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Phonological skills and disfluency levels in preschool children who stutter

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Abstract

The relation between stuttering and aspects of language, including phonology, has been investigated for many years. Whereas past literature reported that the incidence of phonological difficulties is higher for children who stutter when compared to normally fluent children, the suggestion of association between the two disorders also drew several critical evaluations. Nevertheless, only a limited amount of information exists concerning the manner and extent to which the speech sound errors exhibited by young children who stutter, close to stuttering onset, is related to the characteristics of their stuttering, such as its severity. Conversely, information is limited regarding the effects a child's phonological skills may have on his/her stuttering severity. The current study investigated the mutual relations between these two factors in 28 carefully selected preschool children near the onset of their stuttering. The children, 20 boys and 8 girls, ranged in age from 25 to 38 months, with a mean of 32.2 months. The phonological skills of two groups with different ratings of stuttering were compared. Similarly, the stuttering severities of two groups with different levels of phonological skills (minimal deviations–moderate deviations) were compared. No statistically significant differences were found for either of the two factors. Inspection of the data revealed interesting individual differences.

Learning outcomes: The reader will be able to list: (1) differences in the phonological skills of preschool children whose stuttering is severe as compared to children whose stuttering is mild and (2) differences in stuttering severity in preschool children with minimal phonological deviations as compared to children with moderate phonological deviations.

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The relation between stuttering and linguistic aspects, including phonology, has been investigated for many years. Although the scientific literature makes frequent reference to a wide range of disorders that are present concomitantly with childhood stuttering (e.g., Arndt & Healy, 2001; Blood & Seider, 1981), much of this work has concentrated on the accompanying language and speech disorders of young children who stutter (see reviews by Bernstein-Ratner, 1997; Louko, 1995; Nippold, 1990, 2001, 2002, 2004; Watkins, Yairi, & Ambrose, 1999). A number of these studies have emphasized a relation specifically between stuttering and either delayed or different phonological development, suggesting that of all the speech–language problems that co-occur with stuttering, phonological difficulties[1] are the most common (Bloodstein, 1987; Cantwell & Baker, 1985; Louko, Edwards, & Conture, 1990; St. Louis & Hinzman, 1988; Paden, 2004; Wolk, Edwards, & Conture, 1993). A majority of past research has focused on the incidence of disordered phonology in children who stutter, resulting in considerable disagreement regarding estimates. At the high end, St. Louis and Hinzman (1988) reported from 66 to 71% of 48 children who stuttered exhibited mild to moderate deviations in articulation, whereas according to more conservative low-end estimates, it appears likely that the co-occurrence is greater than the 2–6% expected in the general population (Beitchman, Nair, Clegg, & Patel, 1986; Hull, Mielke, Timmons, & Willeford, 1971). Thus, Wolk et al. (1993) concluded that, on average, 30–40% of children who stutter also exhibit disordered articulation or phonology.

Previous research into possible links between stuttering and delayed or different phonological development has included studies that approached this topic from different angles. These have included investigations into: (a) the correlation between the frequency of disfluencies with the number of phonological errors (Louko et al., 1990; Ryan, 1992, 2001; Yaruss & Conture, 1996); (b) the stuttering behavior of children with normal and disordered phonology (Wolk et al., 1993; Yaruss, LaSalle, & Conture, 1998); (c) the phonological *behaviors* of children who stutter and normally fluent children (Wolk et al., 1993); (d) phonological complexity/difficulty (e.g., syllable shape and length; location in utterance) and stuttering (Howell & Au-Yeung, 1995; Throneburg, Yairi, & Paden, 1994); (e) the relation between the development of stuttering and phonological skills (Paden & Yairi, 1996; Paden, Yairi, & Ambrose, 1999; Ryan, 2001; Yairi, Ambrose, Paden, & Throneburg, 1996).

Although relatively recent reports have raised arguments to shed doubts about the extent and strength of a stuttering–phonology link that must be considered in assessing current beliefs (Nippold, 1990, 2001, 2002), findings yielded by the University of Illinois Stuttering Research Program into the co-occurrence of stuttering and phonology provide rationale for continuation of research in this area. Those findings suggest that subtle phonological difficulties, presented at the very early stage of stuttering of preschool children, may be associated with the eventual course of the disorder, that is, whether the children's stuttering persisted or later disappeared. Paden and Yairi (1996) used the *Assessment of Phonological Processes—Revised* (Hodson, 1986) to examine the early phonological differences of 36 children, 12 whose stuttering eventually persisted, 12 who eventually recovered early, 12 who eventually recovered after a longer period, and 12 controls. The mean ages were 47.2, 36.7, and 38.3 months, respectively. The examinations

[1] Earlier studies often have included the term "articulation" when investigating the co-occurrence (e.g., St. Louis & Hinzman, 1988; St. Louis, Murray, & Ashworth, 1991; Williams & Silverman, 1968).

were performed soon after onset. Classification into the respective groups was possible after many months of longitudinal follow-ups. Results showed that close to stuttering onset, the group who eventually persisted differed significantly from normally fluent control subjects on the overall mean percentage of error score as well as scores on specific phonological patterns. Scores of the two groups who eventually recovered and their matched controls, however, did not differ significantly.

