



Temperament dimensions in stuttering and typically developing children

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Abstract

Purpose: The purpose of this study was to determine whether children who stutter (CWS) and typically developing children (TDC) differ from each other on composite temperament factors or on individual temperament scales.

Methods: Participants consisted of 116 age and gender-matched CWS and TDC (3.04–8.11). Temperament was assessed with a Dutch version of the Children's Behavior Questionnaire (CBQ-D; Van den Bergh and Ackx, 2003), a caregiver rating scale.

Results: Results indicated significant differences between participant groups on the composite temperament factors of Negative Affectivity, and Effortful Control. Analysis of the individual temperament scales showed that CWS, compared to the TDC, scored significantly lower on the scales of 'Inhibitory Control' and 'Attentional Shifting' and higher on the scales of 'Anger/Frustration', 'Approach' and 'Motor Activation'. Stuttering severity and months of therapy were not associated with either of the temperament dimensions.

Conclusions: The present study provides data that support the hypothesis that CWS and TDC differ on both composite temperament factors and temperament scales. The findings were interpreted within existing frameworks of temperament development, as well as with regard to previous studies of temperament in CWS.

Educational objectives: After reading this article, the reader will be able to: (1) describe the concept of temperament, including Rothbart's temperamental model, and its functional significance; (2) explain the CBQ-based (Children's Behavior Questionnaire) temperamental differences between CWS and CWNS; and (3) explain possible pathways for interaction between temperament and the development of stuttering.

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1. Introduction

The purpose of this study was to investigate the relationship between temperament and developmental stuttering, using the Children’s Behavior Questionnaire—Dutch (CBQ-D; Van den Bergh & Ackx, 2003), a parental temperament questionnaire. Because temperament has been defined and interpreted differently in the last decades, we start the introduction by addressing the concept of temperament. This is followed by a brief review of the role of temperament in the development of behavioral disorders, followed by a review of current research on temperament and developmental stuttering.

1.1. *The concept of temperament*

At present, most theorists agree that temperament refers to biologically based individual differences that are relatively stable over time, and appear early in the child’s development (e.g., Goldsmith et al., 1987). Early approaches stressed the importance of stability of these traits (Buss & Plomin, 1984; Costa & McCrae, 2001) and saw it as a behavioral (Thomas & Chess, 1977) or primarily emotion-oriented style (Goldsmith & Campos, 1982). More recent models acknowledge that temperament itself develops over time (Goldsmith, 1996; Plomin & Dunn, 1986; Rothbart, 1989), incorporates motivational and self-regulatory systems (Posner & Rothbart, 1998) and is influenced by environmental interactions (Arcus, 2001; Halverson & Deal, 2001; Saudino, 2005).

Rothbart defines temperament as ‘constitutionally based individual differences in reactivity and self-regulation’ (Rothbart, Ahadi, Hershey, & Fisher, 2001). In her definition, ‘reactivity’ refers to the arousability of physiological and sensory response systems, and ‘self-regulation’ are those processes that can modulate (facilitate or inhibit) one’s reactivity. ‘Constitutional’, in turn, is referring to the individual’s biological basis, influenced over time by genetics, maturation, and experience. In other words, the temperament structure changes over time, from a predominantly reactivity-driven concept in infants to a structure with more emphasis on self-regulatory processes in older children (Putnam, Ellis, & Rothbart, 2001). In order to assess temperamental characteristics, Rothbart developed a number of questionnaires aimed at different age ranges. The Children’s Behavior Questionnaire (CBQ; Rothbart et al., 2001) assesses temperament in early to middle childhood and consists of 15 temperament scales. Factor-analyses of these scales repeatedly have revealed 3 composite temperament factors, namely positive reactivity (i.e., the tendency to actively and energetically approach new experiences in an emotionally positive way), negative reactivity (i.e., the tendency to be sad, fearful, easily frustrated, and irritable), and effortful control (i.e., the ability to sustain attention, control one’s behavior, and regulate one’s emotions) (Ahadi, Rothbart, & Ye, 1993; Eggers, De Nil, & van Den Bergh, 2009; Kusanagi, 1993; Rothbart et al., 2001; Van den Bergh & Ackx, 2003). In the CBQ, Positive Reactivity (or Extraversion/Surgency) comprises the scales Impulsivity, Activity Level, High Intensity Pleasure, Motor Activation, Shyness, Approach, and Smiling/Laughter. Negative Reactivity (or Negative Affectivity) comprises the scales Anger/Frustration, Discomfort, Sadness, Fear, and Falling Reactivity/Soothability. Low Intensity Pleasure, Inhibitory Control, Perceptual Sensitivity, Attentional Focusing, Attentional Shifting, and Excitatory Control cluster under Effortful Control (Van den Bergh & Ackx, 2003; for scale definitions and questionnaire sample items see Table 1).

1.2. *Temperament as a moderator in the development of behavioral disorders*

Child temperament researchers recognize how both innate individual differences and the environmental context shape children’s behavior. In particular, temperamental concepts are being used to explain behavioral and physiological patterns, and responses that are evoked under conditions of stress (e.g., novelty situations, interaction with unfamiliar persons, intense stimuli), and conditioned responses to certain stimuli (Gray, 1987; Strelau, 2001). Moreover, the idea of temperament predisposing the susceptibility for or moderating the development of certain disorders (e.g., anxiety disorders) has received widespread attention in health psychology literature (e.g., Kubzansky, Martin, & Buka, 2009; Puttonen et al., 2008; Smith & Williams, 1992; Williams, Wiebe, & Smith, 1992). Recent integration of temperamental research and childhood psychopathology (Frick, 2004; Nigg & Goldsmith, 1998; Rettew & McKee, 2005) has created new insights in possible ways of temperament interaction. For instance, there is mounting empirical evidence that both reactive temperamental factors (Extraversion/Surgency and Negative Affectivity) as well as regulative processes (Effortful Control) play an important role in the onset, development and maintenance of disorders such as anxiety disorders (Bijttebier & Roeyers, 2009; Lonigan & Vasey, 2009). Temperament dimensions have also been identified

Table 1
Scale definitions of the Children’s Behavior Questionnaire-Dutch (CBQ-D) and sample items (Van den Bergh & Ackx, 2003).

Scale	Definition
Extraversion/surgency	
1. Impulsivity	The speed of response initiation. <i>Sample item: Usually rushes into an activity without thinking about it.</i>
2. Activity level	The level of gross motor activity including rate and extent of locomotion. <i>Sample item: Moves about actively (runs, climbs, jumps) when playing in the house.</i>
3. High intensity pleasure	The amount of pleasure or enjoyment related to situations involving high stimulus intensity, rate, complexity, novelty, and incongruity. <i>Sample item: Likes to play so wild and recklessly that s/he might get hurt.</i>
4. Motor activation	The amount of excess repetitive small-motor movement, such as finger tapping. <i>Sample item: Fidgets during quiet activities, such as hearing a story, looking at pictures.</i>
5. Shyness	Slow or inhibited approach in situations involving novelty or uncertainty. <i>Sample item: Sometimes prefers to watch rather than join other children playing.</i>
6. Approach	The amount of excitement and positive anticipation for expected pleasurable activities. <i>Sample item: Becomes very excited while planning for trips.</i>
7. Smiling/laughter	The amount of positive affect in response to changes in stimulus intensity, rate, complexity, and incongruity. <i>Sample item: Laughs a lot at jokes and silly happenings.</i>
Negative affect	
8. Anger/frustration	The amount of negative affect related to interruption of ongoing tasks or goal blocking. <i>Sample item: Gets quite frustrated when prevented from doing something s/he wants to do.</i>
9. Discomfort	The amount of negative affect related to sensory qualities of stimulation, including intensity, rate or complexity of light, movement, sound or texture. <i>Sample item: Is quite upset by a little cut or bruise.</i>
10. Sadness	The amount of negative affect and lowered mood and energy related to exposure to suffering, disappointment, and object loss. <i>Sample item: Becomes upset when loved relatives or friends are getting ready to leave following a visit.</i>
11. Fear	The amount of negative affect, including unease, worry or nervousness related to anticipated pain or distress, and/or potentially threatening situations. <i>Sample item: Is afraid of loud noises.</i>
12. Falling reactivity/soothability	The rate of recovery from peak distress, excitement or general arousal. <i>Sample item: Calms down quickly following an exciting event.</i>
Effortful control	
13. Low intensity pleasure	The amount of pleasure or enjoyment related to situations involving low stimulus intensity, rate, complexity, novelty, and incongruity. <i>Sample item: Enjoys “snuggling up” next to a parent.</i>
14. Inhibitory control	The capacity to plan and to suppress inappropriate approach responses under instructions or in novel or uncertain situations. <i>Sample item: Can easily stop an activity when s/he is told “no”.</i>
15. Perceptual sensitivity	The amount of detection of slight, low intensity stimuli from the external environment. <i>Sample item: Is quickly aware of some new items in the living room.</i>
16. Attentional focusing	The tendency to maintain attentional focus upon task-related channels. <i>Sample item: When picking up toys or other jobs, usually keeps at the task until it’s done.</i>
17. Attentional shifting	The ability to transfer attentional focus from one activity/task to another. <i>Sample item: Can easily shift from one activity to another.</i>
18. Excitatory control	The capacity to perform an action when there is a strong tendency to avoid it. <i>Sample item: Forces her/himself to complete projects, even when tired.</i>

as important individual characteristics influencing the child’s reaction to specific types of treatment (Mash, 2006) and moderating or mediating treatment outcome in various disorders such as anxiety disorders (Rapee & Jacobs, 2002) and attention deficit and hyperactivity disorder (Purper-Ouakil et al., 2010).

