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THESIS APPROVAL

The abstract and thesis of Brian Joseph Riffel for the Master of Science in Speech Communication: Speech and Hearing Science were presented July 10, 1997, and accepted by the thesis committee and the department.

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ABSTRACT

An abstract of the thesis of Brian Joseph Riffel for the Master of Science in Speech Communication: Speech and Hearing Science presented on July 10, 1997.

Title: A Comparison of Speech Onset Latencies Between Persons Who Stutter and Persons Who Do Not Stutter Across Varied Phonological Priming Conditions

A recent theory of stuttering, the "Covert Repair Hypothesis of Disfluencies" (Kolk & Postma, in press; Postma & Kolk, 1992, 1993), accounts for the difference between persons who stutter (PWS) and persons who do not stutter (PWNS) by concluding that PWS are slower than PWNS in their phonological encoding abilities. This belief is supported through experimental studies by Bosshardt (1990) and Postma et al (1990), both of which found PWS to be slower than PWNS in silent reading tasks. In addition, Wijnen and Boers (1994) found that PWS demonstrate longer speech onset latencies than PWNS at baseline, but then approximate the times of PWNS upon "phonological priming." They interpreted their results to indicate that in PWS "the encoding of noninitial parts of syllables, particularly the (stressed) vowel, is delayed" (p.1).

The purpose of the present study was to test the covert repair hypothesis, as it is applied to the difference between PWS and PWNS, while eliminating some of the potential biases found in earlier studies. The research question for this study was: "Is there a significant difference in speech onset latencies between PWS and PWNS across three

conditions in which CV, VC, or no part of a one syllable (CVC) word is primed prior to naming of the target?"

Six PWS ages 27 to 47 were recruited from both the Portland State University Speech and Hearing Clinic and a stuttering support group that meets on campus. All PWS were native speakers of English and diagnosed as a PWS by an ASHA certified speech-language pathologist (SLP). In addition, all PWS still considered themselves to be a PWS through self-report/interview. Only one of the six PWS was currently receiving treatment.

The control group consisted of 20 PWNS ages 18 to 37 recruited from Portland State University. All PWNS were native speakers of English.

All subjects performed a picture naming task designed to measure speech onset latencies across varied phonological priming contexts. Subjects were tested individually by being seated in front of a computer monitor and naming line drawings of common objects as they appeared on the screen. Subjects were asked to name the pictures as quickly and as accurately as possible. The task consisted of 504 experimental trials, presented in two blocks of 252 trials.

Following completion of the task, all naming errors, apparatus malfunctions, and extreme outliers were omitted prior to statistical analysis. Mean speech onset latencies of the two groups were then compared. Statistical analysis was performed using a one between and two within mixed factor ANOVA. Results showed no significant differences in speech onset latencies between the two groups at the .05 alpha level across the varied phonological priming conditions.

A COMPARISON OF SPEECH ONSET LATENCIES BETWEEN
PERSONS WHO STUTTER AND PERSONS WHO DO NOT STUTTER
ACROSS VARIED PHONOLOGICAL PRIMING CONDITIONS

by
BRIAN JOSEPH RIFFEL

A thesis submitted in partial fulfillment of the
requirements for the degree of

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in
SPEECH COMMUNICATION:
SPEECH AND HEARING SCIENCE

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1997

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CHAPTER I

INTRODUCTION

Several theories attempt to explain stuttering by incorporating the differences between persons who stutter (PWS) and persons who do not stutter (PWNS). This appears to be a logical approach, in that several studies have shown mean differences to exist between PWS and PWNS in various areas. Among the areas in which differences have been documented are speech and language development, central auditory functioning, sensory motor performance, and general intelligence. Despite the documentation of these differences, a complete theory of stuttering has yet to withstand experimental testing and become widely accepted.

One of the more recent theories which attempts to explain the existence of stuttering is the "Covert Repair Hypothesis of Disfluencies" (Kolk & Postma, in press; Postma & Kolk, 1992, 1993). The covert repair hypothesis states that disfluencies, which can be described as disruptions in the speech flow of both PWS and PWNS, are the "side effects" of interruptions in speech planning. It is hypothesized that as individuals speak, they monitor their speech plan. If errors in the plan are detected, the speaker attempts to covertly correct the error before its overt appearance. Even if the error is corrected prior to production, it is believed that this "covert repair" disrupts the fluency of the speech output. In applying this hypothesis to the difference between PWS and PWNS, Postma and Kolk believe that PWS are slower in their

phonological encoding abilities. This slower speech planning leads to more errors in the phonemic plans of PWS. Stuttering is viewed as the "'normal' repair reaction to an abnormal phonetic plan" (Kolk & Postma, p.16).