This research was expanded by Paden et al. (1999), employing a much larger sample and more comprehensive procedures. Again, such explorations were made at the first visit when the children were close to the onset of stuttering and still not identifiable as to the future course their stuttering would take. Of the 84 children, 22 were observed to persist in stuttering for at least 48 months after onset (persistent group), whereas 62 had recovered without clinical intervention before that time (recovered group). The two groups were compared, soon after stuttering onset (mean age 42.5 and 33.8 months, respectively), on a number of phonological characteristics, including mean percentage of error, relative levels of severity of phonological impairment, error on specific phonological patterns, progress in the development of key patterns, and the children's strategies for coping with unmastered patterns. Results indicated that the groups whose stuttering would be persistent had poorer mean scores on each of the measures than did the children who would recover from stuttering. One year after the first visit, however, both groups showed progression in phonological development that followed the expected order, and they resorted to typical strategies when patterns had not yet been acquired. The persistent group was progressing more slowly.

In yet another study, Paden, Ambrose, and Yairi (2002) examined the phonological progress of the same 84 children, 1 and 2 years later. Results of the assessment at the 1-year follow-up visit showed that the mean difference between the two groups of children was no longer significant. The children whose stuttering would persist had improved phonologically more than those who would recover from stuttering. At the 2-year visit, the mean percentage of phonological error for the two groups was identical.

Whereas the Paden and Yairi (1996) and Paden et al. (1999, 2002) studies had as their focus the relation between the development of stuttering (persistency versus recovery) and development of phonological skills, the Louko et al. (1990) study compared the phonological processes exhibited by children who stutter to those exhibited by their normally fluent peers and correlated the frequency of disfluencies with the number of phonological processes produces. Participants included 30 children who stuttered (mean age = 54 months) and matched control group of normally fluent children.

Phonological processes observed for children's spontaneous speech were identified. The children who stuttered, as a group, exhibited a total of 18 different phonological processes, while their controls exhibited only 11 processes. Twelve (40%) of the 30 stuttering children exhibited disordered phonology, defined as either two age-inappropriate or ''atypical'' phonological processes, as compared to just 2 children in the control group. None of the findings, however, were statistically significant, and children with more severe stuttering were not necessarily using a greater number of phonological processes than those with milder stuttering. It should be noted that participants in this study were appreciably older than those used in the Illinois studies and, thus, were more likely to have stuttered for longer period. Moreover, the older the children in the group, the greater is the percentage of boys and, hence, the greater the likelihood of finding higher percentages of phonological

difficulties. The nature of phonological deficits vary with age, as children who are 3 years old typically present quite different phonological abilities from those who are 5 years old. Additionally, the method of evaluating phonological competency was different in the Louko et al. (1990) than in the Illinois studies.

One of the most compelling questions concerning a possible stuttering–phonology connection is the mutual consequence of the degree to which the two domains (disfluency and phonological skills) are affected. Among the previous investigations, the Wolk et al. (1993) and Yaruss and Conture (1996) studies are the primary ones that examined the stuttering behavior of children with normal and disordered phonology and the phonological behaviors of children who stutter and normally fluent children. Wolk et al. (1993) reported no statistically significant differences in either the frequency or severity of stuttering in children who stutter with or without concomitant phonological disorders, defined by the authors as at least two age-inappropriate phonological processes or one or more processes that are not typical of normal development. A similar study by Yaruss and Conture (1996) included 3–6-year-old children with a history of stuttering of up to 3 years and a mean of almost 2 years. One group exhibited stuttering and normal phonological abilities while a matched control group evidenced stuttering and disordered phonology, using the same phonological criteria specified in Wolk et al. (1993). No differences were found between the groups in the frequency or duration of disfluencies that occurred in conversational speech. Similarly, the correlation between the number of phonological errors and the number of within-word disfluencies was not statistically significant.

Based on information, such as participants' age, provided in past reports, there are good reasons to believe that many of the children in those studies had been stuttering for 2–3 years or even longer when their phonology and stuttering were assessed. The results of these studies, then, may not accurately reflect the relation between the two disorders at their earlier stages. The length of the stuttering history (post-onset interval) is critical, as we do know that both phonological skills and stuttering change as a function of time. Influenced by many factors, as children grow older, their stuttering may increase or decline and its pattern may be altered. It may completely remit in the majority of them within 1–3 years after onset (e.g., Yairi & Ambrose, 1999). Hence, it is likely that past studies concerning the suggested stuttering–phonology link have missed significant percentages of children who ever stuttered, reporting data that pertain to only a small subset of children who were following the path of persistent, chronic stuttering. Also, in terms of phonology, there are solid grounds for the expectation that a child's phonological skills will change (mostly improve) with age as he/she gets further away from stuttering onset. In short, a delay of even several months results in the exclusion of a large percentage of children who had already recovered from stuttering or who had outgrown early phonological deficiencies.