1.3. Temperament and developmental stuttering

Recently, several researchers have considered the potential role of temperament in the onset and development of stuttering. For instance, Conture et al. (2006) have proposed the ‘Communication-Emotional model of stuttering’. In this

model, distal (i.e., genetics and environment) and proximal contributors (i.e., speech-language planning and production) are linked with exacerbating factors (i.e., experience, emotional reactivity and regulation) and overt stuttering behaviors. They hypothesized that children begin to stutter as a result of deficiencies in speech-language planning and production. The presence of emotional reactivity may lead some children, after continued experience with stuttering, to react stronger to these disfluencies. Trying to cope with these disfluencies (regulation) may interact directly with linguistic planning and execution. Furthermore, Conture et al. suggested that this emotional reactivity/regulation consequently may lead to changes in disfluency types, duration, and/or physical tension. However some recent findings do not seem to support this extension of their model (Mulcahy, Hennessey, Beilby, & Byrnes, 2008).

Other authors have speculated about the possible significance of temperament and/or temperament-related concepts (such as sensitivity towards stuttering, perfectionism, frustration tolerance, anxiety) for understanding the onset, development, and even treatment efficacy of stuttering (Anderson, Pellowski, Conture, & Kelly, 2003; Amster, 1995; Conture, 1991, 2001; Conture & Melnick, 1999; Embrechts, Ebben, Franke, & van de Poel, 2000; Felsenfeld et al., 2000; Gregory, 2003; Guitar, 1976, 1998, 2003; Karrass et al., 2006; Lewis & Goldberg, 1997; Messenger, Onslow, Packman, & Menzies, 2004; Oyler (1998) in Zebrowski & Conture, 1998; Wakaba, 1998). Guitar (1998) for example speculates that some CWS might be born with a heightened emotional sensitivity (hypersensitivity) making them “especially reactive to their early disfluencies” (pp. 83).

Temperament also may be a useful concept to understand the influence of stress and specific stressors on stuttering. It has been demonstrated that stuttering can be influenced by emotional reactions as a result of situational stress (e.g., Alm, 2004a; Blood, Blood, Bennett, Simpson, & Sussman, 1994; Ezrati-Vinacour & Levin, 2004; Menzies, Onslow, & Packman, 1999; Peters & Hulstijn, 1984). Temperament differences may affect the susceptibility of individuals to learning processes and experiences. For instance, specific temperament traits, such as extraversion, make some individuals more susceptible to particular classical and operant conditioning processes (Gray, 1991), which are known to have an important role in the development of compensatory and other behaviors in stuttering (Bloodstein, 1995; Brutton & Shoemaker, 1967; Kamhi, 2003).

Previous studies, employing parental temperament questionnaires, have reported temperament differences between CWS and typically developing children (TDC) (Anderson et al., 2003; Embrechts et al., 2000; Karrass et al., 2006; Lewis & Goldberg, 1997; Oyler (1998) in Zebrowski & Conture, 1998; Wakaba, 1998) and provided support for the interactional patterns of temperament and stuttering described above. The results of these studies, in general, showed that CWS scored significantly lower on scales related to self-regulation (e.g., inhibitory control, adaptability), and higher on reactivity related scales (e.g., activity, impulsivity) compared to children in the control group (for a more detailed overview: see Eggers et al., 2009).

In the present study, the Children’s Behavior Questionnaire (CBQ; Rothbart et al., 2001) was used to study temperament dimensions of stuttering and nonstuttering children. Several approaches can be used for assessing temperament, including behavioral observations in natural (home) or in more structured semi-natural (laboratory) settings (e.g., Goldsmith & Rothbart, 1991), interviews (e.g., Garrison, Biggs, & Williams, 1990; Thomas & Chess, 1977), temperament questionnaires (e.g., Carey & McDevitt, 1978; Duijsens, Spinhoven, Verschuur, & Eurelings-Bontekoe, 1999; Gartstein & Rothbart, 2003), or psychophysical and psychophysiological indicators (Kagan, 1998; McManis, Kagan, Snidman, & Woodward, 2002), as well as a combination of two or more of these methods. Although temperament questionnaires can be susceptible to parental bias and inaccuracy (Vaughn, Taraldson, Cuchton, & Egeland, 2002), they tap into the vast knowledge of caregivers who have experienced the child’s reactions in different situations and over a long period of time. Also, several studies have shown satisfactory test-retest reliability (Slabach, Morrow, & Wachs, 1991), as well as a moderate to strong degree of validity for parental reports (Rothbart & Bates, 1998). Our choice for using the CBQ was based on three elements: (a) the theoretical basis of the questionnaire (e.g., multidimensionality), (b) the availability of a reliable and valid Dutch translation (Van den Bergh & Ackx, 2003), and (c) the age range for usability of the CBQ. Moreover, one of the greatest advantages of this theory-derived instrument, compared to other questionnaires, is that it includes scales that measure traits developing past infancy, resulting in a more varied and detailed view on temperament at that age. In addition, the CBQ not only focuses on behavioral style characteristics but also includes affective qualities, such as strength and speed of responses to emotional stimulation.

Prior to the current study, we investigated whether the structure of the underlying construct being measured was identical for both participant groups. Although there were some minor scale loading differences, the factor-analyses of the CBQ-data obtained from CWS, TDC, and children with vocal nodules in this preceding study (Eggers et al., 2009), revealed, a similar and highly congruent three-factor temperament structure. Given this similarity in temperament

structure between the participant groups we can conclude that if group differences between CWS and TDC on the composite temperament factors (e.g., Effortful Control) or individual temperament scales (e.g., Inhibitory Control) would emerge, they reflect real differences and are not confounded by differences in underlying temperamental make-up between the two groups (Byrne, Shavelson, & Marsh, 1993).

Based on our overview of the literature, we know that high levels of negative reactivity and low levels of effortful control have an impact on disorder onset (e.g., Bijttebier & Roeyers, 2009), and that temperament plays a role in stress responses, conditioning processes (e.g., Gray, 1987), and treatment outcome (e.g., Purper-Ouakil et al., 2010). With regard to stuttering, studies in CWS have revealed elevated scores on reactivity-related scales and lowered scores on self-regulatory scales (for an overview: see Eggers et al., 2009). However, while many of the findings from these previous studies in stuttering can be understood as pointing towards increased reactivity or reduced self-regulation, with the exception of a study by Embrechts et al. (2000), who used a preliminary version of the CBQ, no studies employed a questionnaire specifically conceptualized to measure the triad of positive/negative reactivity and self-regulation in a highly integrated manner. Moreover, previous researchers did not validate their results by evaluating if the structure of the underlying construct being measured was similar for all groups. Therefore, the current study builds on the results reported in our previous paper in which we showed the underlying temperamental construct was similar for both speaker groups. Specifically, in this study, we used the CBQ, a questionnaire that includes the three composite temperament factors, to investigate the following research questions: (a) do CWS, compared to TDC, have a heightened score on the composite temperament factors of Negative Affectivity and/or Extraversion/Surgency and on some of the individual reactivity-related scales; (b) do CWS, compared to TDC, have a lower score on the composite temperament factor of Effortful Control and on some of the individual scales related to self-regulation; (c) is temperament in CWS associated with length of therapy and/or stuttering severity.

2. Methods

2.1. Participants

The 116 children who participated in this study were part of a larger study which was described in more detail in Eggers et al. (2009). TDC were matched for age (± 2 months) and gender (13 girls and 45 boys) to the CWS. If more than one typically developing child could be matched to a child who stuttered, selection occurred at random. The children in the current study ranged in age from 3.04 to 8.11 years. There were 58 CWS (mean age = 5.11 years; $SD = 1.09$ years) and 58 TDC (mean age = 5.11 years; $SD = 1.10$ years). All were native Dutch speakers, with no reported speech, language, hearing, neurological, or psychological problems, except for stuttering in the CWS. The participating CWS produced three or more within-word disfluencies (sound/syllable repetition, prolongation or blocks) and/or monosyllabic word repetition per 100 words of spontaneous speech and scored at least 'mild' on either the Stuttering Severity Instrument-3 (Riley, 1994) or the Test for Stutter Severity-Readers/Non-Readers, a Dutch severity scale which has been shown to correlate very high ($r = .94$) with the SSI (Boey, 2000). Eight CWS were classified as mild, 35 as moderate, 14 were rated severe, and 1 was rated very severe. Four of the CWS had not received fluency therapy prior to the data collection. The other 54 CWS had received fluency therapy for a period of time ranging from 1 month to 24 months (mean = 8.9 months; $SD = 6.5$).

2.2. Temperament questionnaire

The Dutch version of the Children's Behavior Questionnaire (CBQ-D; Van den Bergh & Ackx, 2003) was used to assess the temperamental profiles of the participants. As previously stated, the CBQ was developed by Rothbart et al. (2001), and is a caregiver report measure that provides detailed assessment of temperament in children conforming to Rothbart's reactive and self-regulative model of temperament (Rothbart, 1981, 1989). Although the original English version of the CBQ only included normative data up to age 7, Van den Bergh and Ackx (2003) have demonstrated good reliability and validity for 8- and 9-year-olds, based on a study of 71 children in this age range (average internal consistency of the 18 scales: Cronbach's alpha [α] = .71).

