to 0.3)	0.18
Rhythmicity		10.7 (2.2)		11.5 (2.8)	-0.80	-0.59 (-1.8 to 0.6)	0.32
Reactivity		26.9 (4.0)		26.8 (4.7)	0.03	0.60 (-1.3 to 2.5)	0.54
Cooperation		13.4 (4.2)		13.8 (4.4)	-0.40	-0.26 (-2.2 to 1.7)	0.79
Persistence		14.3 (2.3)		14.2 (2.4)	0.06	0.00 (-1.1 to 1.1)	1.00
Easy-Difficult		56.4 (8.1)		58.3 (7.7)	-1.87	-1.26 (-4.9 to 2.3)	0.49
<b>4 years</b>	18		60				
Approach		20.6 (4.4)		21.4 (6.6)	-0.79	-1.14 (-4.8 to 2.5)	0.54
Rhythmicity		18.9 (4.9)		17.1 (5.1)	1.81	1.01 (-2.0 to 4.0)	0.50
Inflexibility		27.7 (6.1)		24.0 (6.7)	3.73	3.95 (-0.1 to 8.0)	0.06
Persistence		23.0 (3.7)		21.5 (5.1)	1.50	1.90 (-1.1 to 4.9)	0.20
Easy-Difficult		71.3 (9.3)		66.9 (13.7)	4.44	4.71 (-3.2 to 12.6)	0.24
<b>6 years</b>	4		25				
Approach		16.5 (5.9)		17.5 (6.6)	-1.02	2.65 (-10.0 to 15.3)	0.66
Rhythmicity		19.8 (3.3)		15.7 (4.8)	4.03	0.81 (-7.8 to 9.4)	0.84
Inflexibility		19.8 (7.1)		22.7 (7.8)	-2.98	-3.96 (-16.0 to 8.0)	0.49
Persistence		19.8 (6.7)		21.3 (6.0)	-1.57	-3.91 (-17.4 to 9.6)	0.54
Easy-Difficult		56.0 (12.9)		61.6 (14.5)	-5.57	-5.23 (-26.8 to 16.4)	0.61