There is an additional epidemiological consideration as both Yaruss and Conture (1996) and Wolk et al. (1993) had only boys as subjects. It is widely known that more males than females stutter and that the male-favored gender ratio increases with age from about 2:1 at the time of onset to 4:1 or 5:1 in older children and adults (Bloodstein, 1995). There is evidence that an important reason for the increased ratio is a higher recovery rate for females (Bloodstein, 1995; Yairi & Ambrose, 1992, 1999). In other words, samples of older children who stutter may consist of appreciably greater proportions of males than what is found at onset. Additionally, the gender ratio also plays an important role in phonological

development. At young ages, males are more prone than females to exhibit phonological deficits and their phonological skills progress more slowly as well (Smit & Hand, 1997). In view of these facts, a sample of older children who stutter, consisting of all, or unusually high percentage of, males may incorrectly evidence a higher incidence of phonological difficulties than the normal population simply by virtue of the gender ratio (Yairi, 1999). It appears, therefore, that past research into the phonological behaviors of children who stutter and the stuttering behaviors of children with phonological delays or differences may have overlooked certain epidemiological factors such as natural recovery, gender distribution, and post-onset interval. The need to consider these factors was reinforced in the aforementioned series of studies concerning the phonological skills of preschool children close to stuttering onset by Paden and Yairi (1996) and Paden et al. (1999, 2002).

The dynamics of early stuttering may hold many clues as to the etiology of the disorder. Yet, in spite of the fair amount of research, information is limited about the manner and extent to which the phonological deficiencies exhibited by some young children near stuttering onset co-vary with the characteristics of their stuttering, and, if indeed the two factors co-exist, which one of them has a stronger influence on the other. As stated earlier, one of the questions regarding the relation between the two domains concerns the extent, or degree, to which they are affected. That is, what effect does the severity of stuttering have on phonological performance? Conversely, what influence does the level of phonological ability have on the severity of stuttering? If indeed these communication difficulties are related, it would be logical to expect that children who exhibit severe stuttering also exhibit more phonological deficits and vice versa. If the factors are independent, there would not be such a covariance. Whereas previous investigations have considered factors such as stuttering severity and phonological status, there have not been investigations into the stuttering severity and phonological status of very young children who stutter *near stuttering onset*. Thus, if there is some validity to the proposed co-occurrence with phonological delays or differences, it may be of great interest. This line of inquiry may be relevant in that it could illuminate the relation and possible developmental asynchrony between phonological proficiency and fluency during the time when stuttering begins. Additionally, by looking at the possible differences in phonological skills between children with mild and severe stuttering, as well as the differences in stuttering severity between children with minimal and moderate phonological deviations, more information can be gained about the possible mutual effects of stuttering on phonological skills.

One important motivation for exploring the relation between phonological skills and stuttering is the overlap of children's most common age of stuttering onset (between 2 and 4 years of age) with the period when a child's development is advancing rapidly in almost every capacity, including language, and phonological skills (Bernstein-Ratner, 1997; Yairi, 1983). To these we can also add the rapid development, at the same time, of the child's anatomy and physiology involved in speech. The associations and co-influences among the developing speech and language domains make it logical to assume that any interference with normal development or progress in one aspect could have multiple effects (Watkins & Yairi, 1997). Such co-occurrence of developmental processes has given rise to the hypothesis that when difficulties with fluency co-occur with difficulties with phonology, the two domains share common etiologies or the presence of one facilitates the appearance of the other (Paden et al., 2002).

Speech often is viewed as the product of a series of processes that are taking place simultaneously at several levels (Levelt, 1989). Speech output results from incremental planning at numerous stages, with latter parts of an utterance being planned while earlier parts are being articulated, an idea expressed by Fry in 1969, and then echoed by Garrett (1975), Levelt (1989), and Howell (2002). This has been referred to as a ''staged and feedforward'' process (Levelt, Roelofs, & Meyer, 1999).[2] After the stage of conceptual preparation, word generation proceeds through lexical selection, morphological and phonological encoding, phonetic encoding, and articulation itself. Such hypothetical constructs of lexical access form the crux of recent models as the WEAVER++ (Word-form Encoding by Activation and Verification; Levelt et al., 1999) and the EXPLAN (cognitive planning [PLAN] and articulatory execution of speech [EX]; Howell, 2002).

The multi-level, segmented system of speech planning and production raises questions as to how each subsystem can be protected from interferences by other parts of the system. In both of the above models, it could be said that fluency failures arise because of disparity between time available for planning and time available for execution. In other words, as suggested by Fry (1969), if a level of the speech production system goes too fast, speech errors result; if it goes too slowly, hesitations result. In either situation, the speech production system may be out of sync. Stuttering, then, may be regarded as a disorder of mistiming between motor planning and execution, when a child's fluency generating system is tenuous and may not be adequately protected from concurrently performed cognitive processing or competing interferences (i.e., phonological difficulties). If the purpose of the ''binding and checking'' mechanism involved in normal speech production is to prevent any speech error (Levelt et al., 1999), then perhaps this mechanism is flawed in young children who stutter, leading to a higher incidence of phonological difficulties in this population. Furthermore, if word production is initiated only after all of its syllables have been phonetically encoded (Levelt & Wheeldon, 1994), one may ask what happens when there is an encoding error? For a child who stutters, this may place an additional burden on the task of producing fluent speech. In other words, difficulties involving the timing of the phonological planning/encoding system may indeed cause stress within the fluency generating system, or vice versa. Furthermore, speech error data suggest that the phonological encoding process may be slower for all children as compared to adults (Yaruss & Conture, 1996), and that children's phonological encoding processes may be functionally slower. This may be due to a greater number of perseveratory substitutions as opposed to anticipatory substitutions compared to adults, as well as children's greater error rates overall (Dell, Burger, & Svec, 1997). Whereas normally fluent children apparently develop phonological skills fast enough to accommodate their growing communicative needs, some children who stutter may develop these skills later and may not yet have developed the normal perceptual system to detect errors when they occur (Levelt et al., 1999). Similarly, the Covert-Repair Hypothesis (Postma & Kolk, 1993) postulates that speech difficulties of people who stutter result from problems in pre-motor phonological encoding, wherein the speaker attempts to correct speech errors. Here, stuttering is seen as