The CBQ-D consists of 18 subscales, 15 original scales and 3 (Motor Activation, Excitatory Control, and Attention Shifting) that were added later by Rothbart and colleagues, as documented in Van den Bergh and Ackx's (2003) Dutch adaptation. The subscales, clustering under the 3 composite temperament factors of Extraversion/Surgency, Negative

Table 2

Factor pattern based on the 18 subscales of the Dutch version of the Children’s Behavior Questionnaire (CBQ) of the TDC ($n = 146$) and CWS ($n = 69$).

Scale	Factor loading					
	Factor 1		Factor 2		Factor 3	
	TDC	CWS	TDC	CWS	TDC	CWS
Extraversion/surgency						
Impulsivity	.831	.891	.089	.089	-.278	-.124
Activity level	.796	.867	.233	.154	.482	-.160
High intensity pleasure	.780	.708	.004	.036	-.368	-.043
Motor activation	.516	.427	.306	.529	-.583	-.348
Shyness	-.485	-.524	.267	.172	.078	-.013
Approach	.481	.498	.446	.457	-.001	.019
Smiling/laughter	.400	.283	.024	-.137	.411	.552
Negative affect						
Anger/frustration	.464	.292	.782	.827	-.345	-.129
Discomfort	-.043	-.190	.681	.668	.037	.031
Sadness	.007	.057	.672	.795	-.022	-.082
Fear	-.183	-.264	.447	.401	.156	-.151
Falling reactivity/soothability reactivity/soothability	.146	.184	-.420	-.666	.204	.115
Effortful control						
Low intensity pleasure	-.151	-.289	.055	-.130	.716	.603
Inhibitory control	-.409	-.636	-.467	-.577	.711	.434
Perceptual sensitivity	-.060	-.089	.127	-.012	.554	.586
Attentional focusing	-.271	-.182	-.231	-.235	.539	.685
Attentional shifting	-.279	-.478	-.528	-.636	.368	.151
Excitatory control	.377	.167	-.002	.244	-.022	.461

Note. Factor loadings >.30 are highlighted.

Affectivity, and Effortful Control, are defined in Table 1. The CBQ-D consists in a total of 233 items. Each item is rated by the parents using a 7-point Likert scale ranging from “extremely untrue of your child” to “extremely true of your child”. When the child has not been observed in a situation as described in an item, a “not applicable” response option is provided. Factor analysis of the 18-scale instrument was completed in order to compute composite temperament factor scores. Although the matching requirements for the current study resulted in a somewhat smaller sample than our 2009 study, the factor analysis was performed on the larger subject sample of our 2009 study (146 TDC and 69 CWS) in order to reduce sampling error and increase factorial structure stability and reliability (MacCallum, Widaman, Zhang, & Hong, 1999). The factor pattern matrix, which is similar to the one reported in 2009, is depicted in Table 2. Cronbach’s alpha coefficients across the 18 scales averaged .74, indicating a high level of internal consistency (Eggers et al., 2009).

2.3. Procedure

CWS were recruited with the assistance of speech-language pathologists practicing in the Dutch speaking part of Belgium. Children who participated in the control group were recruited through their school system. The parents were asked to fill out the CBQ-D questionnaires. All questionnaires included in the current study were completed by the children’s mothers. A qualified speech-language pathologist determined absence of other speech, language, and hearing problems; no neurological or psychological disorders were reported. More detailed information on participant recruitment and procedure can be found in the paper by Eggers et al. (2009).

2.4. Data analysis

The data were analyzed using PASW Statistics version 17 for Windows (IBM Company, 2009, Chicago, IL). Based on the CBQ-D 18-scale factor structure three normalized composite factor scores were computed for each participant using the regression method (DiStefano, Zhu, & Míndrilá, 2009). A factor score is a composite variable providing

information on the participant’s placement on the factor. Several procedures can be used to compute composite factor scores, ranging from non-refined methods (e.g., summing raw scores corresponding to all items loading on a factor) to more refined methods (e.g., regression method), resulting in more exact and valid composite factor scores. The regression method uses standardized information to create composite factor scores, producing standardized scores similar to a z-score metric. The group of 146 TDC was taken as the norm group in which the computed composite factor scores were standardized to a mean of zero. A subsequent analysis of variance (ANOVA) was performed on the composite temperament factor scores of the 58 CWS and 58 TDC of the current study to examine whether significant differences existed between the participant groups on the 3 composite factors. Possible differences between TDC and CWS on the 18 individual temperament scales were also investigated using an ANOVA, with participant group as the independent variable; and composite factor scores and temperament scales as the dependent variables. The dependent variables were tested simultaneously in order to control for Type 1 errors.

Spearman’s rank correlations were calculated to examine the relationships between duration of therapy (in months), stuttering severity (overall severity ratings were used to create four groups of severity: mild, moderate, severe, and very severe), and respectively composite temperament factor scores and individual temperament scales.

3. Results

3.1. Overall group differences

Fig. 1 gives an overview of the normalized factor scores for the three composite temperament factors for each of the participant groups. There were significant between-group differences found for the composite factor scores Negative Affectivity, $F(1, 114) = 4.49, p = .04$ and Effortful Control $F(1, 114) = 5.43, p = .02$ (Table 3). Extraversion/Surgency did not significantly differ between both groups, $F(1, 114) = 0.48, p = .49$.

The mean scores on the temperament scales and their standard deviations for the CWS and TDC are represented in Table 4. Significant between-group differences were found for the scales Anger/Frustration, $F(1, 114) = 4.72, p = .03$;

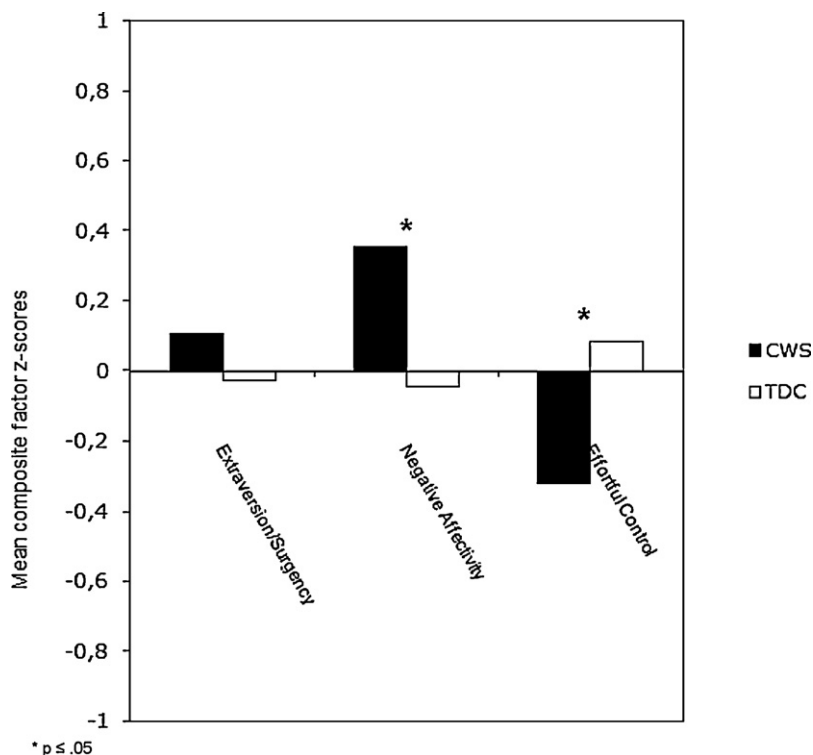


Fig. 1. Mean composite temperament factor z-scores for CWS and TDC on the Children’s Behavior Questionnaire (CBQ; Rothbart et al., 2001).

Table 3
Means, standard deviations, and between-group effect analysis of the composite factor z-scores for CWS and TDC on the CBQ.

Composite factor	CWS		TDC		F	p
	Mean	SD	Mean	SD		
Extraversion/surgency	0.10	1.02	−0.03	0.99	.483	.49
Negative Affectivity	0.36 ^a	1.15	−0.05 ^a	0.88	4.490*	.04*
Effortful Control	−0.32 ^a	0.88	0.09 ^a	0.99	5.435*	.02*

^a Significantly different mean scores.

* $p \leq .05$.

Approach, $F(1, 114) = 3.89, p = .05$; Motor Activation, $F(1, 114) = 4.34, p = .04$; Inhibitory Control $F(1, 114) = 7.49, p = .01$; and Attentional Shifting $F(1, 114) = 6.85, p = .01$ (Fig. 2).

3.2. Relationship with therapy duration

Two-tailed Spearman’s rank correlations revealed no significant correlations between the duration of therapy (in months) for CWS and the composite factor scores or individual scales that differentiated both participant groups: Negative Affectivity ($r_s = .05, p = .70$), Effortful Control ($r_s = -.02, p = .88$), Anger/Frustration ($r_s = .06, p = .66$), Approach ($r_s = -.01, p = .96$), Motor activation ($r_s = -.25, p = .06$), Inhibitory Control ($r_s = -.00, p = .99$), and Attentional Shifting ($r_s = -.10, p = .44$). Thus, therapy duration does not seem to be related to any of the differences found in these temperament dimensions. Similarly, no significant correlations were found for any of the other temperament dimensions (Tables 5 and 6).