The covert repair hypothesis has received some experimental support in recent literature. Wijnen and Boers (1994) compared speech onset latencies of PWS and PWNS across three conditions and concluded that in PWS "the encoding of noninitial parts of syllables, particularly the (stressed) vowel, is delayed" (p. 1). Additional support for this theory has come from studies by Bosshardt (1990) and Postma et al. (1990), both of which found PWS to be slower than PWNS in silent reading tasks, suggesting that speech planning is slower in PWS.

Despite this empirical support, none of the previous studies have performed a pure measure of the phonological encoding process. In addition, Wijnen and Boers (1994) encountered an extremely high error rate during production, thereby calling their results into question.

The proposed study will test the covert repair hypothesis as it is applied to the difference between PWS and PWNS while eliminating some of the potential biases found in earlier studies. The research question for the proposed study is: "Is there a significant difference in speech onset latencies between PWS and PWNS across three conditions in which CV, VC, or no part of a one syllable (CVC) word is primed prior to naming of the target?" If PWS are slower than PWNS in their phonological encoding abilities, differences should be detected between the two groups in speech onset latencies. This is because phonological

encoding is a component of speech onset. Priming refers to the process of pre-activating the internal phonological representation of a word prior to naming of the target. This is accomplished by having the subject name a different picture (prime) prior to naming the target. Presenting a prime that shares the same CV (e.g. "coat/comb") or VC (e.g. "sun/gun") should, in effect, "highlight" the shared portion. If the "(stressed) vowel" is a point of particular difficulty in PWS, relative differences in speech onset latencies between the two groups should be detected across the various phonological priming conditions.

Definitions

The following terms have been used extensively throughout this text. Definitions have been provided to assist in the comprehension of this thesis.

Stuttering: "disruption in the fluency of verbal expression, which is characterized by involuntary, audible or silent, repetitions or prolongations in the utterance of short speech elements, namely: sounds, syllables, and words of one syllable" (Wingate, 1964, p. 488).

Disfluencies: disruptions in the flow of speech; "stuttered disfluencies" are characterized by the one syllable variety referred to in the definition of stuttering, whereas "nonstuttered disfluencies" are the "normal" speech disruptions, such as rephrasing an utterance, pausing, interjection of "uh" or "um," etc.

PWS: person(s) who stutter(s)

PWNS: person(s) who do(es) not stutter

CWS: child(ren) who stutter(s)

CWNS: child(ren) who do(es) not stutter

Sound/Syllable Repetitions: e.g. "p-p-p-pizza"/"ba-ba-basketball"

Sound/Syllable Prolongations: e.g. "mmmmmy
dog..." / "baaaasketball"

Prime: "a word or phoneme presented to a speaker that increases the activation level of the internal representation of that item and facilitates subsequent processing of that item... within spreading activation theories, it is assumed that priming causes an item to reach threshold faster, because activation begins at a higher initial activation level" (Kolk & Postma, pp. 19-20).

Connectionist: model of spoken language consisting of "nodes" representing semantic concepts, words, and phonemes organized into connected hierarchical tiers; activation spreads through this network and determines which items at each level will be selected for the utterance.

Activation: name given to the "excited state" which travels bi-directionally in the connectionist network determining selections.

Selection: process of "choosing" semantic concepts, words, and phonemes in a connectionist model through heightened activation.

CHAPTER II

REVIEW OF THE LITERATURE

Definition of Stuttering

Van Riper (1982) proposed that “stuttering occurs when the forward flow of speech is interrupted by a motorically disrupted sound, syllable, or word or by the speaker’s reactions thereto” (p.15). He stresses the latter part of his definition as a critical feature because avoidance and struggle behaviors not only interrupt the speech flow, but also help to distinguish between disfluencies of persons who stutter (PWS) and persons who do not stutter (PWNS). Inclusion of this distinction between PWS and PWNS is a strength of Van Riper’s definition. Also, for purposes of the proposed study, it is important to reemphasize that Van Riper qualifies only sound, syllable, or word disruptions as spoken aspects of stuttering.