[2] The claim that speech production is purely feedforward has been challenged by findings of several investigators arguing that there is feedback as well as feedforward (Dell, 1986; Dell, Schwartz, Martin, Saffran, & Gagnon, 1997).

a covert or internal repair reaction to some flaw in the movements that are required for speech. When a movement is detected as being incorrect, through proprioceptive and then tactile feedback, speech is interrupted before any perceptually identified distortion of speech has occurred (Yaruss & Conture, 1996).

In light of the above, findings from the research of Paden and Yairi (1996) and Paden et al. (1999, 2002) provided some evidence for at least mild delays in phonological development for children who stutter. A working hypothesis guiding this study was that early, sub-clinical phonological delays or differences in development may reveal clues as to the onset and/or trajectory of stuttering. One of the goals of the study was to evaluate in detail whether asynchronies or close parallels in development between stuttering and phonology were evident (e.g., severe stuttering paired with strong or weak phonological development). The study was designed to provide a close analysis of phonological skills in conjunction with the level of disfluency development, near stuttering onset, before the time when the children's stuttering will ultimately diverge into persistent and recovered pathways. The specific questions of the study were as follows. Near the onset of stuttering: (1) Are there differences in the phonological skills of children whose stuttering is severe as compared to children whose stuttering is mild? (2) Are there differences in stuttering severity in children with minimal phonological deviations as compared to children with moderate phonological deviations? The unique contributions of this study are the availability of data about phonological skills and fluency very near stuttering onset and a participant population carefully selected based on epidemiological considerations.

1. Method

1.1. Participants

The participants included a highly selective sample of 28 preschool children who stutter, narrowly ranging in age from 25 to 38 months with a mean age of 32.3 months (S.D. = 3.58). For this specific study, they were selected from a larger pool of participants in the Stuttering Research Project at the University of Illinois on the basis of the following criteria:

1. *Parental diagnosis*. One parent, or both parents when available, regard the child as having a "stuttering problem."
2. *Speech pathologist diagnosis*. Two certified speech–language pathologists independently diagnose the child as exhibiting a "stuttering problem."
3. *Number of disfluencies*. Either from 3 to 5.9 or above 12 stuttering-like disfluencies (SLD) per 100 syllables in conversational speech.
4. *Post-onset interval*. Stuttering onset occurred (according to parents) no more than 6 months prior to entry into the study.
5. *Health history*. The child must exhibit no history of neurological involvement.

The children were divided into four equal groups closely matched by age and gender. Two of the groups were formed using extreme levels of stuttering severity. The first

stuttering-based group was composed of five boys and two girls, whose stuttering was classified as ''mild.'' The children ranged in age from 28 to 36 months with a group mean of 31.2 months (S.D. = 3.14). To be included, a child must have produced from 3.0 to 5.9 SLD per 100 syllables in a rather lengthy conversational speech sample.

The second group was composed of five boys and two girls whose stuttering was classified as ''severe.'' These children ranged in age from 28 to 38 months with a group mean of 31.4 months (S.D. = 3.40). To be placed in this group, a child must have produced more than 12 SLD per 100 syllables. For the present investigation, the wide difference between the mild and severe stuttering classifications, in terms of SLD counts, prevented any potential overlap by separating the groups, and clearly distinguishing those children with mild stuttering from those children with more severe stuttering.

The remaining two groups were selected according to phonological ability. This was based on the mean percentage of phonological error derived from the *Assessment of Phonological Processes—Revised* (*APP-R*) (Hodson, 1986) that was weighted to reflect age increment by months. Adjusting for monthly differences in age, an age-weighted error score was derived for each child by adding (or subtracting) .417 point for each month past or prior to age 3 years (Paden et al., 1999). For the purposes of this investigation, a child was regarded as having moderate phonological deviations if he/she received a mean percentage of phonological error of 39% or more and was regarded as exhibiting minimal phonological deviations if he/she received a mean error score of lower than 19%. The differences between the two phonological classifications sufficiently prevented overlap and clearly separated the groups. Although formal normative data do not yet exist for the *APP-R*, Porter and Hodson (2001) provide some normative *APP-R* data derived from phonological deviation percentage of occurrence means. Encompassing 70 children between the ages of 2.6 and 3.6 years, which is the approximate age-range under investigation in the present study, it was found that the phonological deviation average was 11.4%.