3.3. Relationship with stuttering severity

Two-tailed Spearman’s rank correlations indicated that there was no significant correlation between the stuttering severity ratings and the composite temperament factor scores or the temperament scales that differentiated

Table 4
Means, standard deviations, and between-group effect analysis of the CBQ scale scores for CWS and TDC.

Scale	CWS		TDC		F	p
	M	SD	M	SD		
Impulsivity	4.67	0.80	4.56	0.70	.685	.41
Activity level	4.87	0.91	4.59	0.87	2.946	.09
High intensity pleasure	4.30	1.51	4.50	1.11	.711	.40
Motor activation	3.11 ^a	0.83	2.77 ^a	0.92	4.340*	.04*
Shyness	3.56	1.16	3.48	1.09	.120	.73
Approach	4.99 ^a	0.85	4.71 ^a	0.65	3.893*	.05*
Smiling/laughter	5.32	0.70	5.50	0.67	2.080	.15
Anger/frustration	4.32 ^a	1.02	3.94 ^a	0.84	4.718*	.03*
Discomfort	3.89	1.00	3.72	0.93	.922	.34
Sadness	4.05	0.76	3.95	0.66	.597	.44
Fear	3.92	1.04	3.72	0.86	1.299	.26
Falling reactivity/soothability	4.73	0.77	4.91	0.69	1.777	.19
Low intensity pleasure	5.06	0.72	5.20	0.77	1.025	.31
Inhibitory control	4.01 ^a	0.97	4.47 ^a	0.82	7.489*	.01*
Perceptual sensitivity	4.00	0.78	5.07	0.85	.181	.67
Attentional focusing	4.84	0.88	4.92	0.84	.232	.63
Attentional shifting	3.95 ^a	0.82	4.32 ^a	0.70	6.854*	.01*
Excitatory control	4.61	0.65	4.50	0.66	.928	.34

^a Significantly different mean scores.

* $p \leq .05$.

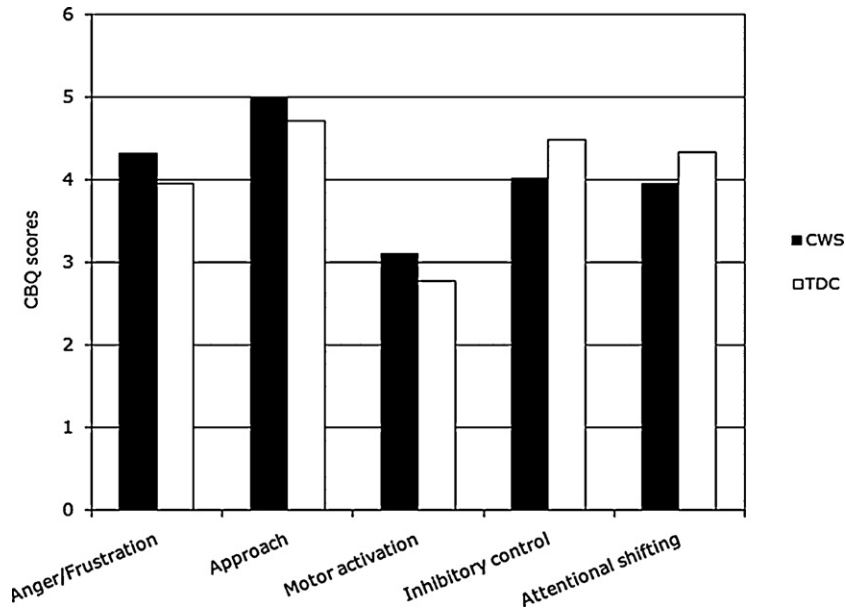


Fig. 2. Mean scores on the CBQ scales with significant between-group differences for CWS and TDC. Note: Nonsignificant between-group differences are not included.

Table 5

Spearman’s rank correlations between composite temperament factor scores and respectively duration of therapy and stuttering severity for CWS.

Composite factor	Therapy duration		Stuttering severity	
	r_s	p	r_s	p
Extraversion/surgency	-.078	.56	-.035	.79
Negative Affectivity	.053	.70	.189	.15
Effortful control	-.020	.88	-.160	.23

Table 6

Spearman’s rank correlations between temperament scale scores and respectively duration of therapy and stuttering severity for CWS.

Scale	Therapy duration		Stuttering severity	
	r_s	p	r_s	p
Impulsivity	-.160	.23	.079	.56
Activity level	-.031	.82	-.074	.59
High intensity pleasure	.033	.81	-.075	.58
Motor activation	-.247	.06	.094	.49
Shyness	.023	.86	.068	.62
Approach	-.006	.96	.107	.43
Smiling/laughter	.016	.91	-.143	.29
Anger/frustration	.059	.66	.110	.42
Discomfort	.167	.21	.069	.61
Sadness	-.030	.82	.140	.30
Fear	.111	.41	.253	.06
Falling reactivity/soothability	-.091	.50	-.219	.10
Low intensity pleasure	.077	.57	-.230	.09
Inhibitory control	-.002	.99	-.148	.28
Perceptual sensitivity	-.233	.08	-.043	.75
Attentional focusing	.015	.91	-.020	.88
Attentional shifting	-.104	.44	-.189	.16
Excitatory control	.060	.65	.010	.94

between the CWS and the control group: Negative Affectivity ($r_s = .19, p = .15$), Effortful Control ($r_s = -.16, p = .23$), Anger/Frustration ($r_s = .11, p = .42$), Approach ($r_s = .11, p = .43$), Motor activation ($r_s = .09, p = .49$), Inhibitory Control ($r_s = -.15, p = .28$), and Attentional Shifting ($r_s = -.19, p = .16$). In other words, stuttering severity was not found to be related to any of the between group temperamental differences. Similarly no differences were found for the remaining composite temperament factor (Table 5) or any of the other scales (Table 6).

4. Discussion

The primary purpose of our study was to examine whether significant differences could be found in the three composite temperament factors – Extraversion/Surgency, Negative Affect, and Effortful Control – and the individual temperament scales between CWS and TDC. In addition we examined whether both of these temperament dimensions were associated with the stuttering severity and/or treatment duration. The findings of the present parent questionnaire study have confirmed our hypothesis of increased Negative Affectivity and lowered Effortful Control in CWS. In addition, on the individual temperament scales CWS scored lower than TDC in Inhibitory Control and Attentional Shifting, and higher in Motor Activation and Approach (Fig. 2). These results are consistent with the previous literature describing CWS as more sensitive and/or reactive (Embrechts et al., 2000; Fowlie & Cooper, 1978; Glasner, 1949; Guitar, 2003; Karrass et al., 2006; Oylar (1998) in Zebrowski & Conture, 1998; Wakaba, 1998) and lower in self-regulatory processes (Anderson et al., 2003; Embrechts et al., 2000; Karrass et al., 2006).

Byrne et al. (1993) have argued that multigroup analysis should be preceded by testing if the structure of the underlying construct being measured is similar for all groups because results of mean group score comparisons might be confounded by possible differences in underlying construct. Based on our previous (Eggers et al., 2009) and current study in which a high similarity in temperament structure for CWS and TDC was reported, we can state that these found differences reflect real mean group differences and are not a reflection of differences in the underlying temperament structure.

No significant correlation was found between temperament and duration of therapy or stuttering severity for the stuttering group. In the remainder of this paper, we will provide a more in-depth discussion of our findings.

4.1. Group differences in composite temperament factor scores

Compared to TDC, CWS scored higher on the composite factor score of Negative Affect, due primarily to the observed between-group difference on Anger/Frustration, and lower on Effortful Control, due to the differential score on Inhibitory Control and Attentional Focusing. There are no other studies in CWS where clustering in these higher order factors was performed, so we cannot directly compare to other studies. However, Karrass et al. (2006), using McDevitt and Carey's Behavior Style Questionnaire (BSQ), found significant higher scores for 3-to-5 year old CWS compared to a group of matched TDC on a scale measuring emotional reactivity, and significantly lower scores on scales measuring emotion and attention regulation. Their reactivity and regulation scales were self-constructed by clustering different BSQ-items which rated emotional reactivity and emotion and attention regulation. While their index for emotional reactivity correlated moderately with the CBQ's composite temperament factor of Negative Affect ($r = .42; p < .05$; in Karrass et al., 2006), thus corroborating our current findings, no information was provided on the correlation between emotion/attention regulation indices and the CBQ's composite factor Effortful Control.

High levels of positive and/or negative reactivity (i.e., Negative Affect) combined with low levels of Effortful Control were found to play an important role in the onset, development and maintenance of a number of behavioral disorders (Bijttebier & Roeyers, 2009; Lonigan, Vasey, Philips, & Hazen, 2004; Lonigan & Vasey, 2009). Specific, high levels of negative reactivity and low levels of Effortful Control are considered to predispose the onset of these disorders or to influence their development and symptomatology over time (Muris & Ollendick, 2005; Nigg, 2006). Researchers have only recently begun to study the underlying mechanisms and they are still not fully understood. Lonigan et al. (2004) found evidence for an increased attentional bias (increased vigilance and orienting) towards threat-relevant and negatively valenced stimuli in individuals with high Negative Affect. This increase in attentional bias was only present when they also scored lower on Effortful Control. Individuals high in Negative Affect and Effortful Control were able to compensate for their reactive attentional bias through their high capacity for attentional control (Lonigan & Vasey, 2009). Given that research in other developmental disorders has provided evidence of a link between temperament and disorder onset, development, and maintenance, one could easily extend this observed link to developmental stuttering.

This hypothesis is in line with earlier suggestions made by Seery, Watkins, Mangelsdorg, and Shigeto (2007) and Yairi (2007), that the temperamental dimensions observed in all or some CWS may be related to stuttering development and symptomatology. Furthermore, the speculation by Lonigan and Vasey that high efficiency of Effortful Control could act as a protective factor for the development of behavioral disorders also deserves further investigation with regard to stuttering.

The advantage of composite temperament factors, the highest order traits, is their enormous bandwidth, making them ideal for detecting general distinctions in temperament between participant groups, although they are not as valuable for predicting specific behavioral patterns; the disadvantage is that in any hierarchical representation, one always loses information as one moves up the hierarchical levels (John & Srivastava, 2001). In other words, item information is inevitably lost when aggregated into scales, and scale information is lost when aggregated into composite factors (John, Hampson, & Goldberg, 1991). Comparing participant groups on the three composite temperament factors will therefore give a rather broad overview of possible differences, but is not specific enough to provide adequate insight in the more fine-grained temperament dimensions. For that reason, we also compared our participant groups at the lower level of the hierarchy, i.e., the 18 temperament scales, which provides a clearer, more accurate view and offers information that is otherwise masked at a higher level (Briggs, 1989).

4.2. Group differences in individual temperament scales

4.2.1. CWS scored higher on anger/frustration, approach, and motor activation

The analysis of the lower levels of the temperamental hierarchy revealed that CWS, when compared to normally fluent peers, scored higher on Anger/Frustration, Approach, and Motor Activation. Rothbart et al. (2001) defined Anger/Frustration as the amount of negative affect related to interruption of ongoing tasks or goal blocking. Others have also described low frustration tolerance, a concept similar to Anger/Frustration, as a component with the potential to influence the development of stuttering (e.g., Hill, 1999; Riley & Riley, 1979). Starkweather (2002) even speculates on the possibility of low tolerance for frustration as one of the genetically transmitted traits influencing the probability that a child will develop stuttering.

The higher ratings on Approach, which is defined as the amount of excitement and positive anticipation for expected pleasurable activities, might result in an increase in situational stress, especially when combined with the increased scores on Anger/Frustration. Approach behaviors are believed to be activated through the Behavioral Approach System (BAS), which has been associated with the basal ganglia and its projections, and is moderated by the neurotransmitter dopamine (Gray, 1991). It could be that the lower scores on Inhibitory Control, a trait that can regulate approach tendencies, have an impact on Approach, which in turn would result in an increase of the latter.

Motor Activation is defined as the amount of excess motor movement such as eye blinking, finger tapping, muscle twitching, fidgeting, and chewing fingernails. While at first glance some of these excessive motor movements could be related to secondary stuttering behaviors, the items in the Children's Behavior Questionnaire are formulated in such a way that these movements are not related to the speech act itself. Instead, within the context of temperament research, motor activity is seen as an indication of positive reactivity. This is thought to suggest that in stressful situations people with a higher motor reactivity are easier aroused which in turn can be reflected in an overall increased muscular tension (Kagan, 1998). Therefore, this finding might suggest that CWS increase overall muscular tension more easily in demanding situations. Building on Bloodstein's (1995) suggestion that the more localized increased facial and/or glottal muscle tension during moments of stuttering in CWS might reflect the emerging extra muscular effort when anticipating difficulties in their speech, one could speculate that CWS are more prone to reacting with increased muscular tension during speech disruptions compared to TDC. This could also map onto Guitar's (1998) speculation that increased muscular tension may act as a precipitator of speech disruptions.

4.2.2. CWS scored lower on inhibitory control and attentional shifting

CWS compared to the control participants scored lower on Inhibitory Control and Attentional Shifting, indicating that they are less able to suppress inappropriate approach responses under instructions or in new or uncertain situations or to shift attention from one activity to another. Our finding is in line with the results of the study by Embrechts et al. (2000), and similar results have been reported in a number of other studies that have used the BSQ. Although the CBQ scales of Attentional Focusing and Shifting are not represented as such in the BSQ, they are related to the BSQ-scales of Attention Span/Persistence, and Distractibility (McDevitt & Carey, 1978; Thomas & Chess, 1977), for

which differences between stuttering and nonstuttering children have been reported (Anderson et al., 2003; Karrass et al., 2006).

It has been argued that children are able to regulate their behavior through the use of two different systems, namely an emotional system (fear) and a later developing more attention based system (e.g., effortful control) (Rothbart, Ahadi, & Evans, 2000). Children that are able to volitionally use their attention, by focusing on or shifting away, can easier inhibit dominant inappropriate responses (Kochanska, 1997). Neuroimaging data (e.g., Casey et al., 1995) have provided evidence for the presence of three attentional networks related to alerting, orienting and executive control. The main focus of the executive attention network, also named the anterior attention system, is monitoring and handling conflict situations and is involved in the regulation of emotional reactivity as well as cognitive processing. It has been associated with the anterior cingulate gyrus and the basal ganglia and is assumed to be modulated through the neurotransmitter dopamine (Posner et al., 2003). Inhibitory control and attentional shifting (sometimes included in the attentional focusing scale), which according to some authors is the primary index for effortful control, are the scales most related to tasks requiring the anterior attentional network (Davis, Bruce, & Gunnar, 2002). Because this network is linked to the activation of the Anterior Cingulate and the basal ganglia and these cortical and subcortical structures are implicated in some neural models of developmental stuttering (e.g., Alm, 2004b; Smits-Banstra & De Nil, 2007), one might therefore speculate that the lower scores on Inhibitory Control and Attentional Shifting are the result of a lower efficiency in the anterior attentional network.

4.3. Relationship with therapy duration and stuttering severity

Our results did not point to a significant correlation between treatment duration and composite factor scores or temperament scales. This might suggest that temperament characteristics are robust against therapy interventions lasting a few weeks to a few months; or alternatively, that treatment approaches would need to address temperament directly in order to result in significant changes. On the other hand this might suggest that duration of direct speech treatment and counseling are not necessarily associated with intersubject variability of temperament scale scores. However, treatment or the type of treatment was not directly controlled in this study and as such any conclusions regarding the predictive value of temperament dimensions for treatment duration are tentative at best.

We also found no association between any of the temperament dimensions and overall stuttering severity. This does not mean however that temperament cannot be associated with specific aspects of stuttering severity, such as duration of stuttering moments and secondary behaviors. Gray (1991) already hypothesized, based on his classification of three emotional response systems (BIS, behavioral inhibition system; BAS, behavioral activation system; and the fight/flight system), that one individual with a specific temperamental constellation may be more prone to struggle or escape behaviors while another is more prone to a ‘freezing’ reaction. This was also mentioned by Guitar (1998). Unfortunately, our data did not allow for a differential correlation of these various elements that may make up severity, but such more detailed correlational analyses should be attempted in future studies.

4.4. Implications for the role of temperament in developmental stuttering

Although our methodology does not allow for a direct causal linkage between temperament and stuttering, one could speculate about the role temperament may play in the onset and/or development of stuttering and treatment outcome through one or more of several interaction pathways, namely (a) as a moderator in stress-related situations, (b) as a moderator in conditioning processes, and/or (c) as suggested by Conture et al. (2006), as a moderator in linguistic processing. First, temperament could act as a moderator in stress-related situations. Our present findings, pointing in the direction of an increased reactivity combined with a limited self-regulation for CWS, could mean that when confronted with moments of stuttering and/or abnormal disfluencies in their speech, children react stronger to these interruptions in combination with a feeling of loss of control emerging faster due to the lack of adequate self-regulation.

Alternatively, there could also be an indirect pathway by which children evaluate a novel situation more easily as stressful (i.e., reactivity), resulting from difficulty in shifting their attention away from such situation (i.e., regulation) and having trouble selecting the proper reaction. This in turn may lead to increased negative emotional arousal, which has been associated with conditioning processes (LeDoux, 1994). In addition, increased excitement for certain activities in CWS could further complicate their behavior.

Finally, our findings might also be interpreted by the possibility of temperament serving as a moderator in linguistic processing. Wolfe and Bell (2004) found evidence that parental ratings of Inhibitory Control and Attentional Focusing (including shifting) were related to working memory. Low scores on these temperament scales led to lowered scores on working memory tasks, such as yes–no and Stroop-like tasks (e.g., MacLeod, 1991). In addition, performance on these tasks (i.e., yes–no and Stroop-like tasks) was also negatively correlated to scores on the approach scale. Both findings were also apparent in our group of stuttering children. Working memory, responsible for storing and processing incoming information, plays a crucial role in language processing. Baddeley's model (2003) of working memory is comprised of three subsystems, including a phonological working memory (i.e., phonological loop), which consists of a limited capacity phonological storage and an articulatory rehearsal system. This phonological loop plays an important role in speech-language acquisition, comprehension, and production (Adams & Gathercole, 1995; Montgomery & Windsor, 2007). Based on Levelt's model, speech-language production can be divided in three distinct phases: conceptualization, formulation, and articulation (Postma & Kolk, 1993). During the formulation stage grammatical and phonological encoding, i.e., selecting the appropriate words and phonemes, take place. Working memory is essential for storing these encoded sequences before they are being articulated. Central to this language production model is the role of several monitoring loops and various authors have suggested stuttering to be a result of aberrant monitoring (Bernstein Ratner & Wijnen, 2006; Postma & Kolk, 1993). While still speculative, our findings could map onto this hypothesis because central attentional control functions are key to the monitoring loops of this system.