The first phonology-based group was composed of five boys and two girls who stutter and who were labeled as exhibiting minimal phonological deviations. The children in this group ranged in age from 28 to 37 months with a group mean of 33.8 months (S.D. = 3.23). The *APP-R* scores for this group ranged from 5.22 to 14.70.

The second phonology-based group was composed of five boys and two girls who stutter and who were labeled as exhibiting moderate phonological deviations. The children ranged in age from 25 to 37 months with a group mean of 32.5 months (S.D. = 4.57). The *APP-R* scores for this group ranged from 39.08 to 46.60. It should be noted here that, although this group of children did obtain a higher (poorer) mean percentage of phonological error score on the *APP-R*, generally they did not exhibit major phonological impairments.

1.2. Procedures

1.2.1. Recording and disfluency analysis

A conversational speech sample of approximately 1000 words was obtained from each of the 28 children during their initial visit. The conversations between the child and one parent took place in a sound-treated room and were simultaneously audio- and video-recorded.

Each child's utterances were orthographically transcribed and screened for disfluencies. Using the Systematic Analysis of Language Transcripts program (SALT; Miller & Chapman, 1996), all perceived disfluencies were marked on the transcripts, including instances when multiple disfluencies occurred in the same word. For the purpose of this study, only three categories were used: (a) part–word repetition; (b) single-syllable word repetition; (c) disrhythmic phonation (sound prolongation and blocks). These were labeled as stuttering-like disfluencies (Yairi and Ambrose, 1999).

The first author, who has had extensive experience in disfluency analysis, listened to recorded speech samples and counted disfluencies for each of the 28 subjects. The frequency of each of the three disfluency categories per 100 syllables was calculated for each subject. A total SLD count was derived by combining the frequencies per 100 syllables of all three disfluency categories under this classification. Interjudge reliability for the disfluency identification was calculated between the investigator and another very experienced investigator. Interjudge point-by-point agreement (with another investigator experienced with the technique) for location and type of SLD was .89. This was based on the number of agreements divided by the number of agreements plus disagreements. Only SLD occurrences were considered. Fluent events were not included in the calculations.

1.2.2. Phonological analysis

The *Assessment of Phonological Processes—Revised* (Hodson, 1986) was administered to all 28 children. The test assesses phonological capabilities through the child's elicited production of 50 single syllable and multisyllable words and requires children to attempt all phonemes in prevocalic and postvocalic positions where they typically occur in American English. Thus, numbers and types of errors on 10 different phonological processes can be compared directly across children. Although the *APP-R* is based on single-word utterances, Garrett and Moran (1992) compared three phonological measures: phonological deviancy scores (PDS) from the *APP-R*, Percent Consonants Correct (PCC) from conversational speech, and listener severity ratings for 20 children. Their results indicated that the measures were highly inter-correlated, and the authors concluded that the "'PCC and PDS are both accurate indicators of severity."

The investigator who administered the *APP-R* transcribed the children's responses live. Next, two other investigators, one of whom is the first author, independently transcribed the children's responses from audiotape. The transcriptions for each child were compared. Reaching consensus as a means of verifying transcription accuracy has been used for many years (e.g., Shriberg, Kwiatkowski, & Hoffman, 1984). There were no disagreements between the first and second analyses of the transcriptions of the child's productions on the *APP-R*.

In scoring the test, the number of times a targeted pattern was not produced is tallied and divided by the total opportunities for that pattern's occurrence. The child receives a percentage of error on each of the 10 phonological patterns assessed. The mean percentage of phonological error across all 10 patterns is then computed. This score indicates the extent of phonological severity. Next, the age-weighted error score was calculated for each child. It is important to note here that because these are error scores, a higher number indicates *poorer* phonological performance. These data provide the bases for distinguishing between the phonologically based groups in this study.

2. Results

The four groups of children were evaluated on two measures: (a) number of stuttering-like disfluencies and (b) error scores on the *Assessment of Phonological Processes—Revised*. Individual subject data and descriptive statistics for each of the four groups are presented.

2.1. Stuttering-based groups

Individual child data for age, gender, number of SLD, and mean percentage of error score on the *APP-R* for the two groups formed on the basis of stuttering severity are presented in Table 1.

2.1.1. Mild stuttering

As can be seen in the upper portion of Table 1, as defined for purposes of this investigation, the group appears to be quite homogeneous with respect to number of SLD, narrowly ranging from 3.34 to 5.09 with a mean of 4.16 (S.D. = .72). The groups' phonology data (the dependent variable), however, indicated a wider distribution of *APP-R* scores from 7.27 to 34.27 (covering about 27% of the possible range of 0–100) with a mean of 23.90 (S.D. = 10.40), indicating a phonological severity rating in the moderate category.