4.5. Caveats and suggestions for future research

While we have discussed primarily the scales that showed between-group differences, some might argue that an equally important finding is that most scales did not yield significant differences. However, one would not expect to find differences on the majority of the temperament scales since it would be most unlikely that they all have a role in the onset and development of stuttering. Furthermore, it may be important to emphasize that high or low scores on temperamental traits do not point to clinical disorders but are merely a reflection of the distribution of scores on a bipolar continuum in a normal population. For instance, a lower group mean score on inhibitory control is not indicative of any disorder but only reflects a lower efficiency in suppressing inappropriate approach responses.

Every method used for assessing temperament has some limitations, including (parental) questionnaires (cf. supra). While most of the temperament research is based on questionnaire assessment procedures for reasons discussed in the introduction (Strelau, 1998), our current findings need to be replicated using experimental methods that allow us to directly observe and measure behavioral patterns. Such experimental paradigms also will allow us to analyze the existence of a direct link, if any, between temperament and stuttering.

5. Conclusions

The present study provides further data supporting the hypothesis that CWS and typically developing children differ in temperamental characteristics. Evidence was found for heightened reactivity (higher in Negative Affect, and in individual scales of Anger/Frustration, Motor Activation, and Approach) and limited processes of self-control (lower in Effortful Control, and in individual scales of Inhibitory Control and Attentional Shifting).

While communication disorders may worsen or improve over time, temperament is supposed to be relatively stable (Rothbart, Derryberry, & Hershey, 2000). So the study of temperament may offer a way to capture pre-onset causal, trigger or contributing factors as opposed to reactive effects of the communication disorder.

Trying to formulate clinical considerations is quite premature since further research, based on direct observations, behavioral experiments, psychophysical, and/or psycho physiological measures is still needed for a multidimensional and more detailed view of possible differences and relationships. However, such research may provide additional information that would allow clinicians to match treatment approach with specific temperamental patterns observed in individual CWS. It also may shed further light on issue of spontaneous recovery and treatment outcome. If the current results are confirmed in follow-up studies, they could validate the frequently described use of desensitization training for the moments of stuttering but also for specific stress inducing stimuli or environments (e.g., Gregory, 2003; Shapiro, 1999; Van Riper, 1973) as this will reduce the reactivity of a child towards certain stimuli. It would also illustrate the importance of parental guidance (e.g., Rustin, Boterill, & Kelman, 1996; Shapiro, 1999) in young CWS, training parents to react adequately to certain behaviors and situations. Children with heightened Negative Reactivity

may benefit from a less protective parenting style, allowing them to acquire essential coping strategies, while children with lowered Effortful Control may experience more difficulties with an authoritarian or permissive parenting style (Kristal, 2005; Kochanska, 1993).

CONTINUING EDUCATION

Temperament dimensions in stuttering and typically developing children

QUESTIONS

1. In Rothbart's temperament model:
 - (a) Temperament is defined as genetically determined individual differences in self-regulation
 - (b) Reactivity refers to the arousability of physiological and sensory response systems
 - (c) Older children have a predominantly reactivity-driven temperament structure
 - (d) Self-regulatory processes refer to inhibitory processes
2. In reviewing the literature with regard to parental temperament questionnaires and stuttering, the authors concluded that:
 - (a) CWS scored higher on scales related to self-regulation and lower on reactivity-related scales
 - (b) CWS scored lower on scales related to self-regulation and higher on reactivity-related scales
 - (c) CWS differed from CWNS but the direction of these differences is unclear
 - (d) CWS did not differ from children in the control groups
3. The authors hypothesized that temperamental dimensions might play a role in the onset and/or development of stuttering:
 - (a) As a moderator in stress-related situations
 - (b) As a moderator in conditioning processes
 - (c) As a moderator in linguistic processing
 - (d) All of the above
4. Results of the current study indicated that:
 - (a) CWS scored higher on Positive and Negative Affect and lower on Effortful Control
 - (b) CWS scored lower on Effortful Control as a result of lowered scores on all of its composite subscales
 - (c) CWS were less able to suppress inappropriate approach responses under instructions or in new or uncertain situations
 - (d) CWS were more able to suppress inappropriate approach responses under instructions or in new or uncertain situations
5. Based on the findings with regard to the Attentional Shifting scale:
 - (a) CWS were found to be less able to shift attention from one activity to another
 - (b) CWS were found to be less able to maintain attentional focus upon task-related channels
 - (c) CWS were found to be more able to shift attention from one activity to another
 - (d) The authors speculated that these findings might be the result of a heightened efficiency of the anterior attentional network

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References

- Adams, A. M., & Gathercole, S. E. (1995). Phonological working memory and speech production in preschool children. *Journal of Speech and Hearing Research, 38*, 403–414.
- Ahadi, S. A., Rothbart, M. K., & Ye, R. M. (1993). Children's temperament in the US and China: Similarities and differences. *European Journal of Personality, 7*, 359–377.
- Alm, P. A. (2004a). Stuttering, emotions, and heart rate during anticipatory anxiety: A critical review. *Journal of Fluency Disorders, 29*, 123–133.

- Alm, P. A. (2004b). Stuttering and the basal ganglia circuits: A critical review of possible relations. *Journal of Communication Disorders*, 37, 325–369.
- Amster, B. (1995). Perfectionism and stuttering. In C. W. Starkweather, & H. F. M. Peters (Eds.), *Proceedings of the First World Congress on fluency disorders* (pp. 540–543). The Netherlands: International Fluency Association.
- Anderson, J. D., Pellowski, M. W., Conture, E. D., & Kelly, E. M. (2003). Temperamental characteristics of young children who stutter. *Journal of Speech, Language and Hearing Research*, 46, 1221–1233.
- Arcus, D. (2001). Inhibited and uninhibited children: Biology in the social context. In T. D. Wachs, & G. A. Kohnstamm (Eds.), *Temperament in context* (pp. 43–60). Mahwah, NJ: Lawrence Erlbaum Associates, Publishers.
- Baddeley, A. (2003). Working memory and language: An overview. *Journal of Communication Disorders*, 36, 189–208.
- Bernstein Ratner, N., & Wijnen, F. (2006). The vicious cycle: Linguistic encoding, self monitoring and stuttering. In *Seminar presented at the Fifth World Congress of the International Fluency Association* Dublin, July.
- Bijttebier, P., & Roeyers, H. (2009). Temperament and vulnerability to psychopathology: Introduction to the special section. *Journal of Abnormal Child Psychology*, 37, 305–308.
- Blood, G. W., Blood, I. M., Bennett, S., Simpson, K. C., & Sussman, E. J. (1994). Subjective anxiety measurements and cortisol responses in adults who stutter. *Journal of Speech and Hearing Research*, 37, 760–768.
- Bloodstein, O. (1995). *A handbook on stuttering* (5th ed.). San Diego, CA: Singular Publishing Group.
- Boey, R. (2000). *Stotteren: Detecteren en meten. Test voor Stottererst—Lezers/Niet-Lezers. [Stuttering: Detection and measurement. Test for stuttering severity—Readers/non-readers]*. Leuven: Garant.
- Briggs, S. R. (1989). The optimal level of measurement for personality constructs. In D. M. Buss, & N. Cantor (Eds.), *Personality psychology: Recent trends and emerging directions*. New York: Springer-Verlag.
- Brutten, E., & Shoemaker, D. (1967). *The modification of stuttering*. Prentice Hall: Englewood Cliffs, NJ.
- Buss, A. H., & Plomin, R. (1984). *Temperament: Early developing personality traits*. Hillsdale, NJ: Erlbaum.
- Byrne, B. M., Shavelson, R. J., & Marsh, H. W. (1993). Multigroup comparisons in self-concept research: Reexamining the assumption of equivalent structure and measurement. In T. M. Brinthaup, & R. P. Lipka (Eds.), *The self: Definitional and methodological issues* (pp. 172–203). Albany, NY: State University of New York Press.
- Carey, W. B., & McDevitt, S. C. (1978). Revision of the infant temperament questionnaire. *Pediatrics*, 61, 735–739.
- Casey, B. J., Trainor, R., Giedd, J., Vauss, Y., Vaituzis, C. K., Hamburger, S., et al. (1995). The role of the anterior cingulate in automatic and controlled processes: A developmental neuroanatomical study. *Developmental Psychobiology*, 30, 61–69.
- Conture, E. G. (1991). Young stutterer's speech production: A critical review. In H. Peters, W. Hulstijn, & C. Starkweather (Eds.), *Speech motor control and stuttering* (pp. 365–384). Amsterdam: Elsevier Science Publishers.
- Conture, E. G. (2001). *Stuttering: Its nature, diagnosis and treatment*. Boston: Allyn & Bacon.
- Conture, E. G., & Melnick, K. S. (1999). Parent-child group approach to stuttering in preschool children. In M. Onslow, & A. Packman (Eds.), *The handbook of early stuttering intervention* (pp. 17–51). San Diego: Singular Publishing Group.
- Conture, E. G., Walden, T. A., Arnold, H. S., Graham, C. G., Hartfield, K. N., & Karrass, J. (2006). A communication-emotional model of stuttering. In A. Bernstein Ratner, & J. Tetnowski (Eds.), *Current issues in stuttering research and practice* (pp. 17–46). Mahwah, NJ: Lawrence Erlbaum Associates, Publishers.
- Costa, P. T., & McCrae, R. R. (2001). A theoretical context for adult temperament. In T. D. Wachs, & G. A. Kohnstamm (Eds.), *Temperament in context* (pp. 1–22). Mahwah, NJ: Lawrence Erlbaum Associates, Publishers.
- Davis, E. P., Bruce, J., & Gunnar, M. R. (2002). The anterior attention network: Associations with temperament and neuroendocrine activity in 6-year-old children. *Developmental Psychobiology*, 40, 43–56.
- DiStefano, C., Zhu, M., & Míndrila, D. (2009). Understanding and using factor scores: Considerations for the applied researcher. *Practical Assessment, Research & Evaluation*, 14(20). Available online: <http://pareonline.net/getvn.asp?v=14&n=20>
- Duijsens, I. J., Spinhoven, P., Verschuur, M., & Eurlings-Bontekoe, L. H. M. (1999). De ontwikkeling van de Nederlandse verkorte temperament en karakter vragenlijst (TCI-105). [Development of the Dutch short version of the Temperament and Character Inventory]. *Nederlands Tijdschrift Voor de Psychologie*, 54, 276–283.
- Eggers, K., De Nil, L. F., & van Den Bergh, B. R. H. (2009). Factorial temperament structure of stuttering, voice disordered, and normal speaking children. *Journal of Speech, Language and Hearing Research*, 52, 1610–1622.
- Embrechts, M., Ebben, H., Franke, P., & van de Poel, C. (2000). Temperament: A comparison between children who stutter and children who don't stutter. In H. G. Bosshardt, J. S. Yaruss, & H. F. M. Peters (Eds.), *Proceedings of the Third World Congress on Fluency Disorders: Theory, research, treatment, and self-help* (pp. 557–562). Nijmegen, The Netherlands: University of Nijmegen Press.
- Ezrati-Vinacour, R., & Levin, I. (2004). The relationship between anxiety and stuttering: A multidimensional approach. *Journal of Fluency Disorders*, 29, 135–148.
- Felsenfeld, S., Kirk, K. M., Zhu, G., Statham, D. J., Neale, M. C., & Martin, N. G. (2000). A study of the genetic and environmental etiology of stuttering in a selected twin sample. *Behavior Genetics*, 30, 359–366.
- Fowlie, G. M., & Cooper, E. B. (1978). Traits attributed to stuttering and nonstuttering children by their mothers. *Journal of Fluency Disorders*, 3, 233–246.
- Frick, P. J. (2004). Integrating research on temperament and childhood psychopathology: Its pitfalls and promise. *Journal of Clinical Child and Adolescent Psychology*, 33, 2–7.
- Garrison, W. T., Biggs, D., & Williams, K. (1990). Temperament characteristics and clinical outcomes in young children with diabetes mellitus. *Journal of Child Psychology and Psychiatry*, 31(7), 1079–1088.
- Gartstein, M. A., & Rothbart, M. K. (2003). Studying infant temperament via the revised infant behavior questionnaire. *Infant Behavior & Development*, 26, 64–86.

- Glasner, P. (1949). Personality characteristics and emotional problems in stutterers under the age of five. *Journal of Speech and Hearing Disorders*, *14*, 135–138.
- Goldsmith, H. H. (1996). Studying temperament via construction of the toddler behavior assessment questionnaire. *Child Development*, *67*, 218–235.
- Goldsmith, H. H., & Campos, J. J. (1982). Toward a theory of infant temperament. In R. N. Emde, & R. J. Harmon (Eds.), *The development of attachment and affiliative systems* (pp. 161–193). New York: Plenum.
- Goldsmith, H. H., & Rothbart, M. K. (1991). Contemporary instruments for assessing early temperament by questionnaire and in the laboratory. In A. Angleitner, & J. Strelau (Eds.), *Explorations in temperament: International perspectives on theory and measurement* (pp. 249–272). New York: Plenum.
- Goldsmith, H. H., Buss, A. H., Plomin, R., Rothbart, M. K., Thomas, A., Chess, S., et al. (1987). Roundtable: What is temperament? Four approaches. *Child Development*, *58*, 505–529.
- Gray, J. A. (1987). Perspectives on anxiety and impulsivity: A commentary. *Journal of Research in Personality*, *21*, 493–509.
- Gray, J. A. (1991). The neuropsychology of temperament. In A. Angleitner, & J. Strelau (Eds.), *Explorations in temperament: International perspectives on theory and measurement* (pp. 105–128). New York: Plenum.
- Gregory, H. H. (2003). *Stuttering therapy: Rationale and procedures*. Boston: Allyn & Bacon.
- Guitar, B. (1976). Pretreatment factors associated with the outcome of stuttering therapy. *Journal of Speech and Hearing Research*, *19*, 590–600.
- Guitar, B. (1998). *Stuttering: An integrated approach to its nature and treatment*. Baltimore: Williams & Wilkins.
- Guitar, B. (2003). Acoustic startle responses and temperament in individuals who stutter. *Journal of Speech Language and Hearing Research*, *46*, 233–240.
- Halverson, C. F., & Deal, J. E. (2001). Temperamental change, parenting and the family context. In T. D. Wachs, & G. A. Kohnstamm (Eds.), *Temperament in context* (pp. 61–80). Mahwah, NJ: Lawrence Erlbaum Associates, Publishers.
- Hill, D. (1999). Evaluation of child factors related to early stuttering: A descriptive study. In N. Bernstein Ratner, & E. C. Healey (Eds.), *Stuttering research and practice: Bridging the gap* (pp. 145–174). Mahwah, NJ: Lawrence Erlbaum Associates, Publishers.
- John, O. P., & Srivastava, S. (2001). The big five trait taxonomy: History, measurement, and theoretical perspectives. In L. A. Pervin, & O. P. John (Eds.), *Handbook of personality: Theory and research* (2nd ed., pp. 102–138). New York: The Guilford Press.
- John, O. P., Hampson, S. E., & Goldberg, L. R. (1991). The basic level in personality-trait hierarchies: Studies of trait use and accessibility in different contexts. *Journal of Personality and Social Psychology*, *60*, 348–361.
- Kagan, J. (1998). Biology and the child. In W. Damon, & N. Eisenberg (Eds.), *Handbook of child psychology. Vol. 3: Social, emotional and personality development* (pp. 177–235). New York: John Wiley & Sons, Inc.
- Kamhi, A. G. (2003). Two paradoxes in stuttering treatment. *Journal of Fluency Disorders*, *28*, 187–195.
- Karrass, J., Walden, T. A., Conture, E. G., Graham, C. G., Arnold, H. S., Hartfield, K. N., et al. (2006). Relation of emotional reactivity and regulation to childhood stuttering. *Journal of Communication Disorders*, *39*, 402–423.
- Kochanska, G. (1993). Towards a synthesis of parental socialization and child temperament in early development of conscience. *Child Development*, *64*, 325–347.
- Kochanska, G. (1997). Multiple pathways to conscience for children with different temperaments: From toddlerhood to age 5. *Developmental Psychology*, *3*, 228–240.
- Kristal, J. (2005). *The temperament perspective: Working with children's behavioral styles*. New York: Paul H. Brookes Publishing Co.
- Kubzansky, L. D., Martin, L. T., & Buka, S. L. (2009). Early manifestations of personality and adult health: A life course perspective. *Health Psychology*, *28*, 364–372.
- Kusanagi, E. (1993). *A psychometric examination of the Children's Behavior Questionnaire (Annual Report, 1991–1992, No. 15)*. Sapporo, Japan: Hokkaido University, Faculty of Education, Research and Clinical Center for child Development.
- LeDoux, J. E. (1994). Cognitive–emotional interactions in the brain. In P. Eckman, & R. J. Davidson (Eds.), *The nature of emotion. Fundamental questions*. Oxford: Oxford University Press.
- Lewis, K. E., & Goldberg, L. L. (1997). Measurement of temperament in the identification of children who stutter. *European Journal of Disorders of Communication*, *32*, 441–448.
- Lonigan, C. J., & Vasey, M. W. (2009). Negative affectivity, effortful control, and attention to threat-relevant stimuli. *Journal of Abnormal Child Psychology*, *37*, 387–399.
- Lonigan, C. J., Vasey, M. W., Philips, B. M., & Hazen, R. A. (2004). Temperament, anxiety, and the processing of threat-relevant stimuli. *Journal of Clinical Child and Adolescent Psychology*, *33*, 8–20.
- MacCallum, R. C., Widaman, K. F., Zhang, S., & Hong, S. (1999). Sample size in factor analysis. *Psychological Methods*, *4*, 84–99.
- MacLeod, C. M. (1991). Half a century of research on the Stroop effect: An integrative review. *Psychological Bulletin*, *109*, 163–203.
- Mash, E. J. (2006). Treatment of child and family disturbance: A cognitive-behavioral systems perspective. In E. J. Mash, & R. A. Barkley (Eds.), *Treatment of childhood disorders* (3rd ed., pp. 3–62). New York: The Guilford Press.
- McDevitt, S. C., & Carey, W. B. (1978). A measure of temperament in 3–7 year old children. *Journal of Child Psychology and Psychiatry and Allied Disciplines*, *19*, 245–253.
- McManis, M. H., Kagan, J., Snidman, N. C., & Woodward, S. A. (2002). EEG asymmetry, power, and temperament in children. *Deviant Psychology*, *41*, 169–177.
- Menzies, R., Onslow, M., & Packman, A. (1999). Anxiety and stuttering: Exploring a complex relationship. *American Journal of Speech-Language Pathology*, *8*, 3–10.
- Messenger, M., Onslow, M., Packman, A., & Menzies, R. (2004). Social anxiety in stuttering: Measuring negative social expectancies. *Journal of Fluency Disorders*, *29*, 201–212.
- Montgomery, W. J., & Windsor, J. (2007). Examining the language performances of children with and without specific language impairment: Contributions of phonological short-term memory and speed of processing. *Journal of Speech, Language, and Hearing Disorders*, *50*, 778–797.