Only two of the seven children achieved *APP-R* scores of 7.27 and 12.53 that would characterize them as exhibiting minimal phonological deviations. The five remaining

Table 1
Individual data and group means for the mild (MS) and severe (SS) stuttering groups, including age, gender, stuttering-like disfluencies (SLD) per 100 syllables, and mean age-weighted error score on the *Assessment of Phonological Processes—Revise*d (*APP-R*)

Subject	Age (months)	Gender	SLD	*APP-R*
Mild stuttering group				
MS1	28	M	4.41	23.04
MS2	29	M	3.51	30.68
MS3	29	M	3.70	12.53
MS4	30	M	3.34	26.66
MS5	32	F	5.08	34.27
MS6	35	M	4.01	32.89
MS7	36	F	5.09	7.27
Group means	31.2		4.16	23.90
Severe stuttering group				
SS1	28	M	14.50	32.78
SS2	29	F	23.73	21.09
SS3	29	M	12.67	29.13
SS4	31	M	14.95	23.73
SS5	32	M	25.44	6.03
SS6	33	M	19.95	36.44
SS7	38	F	13.07	27.67
Group means	31.4		17.76	25.27

children exhibited phonological deviancy scores that would classify them as being moderate to high moderate.

2.1.2. Severe stuttering

The lower portion of Table 1 shows that the SLD scores for this group ranged from 13.07 to 25.44. The wider SLD range as compared to the mild stuttering group was expected because upper limits were not imposed. The mean SLD was 17.76 (S.D. = 5.26). With regard to the phonological performance of the children, the *APP-R* scores, spanning 6.03–36.44, revealed a range of 30.41 points, similar to that of the mild stuttering group. The group mean of the *APP-R* scores was 25.27 (S.D. = 9.93), only slightly higher than that of the group mean of the mild stuttering group, indicating a phonological severity rating in the moderate range.

Inspecting the distribution of phonology scores for the severe stuttering group, a slight trend toward moderate phonological deviations being paired with more severe stuttering may be observed as only one child would be characterized as exhibiting minimal phonological deviations. The six remaining children exhibited *APP-R* scores in the moderate to the high-end moderate range.

2.2. Phonology-based groups

Similar analyses were performed in regard to the stuttering measure of the groups assigned according to phonological ability. Individual child data for age, gender, number of SLD, and mean percentage of error score on the *APP-R* for the two groups formed on the basis of phonological ability are presented in Table 2.

2.2.1. Minimal phonological deviations

Individual data for the children with minimal phonological deviations are presented in the upper portion of Table 2. The *APP-R* scores are quite homogeneous, ranging only from 5.22 to 14.70 (a range of 9.48 points). The mean score was 9.50 (S.D. = 3.76). A large internal group variability is seen in the number of SLD with the highest score of 18.88 being almost three times larger than 6.31, the lowest score. As we shall see, the mean SLD was 10.93 (S.D. = 4.60), even closer to severe stuttering than the mean for the moderate deviation group.

Furthermore, unlike the group with moderate phonological deviations, there were no children in the minimal deviation group with SLD scores representing mild stuttering. Of the seven children in the minimal deviation group, four would be rated as exhibiting moderate stuttering, one close to severe, and two as severe stuttering based on their respective SLD scores.

2.2.2. Moderate phonological deviations

As can be seen in the lower portion of Table 2, the children are quite homogeneous with respect to phonological scores, as was intended, with a narrow range of 7.5 points, representing only 7.5% of the overall *APP-R* scale, only slightly narrower than that found in the minimal deviations group. The group mean of the age-weighted phonology scores was 43.65 (S.D. = 2.67). When inspecting the respective SLD data, however, considerable

Table 2
Individual data and group means for the moderate phonological deviation (MdP) and minimal phonological deviation (MnP) groups including age, gender, stuttering-like disfluencies (SLD) per 100 syllables, and mean age-weighted error score on the *Assessment of Phonological Processes—Revised* (*APP-R*)

Subject	Age (months)	Gender	SLD	*APP-R*
Minimal deviation group				
MnP1	28	M	6.31	7.41
MnP2	31	M	15.43	14.70
MnP3	34	F	8.78	14.29
MnP4	35	M	8.11	5.22
MnP5	36	M	7.78	8.06
MnP6	36	F	11.21	10.35
MnP7	37	M	18.88	6.46
Group means	33.8		10.93	9.50
Moderate deviation group				
MdP1	25	M	3.48	39.08
MdP2	29	F	14.71	40.97
MdP3	30	M	4.65	46.60
MdP4	35	M	11.19	44.33
MdP5	36	M	11.94	45.29
MdP6	36	M	10.81	45.25
MdP7	37	F	12.89	44.03
Group means	32.5		9.95	43.65

variability is observed with a range of 11.23 points, the highest count being three times as large as the lowest count. It is interesting to note that two of the seven children in this group were characterized as exhibiting mild stuttering, with SLD counts under 5 per 100 syllables. Nevertheless, five had SLD counts of 10 or more per 100 syllables; of these, two had above 12 and one very close to 12 SLD, the point marking severe stuttering in this study. Furthermore, the mean SLD for the moderate deviation group, 9.95 (S.D. = 4.23), leans toward the higher than lower end of the scores.

2.3. Statistical analysis

A summary of the four groups' data for each of the measures is presented in Table 3. Because of the relatively small number of subjects per group ($n = 7$), the non-parametric Mann–Whitney U statistic was used for group comparisons.