- Mulcahy, K., Hennessey, N., Beilby, J., & Byrnes, M. (2008). Social anxiety and the severity and typography of stuttering in adolescents. *Journal of Fluency Disorders*, 33, 306–319.
- Muris, P., & Ollendick, T. H. (2005). The role of temperament in the etiology of child psychopathology. *Clinical Child and Family Psychology Review*, 8, 271–289.
- Nigg, J. T. (2006). Temperament and developmental psychopathology. *Journal of Child Psychology and Psychiatry, and Allied Disciplines*, 47, 395–422.
- Nigg, J. T., & Goldsmith, H. H. (1998). Developmental psychopathology, personality, and temperament: Reflections on recent behavioral genetics research. *Human Biology*, 70, 387–412.
- Peters, H. F., & Hulstijn, W. (1984). Stuttering and anxiety: The difference between stutterers and nonstutterers in verbal apprehension and physiological arousal during the anticipation of speech and non-speech tasks. *Journal of Fluency Disorders*, 9, 67–84.
- Plomin, R., & Dunn, J. (Eds.). (1986). *The study of temperament: Changes, continuities and challenges*. Hillsdale: Lawrence Erlbaum Associates.
- Posner, M. I., & Rothbart, M. K. (1998). Attention, self-regulation and consciousness. *Philosophical Transactions of the Royal Society of London: Biological Sciences*, 353, 1915–1927.
- Posner, M. I., Rothbart, M. K., & Rueda, M. R. (November, 2003). Brain mechanisms and learning of high level skills. In *Paper presented at the meeting on Brain and Education on the occasion of the 400th anniversary of the founding of the Papal Academy of Sciences* Vatican City.
- Postma, A., & Kolk, H. H. J. (1993). The covert repair hypothesis: Prearticulatory repair processes in normal and stuttered disfluencies. *Journal of Speech and Hearing Research*, 36, 472–487.
- Purper-Ouakil, D., Cortese, S., Wohl, M., Aubron, V., Orejarena, S., Michel, G., et al. (2010). Temperament and character dimensions associated with clinical characteristics and treatment outcome in attention-deficit/hyperactivity disorder boys. *Comprehensive Psychiatry*, 51, 286–292.
- Putnam, S. P., Ellis, L. K., & Rothbart, M. K. (2001). The structure of temperament from infancy through adolescence. In A. Elias, & A. Angleitner (Eds.), *Advances/proceedings in research on temperament* (pp. 165–182). Lengerich, Germany: Pabst Scientist Publishers.
- Puttonen, S., Elovainio, M., Kivimäki, M., Koskinen, T., Pulkki-Råback, L., Viikari, J. S., et al. (2008). Temperament, health-related behaviors, and autonomic cardiac regulation: The cardiovascular risk in young Finns study. *Biological Psychology*, 78, 204–210.
- Rapee, R. M., & Jacobs, D. (2002). The reduction of temperamental risk for anxiety in withdrawn preschoolers: A pilot study. *Behavioural and Cognitive Psychotherapy*, 30, 211–215.
- Rettew, D. C., & McKee, L. (2005). Temperament and its role in developmental psychopathology. *Harvard Review of Psychiatry*, 13, 14–27.
- Riley, G. D. (1994). *Stuttering Severity Instrument for Children and Adults* (3rd ed.). Austin, TX: Pro-Ed.
- Riley, G., & Riley, J. (1979). A component model for diagnosing and treating children who stutter. *Journal of Fluency Disorders*, 4, 279–293.
- Rothbart, M. K. (1981). Measurement of temperament in infancy. *Child Development*, 52, 569–578.
- Rothbart, M. K. (1989). Temperament and development. In G. Kohnstamm, J. Bates, & M. K. Rothbart (Eds.), *Temperament in childhood* (pp. 187–248). Chichester, England: Wiley.
- Rothbart, M. K., & Bates, J. E. (1998). Temperament. In W. Damon, & N. Eisenberg (Eds.), *Handbook of child psychology. Vol. 3: Social, emotional and personality development* (pp. 105–176). New York: John Wiley & Sons, Inc.
- Rothbart, M. K., Ahadi, S. A., & Evans, D. E. (2000). Temperament and personality: Origins and outcomes. *Journal of Personality and Social Psychology*, 78, 22–35.
- Rothbart, M. K., Derryberry, D., & Hershey, K. (2000). Stability of temperament in childhood: Laboratory infant assessment to parent report at seven years. In V. J. Molfese, & D. L. Molfese (Eds.), *Temperament and personality: Development across the life span*. Mahwah, New Jersey: Lawrence Erlbaum Associates, Publishers.
- Rothbart, M. K., Ahadi, S. A., Hershey, K. L., & Fisher, P. (2001). Investigation of temperament at three to seven years: The Children's Behavior Questionnaire. *Child Development*, 72, 1394–1408.
- Rustin, R., Boterill, W., & Kelman, E. (1996). *Assessment and therapy for young dysfluent children: Family interaction*. London: Whurr Publishers Ltd.
- Saudino, K. J. (2005). Behavioral genetics and child temperament. *Developmental and Behavioral Pediatrics*, 26, 214–223.
- Seery, C., Watkins, R. V., Mangelsdorg, S. C., & Shigeto, A. (2007). Subtyping stuttering II: Contributions from language and temperament. *Journal of Fluency Disorders*, 32, 197–217.
- Shapiro, D. A. (1999). *Stuttering intervention: A collaborative journey to fluency freedom*. Austin, TX: Pro-Ed.
- Slabach, E. H., Morrow, J., & Wachs, T. D. (1991). Questionnaire measurement of infant and child temperament: Current status and future directions. In A. Angleitner, & J. Strelau (Eds.), *Explorations in temperament: International perspectives on theory and measurement* (pp. 205–234). New York: Plenum.
- Smith, T. W., & Williams, P. G. (1992). Personality and health: Advantages and limitations of the five-factor model. *Journal of Personality*, 60, 395–423.
- Smits-Banstra, S., & De Nil, L. F. (2007). Sequence skill learning in persons who stutter: Implications for cortico-striato-thalamo-cortical dysfunction. *Journal of Fluency Disorders*, 32, 251–278.
- Starkweather, C. W. (2002). The epigenesis of stuttering. *Journal of Fluency Disorders*, 27, 269–288.
- Strelau, J. (1998). *Temperament: A psychological perspective*. New York: Plenum Press.
- Strelau, J. (2001). The role of temperament as a moderator of stress. In T. D. Wachs, & G. A. Kohnstamm (Eds.), *Temperament in context* (pp. 153–172). Mahwah, NJ: Lawrence Erlbaum Associates, Publishers.
- Thomas, A., & Chess, S. (1977). *Temperament and development*. New York: Brunner/Mazel.
- Van den Bergh, B., & Ackx, M. (2003). Een Nederlandse versie van Rothbarts 'Children's Behavior Questionnaire'. [The Dutch version of Rothbart's Children's Behavior Questionnaire]. *Kind en Adolescent*, 24, 77–84.
- Van Riper, C. (1973). *The treatment of stuttering*. Prentice-Hall, Inc.: Englewood Cliffs, NJ.

- Vaughn, B. E., Taraldson, B. J., Cuchton, L., & Egeland, B. (2002). The assessment of infant temperament: A critique of the Carey infant temperament questionnaire. *Infant Behavior & Development, 25*, 98–112.
- Wakaba, Y. (1998). Research on temperament of children who stutter with early onset. In E. C. Healy, & H. F. M. Peters (Eds.), *Stuttering: Proceedings of the Second World Congress on Fluency Disorders* (pp. 84–87). Nijmegen, The Netherlands: University Press Nijmegen.
- Williams, P. G., Wiebe, D. J., & Smith, T. W. (1992). Coping processes as mediators of the relationship between hardiness and health. *Journal of Behavioral Medicine, 15*, 237–255.
- Wolfe, C. D., & Bell, M. A. (2004). Working memory and inhibitory control in early childhood: Contributions from physiology, temperament, and language. *Developmental Psychobiology, 44*, 68–83.
- Yairi, E. (2007). Subtyping stuttering I: A review. *Journal of Fluency Disorders, 32*, 165–196.
- Zebrowski, P., & Conture, E. (1998). Influence of non-treatment variables on treatment effectiveness for school-age children who stutter. In A. Cordes, & R. Ingham (Eds.), *Treatment efficacy for stuttering: A search for empirical bases* (pp. 293–310). San Diego: Singular Publishing Group.

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