Table 3
Summary of group means and standard deviations (in parentheses) for stuttering-like disfluencies (SLD) per 100 syllables and mean age-weighted error score on the *APP-R* for all subject groups

Group/measure	SLD	*APP-R*
Mild stuttering	4.16 (.72)	**23.90** (10.40)
Severe stuttering	17.76 (5.26)	**25.27** (9.93)
Minimal phonological deviation	**10.93** (4.60)	9.50 (3.76)
Moderate phonological deviation	**9.95** (4.23)	43.65 (2.67)

Table 4
Correlation coefficients between stuttering-like disfluencies (SLD) per 100 syllables and mean age-weighted error scores on the *APP-R* for each of the sub-groups ($n = 7$) and for all children combined ($n = 28$)

Group	*r*	*p*
Mild stuttering	−.20	.6687
Severe stuttering	−.64	.1245
Minimal phonological deviation	.15	.7505
Moderate phonological deviation	.11	.8063
All children	−.10	.6075

For the two groups formed on the basis of their stuttering severity, comparisons were made between their phonological test scores. The observed *U* value of 24.00 was not statistically significant ($p = .95$). Similarly, the comparison of the SLD scores between the moderate deviation and minimal deviation groups yielded a *U* value of 23.00 that was not statistically significant ($p = .85$).

Additionally, for each of the four groups ($n = 7$ per group), as well as for all 28 children pooled together, a Pearson correlation between phonological test scores and the number of SLD was calculated. None of the correlations were statistically significant. These results are included in Table 4.

3. Discussion

As we have already asserted, the dynamics of early stuttering may hold many clues as to the etiology of the disorder. If there is some validity to the proposed co-occurrence with phonological delays or differences, it may be of great interest. Indeed, Paden and Yairi (1996) and Paden et al. (1999, 2002) reported some indications for mild, but temporary, delays in phonological development in a selected sub-group of children who stutter during the early phase of stuttering. This line of inquiry could illuminate the relation and possible developmental asynchrony between phonological proficiency and fluency during that period.

In a long line of investigations of the relations between stuttering and level of phonological skills in preschool children, the present study is distinctive by its unique epidemiological foundations reflected in the composition of the participants. The study employed: (a) clearly separated groups representing two levels of stuttering severity and two levels of phonological skills, (b) only children within 6 months of stuttering onset, (c) children within a narrow age-range, and (d) groups of children who composed an appropriate gender distribution for the stuttering population of the age under study. Although the groups are small, the carefully selected samples have allowed for a more epidemiologically sound examination of the supposed stuttering–phonology link than had been possible in the past.

3.1. Group data

Generally, findings of a lack of statistically significant differences between the stuttering of children with minimal and moderate phonological deviations and between the

phonological skills of children with severe and mild stuttering agree with previous investigations (Wolk et al., 1993; Yaruss & Conture, 1996), strengthening their conclusions that the said stuttering–phonology connection is not clearly related to either stuttering severity or level or phonological skills. Neither factor varied systematically when the other one did. Furthermore, the present findings show that this is true from the very early stages of the stuttering disorder. Although the present investigation addressed several methodological concerns of previous investigations, still no firm relation was found between the severity of stuttering and phonological deficiencies. In other words, if reported stuttering–phonology relations in past studies resulted from unsound procedures, as has been argued by Nippold (2001, 2002), her view that the two disorders do not seem to be related would seem to receive some support by the current findings obtained by means of improved procedures. Still, one should keep in mind the limitations of the study. First, the children selected did not represent a random sample of either population of those who stutter or those with phonological deviations. They were selected from the extremes to optimize the ''severity'' classification of each domain. Therefore, generalization must be kept limited. Second, it again should be noted that these data were examined near stuttering onset, before the eventual path of stuttering was determined. Third, processes of speech planning and execution unrelated to the severity of either stuttering or phonological skills might underlie the commonly assumed stuttering–phonology link. Additionally, our findings are consistent with other research where stuttering severity was *not* found to be a relevant parameter in several other aspects of early stuttering. For example, Yairi et al. (1996) and Yairi and Ambrose (1999) reported that stuttering severity was not a predictor of persistent stuttering. Similarly, genetic research has shown that stuttering is not more severe if an individual who stutters has a high number of family members who also stutter (Ambrose, Cox, & Yairi, 1997).

3.2. Individual data

Although the group data failed to produce evidence of a link between the severity of stuttering and phonological skills, the individual data provide interesting observations. Most apparent is the fact that a few children behaved in the opposite direction of our predictions. For example, one child (SS5) in the severe stuttering group had a low (good) phonology score, and one child (MdP4) in the moderate phonological deviation group who had the highest (poorest) phonology score had a relatively low number of SLDs. On the other hand, out of 14 children classified as having either poorer phonology or severe stuttering, 4 either satisfied or came close to satisfying both criteria. This is more than 25% of the combined group. Similarly, out of 14 children in the mild stuttering and minimal phonological deviation groups, 3 (more than 20%) either fulfilled the criteria for the two groups or came close to fulfilling them. These findings raise several questions: (a) Who are the few children who exhibited the exception in their respective groups? (b) What combination(s) of factors does it take to create the association? (c) Does co-occurrence mean that the two disorders are linked? It is interesting to note in this respect that several authors entertained the idea that there is a sub-group of children whose stuttering is related to their articulatory/phonological skills (Blood & Seider, 1981; Van Riper, 1971). Thus, the factor of phonology could be further investigated in research designed to differentiate

stuttering sub-groups. Also, inasmuch as evidence for genetic bases has been reported for phonological disorders (Lewis, 1990; Lewis, Ekelman, & Aram, 1989; Lewis & Thompson, 1992) as well as for stuttering (Ambrose et al., 1997; Kidd, 1984), there are reasonable grounds for hoping that ongoing or future genetic research will shed light on the relations between the two domains and the influence they might have on the eventual course of stuttering.

Overall, though, in the present investigation, what does this lack of statistically significant differences between the stuttering of children with minimal and moderate phonological deviations and the phonological skills of children with severe and mild stuttering tell us? Perhaps the speech production systems of these children are more flexible and resilient than we have assumed, in that they were adequately protected from concurrently performed cognitive processes or competing interferences (Bosshardt, 2002; Kent, 1984). In other words, the presence of a large amount of disfluency did not negatively affect phonological skills, nor did the presence of moderate phonological impairment negatively affect the stuttering severity. In fact, it could be said that the majority of the children were able to evenly divide planning and processing resources involved in order to exhibit limiting the co-occurrence of severe stuttering and moderate phonological impairment. Such ability would enable these children to better adapt to the rapid changes in both domains during this highly developmental period of life. Information pertaining to these abilities could prove useful as future investigations strive toward an understanding of patterns in early phonology and fluency that may help in the projection of the eventual course of stuttering.

3.3. Future research

Although the present investigation included a methodologically sound approach, it failed to detect an apparent link between stuttering severity and severity of phonological deficiency. As discussed above, however, generalization of the finding is limited. Because of these limitations, and in view of Paden et al.'s (2002) positive findings, additional information on the relation between stuttering severity and the level of phonological skill for a much larger sample, covering the entire range of children who stutter, and with more attention to those who persist in stuttering, should be obtained. In addition to carefully controlled basic variables of age, gender, and time from stuttering onset, future research should consider including multiple variables, such as genetic background (i.e., familial co-incidence), detailed phonological processes and phonological complexity, language skills, motor–speech capabilities, and specific features of stuttering that may contribute to the possible identification of subtypes of children whose stuttering will ultimately diverge into persistent and recovered pathways. Examinations such as this would allow investigators to re-address several models and explanations concerned with the proposed stuttering–phonology links, such as the EXPLAN (Howell, 2002), the trade-off model (Bernstein-Ratner, 1997), and the model of interference (Bosshardt, 2002). Current linguistic models such as the aforementioned WEAVER++ (Levelt et al., 1999) also could be incorporated in order to more specifically address the role disfluencies play in the multi-level, segmented system of speech planning and production. Additionally, contrasting phonological skills with abilities in other domains, such as language (e.g., semantics and syntax) and motor

proficiency, may be informative in identifying developmental asynchronies or parallels. Studying such variations in the stuttering–phonology link by pursuing research that includes a larger number of children, not just those at the extremes, also may provide relevant information and may conclude that the co-occurrence of stuttering and phonological difficulties is not greater than chance.

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Appendix A. Continuing education/study questions

1. A review of the literature reveals that studies into the phonological abilities of children who stutter (e.g. Paden & Yairi, 1996; Paden, Yairi, & Ambrose, 1999) found which of the following:
   a. Persistent and recovered children performed (phonologically) similarly near onset, but the persistent children worsened over time.
   b. Persistent children started out more delayed, but eventually caught up with the recovered children in terms of phonological ability.
   c. Recovered children started out more delayed, but eventually caught up with the persistent children in terms of phonological ability.
   d. There were no differences between the two groups in terms of phonological ability.
2. Which of the following was *not* a characteristic of the preschool children participating in this investigation?
   a. All children were within 6 months of stuttering onset.
   b. All children were within a narrow age-range.
   c. Groups of children reflected appropriate gender distribution for stuttering population.
   d. Children exhibited fewer than 3 SLD per 100 syllables.
3. Past research into the phonological behaviors of children who stutter and the stuttering behaviors of children with phonological delays may have overlooked certain epidemiological factors such as:
   a. Genetic factors.
   b. Natural recovery.
   c. Gender distribution.
   d. Pos-onset interval (length of stuttering history).
4. For the purposes of this study, three categories of disfluencies were used for analysis. Which of the following was *not* a disfluency type used for analysis?
   a. Part–word repetitions.
   b. Single-syllable word repetitions.
   c. Multi-syllable word repetitions.
   d. Disrhythmic phonations.

5. Which of the following was a finding in the present study?
   a. There were statistically significant differences in the phonological skills of children with mild versus severe stuttering.
   b. There were statistically significant differences in the stuttering severity of children with mild phonological deviations versus moderate phonological deviations.
   c. There were no statistically significant differences in any of the groups.
   d. Individually, all children performed as expected.

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