Wingate (1964) defined stuttering as:

(a) Disruption in the fluency of verbal expression, which is (b) characterized by involuntary, audible or silent, repetitions or prolongations in the utterance of short speech elements, namely: sounds, syllables, and words of one syllable. These disruptions (c) usually occur frequently or are marked in character and (d) are not readily controllable. (p. 488)

Wingate’s definition expands upon Van Riper’s by being more detailed. Specifically, an important distinction Wingate makes is that the affected speech element is a maximum of one syllable in length, which helps to further differentiate between stuttered disfluencies and normal

disfluencies. A major criticism of Wingate's (1964) definition is that he perhaps overstates it by saying "one or the other, or both, of these kernel characteristics [repetitions and prolongations] are found in *all* cases of stuttering." (p.487)

Wingate's insistence that repetitions and/or prolongations are always a part of stuttering is the main source of disagreement between his view and that of Perkins (1990), who leads a relatively recent movement in the quest for a definition of stuttering. Rather than focusing on what the listener perceives, Perkins has proposed defining stuttering from the perspective of the speaker as a speech production disorder. According to Perkins, "Stuttering is the involuntary disruption of a continuing attempt to produce a spoken utterance." (p. 376) Although this position is controversial, it has been supported by experimental research on at least one occasion (Moore & Perkins, 1990). However, one must be careful not to interpret this definition as saying that listeners are unable to identify stuttering. Perkins (1990) states, "My position is not that stuttering, typically, cannot be detected." (p. 375) In fact, he goes on to say "I would have little quarrel with Wingate's standard definition if by it he meant that syllable repetitions and prolongations are what the listener is most likely to hear when a speaker experiences stuttering." (p. 375)

Although consensus has yet to be reached with respect to a definition for stuttering, it is apparent that sound/syllable repetitions and prolongations, the focus of the proposed research, are generally accepted as the most prominent perceptual features of stuttering. The

proposed study will attempt to lend support to recent research which has possibly discovered an explanation for the occurrence of sound/syllable repetitions and prolongations in the speech of PWS.

Theories of Stuttering

The initial trend in stuttering research was to view stuttering through the "Medical Model" as being the result of some physical/chemical breakdown or an inherited characteristic, either of which led to failure in the speech system. One of the earliest proposals as to the cause of stuttering was the "Theory of Cerebral Dominance (Orton & Travis, 1929). The ability to produce coordinated speech was believed to lie in the hemispheres of the cerebral cortex. Therefore, a disruption in speech was attributed to a problem in these cortical hemispheres. Specifically, stuttering was thought to be a result of insufficient cerebral dominance. Although this theory experienced some initial favor, it has since failed to gain acceptance or experimental support.

Johnson (1955) proposed one of the most influential theories of stuttering as part of a trend which shifted away from the Medical Model and began to view stuttering as a learned behavior which could be manipulated. His "Diagnosogenic Theory" blamed parents' labeling of a child's normal disfluencies as "stuttering" for providing the underlying cause of stuttering. He believed that the parents' initial "diagnosis" or labeling of stuttering and the accompanying emotional reaction caused anxiety in the child which produced and/or maintained stuttering behavior. Although evidence currently exists which distinguishes

between children who stutter (CWS) versus children who are normally disfluent, this theory still carries influence which, unfortunately, can lead to ineffective treatment and unnecessary parental guilt.

Adams (1990), Starkweather and Gottwald (1990) consolidated previous stuttering research findings into an etiological theory known as the "Demands and Capacities" model. "Demands" refer to environmental and/or self-imposed speaking pressures. These can include instances such as having to speak too quickly or in an uncomfortable situation, or having to produce longer and/or more complex utterances. "Capacities" refer to the speaker's cognitive, linguistic, motoric, and/or emotional abilities to produce fluent speech. Stuttering is believed to result whenever speaking "demands" exceed the speakers innate "capacities." A strength of this theory is that it accounts for the heterogeneous nature of stuttering by allowing for greater diversity in those individuals classified as PWS. Within this model, PWS may encompass a wide range of "demands" and "capacities," provided that "demands" outweigh "capacities." However, this model does not contain a provision for normal disfluencies, which seems to imply that stuttering is merely a situational occurrence that arises whenever a speaker's demands exceed their capacities, rather than a disorder unique to PWS. Adams acknowledges that the model is in the initial stages and has yet to be developed and tested.

Perkins, Kent, and Curlee (1991) have proposed the "Theory of Neuropsycholinguistic Function in Stuttering." In this theory, speech is thought to consist of linguistic and paralinguistic components which

originate from different neural systems before integrating at a common output system. Fluent speech requires this integration to be "synchronous." If the integration is "dyssynchronous," the result can be either normal disfluency or stuttering, depending on both the degree of awareness as to the cause of the disruption and time pressure.

Stuttering, in this theory, is defined as "disruption of speech that is experienced by the speaker as loss of control." (p. 735) Degree of control loss is then considered the measure of severity. Loss of control is thought to increase as awareness of the cause of the speech disruption decreases and time pressure to perform an utterance increases. Although this theory addresses the distinction between the *behaviors* of stuttering and normal disfluencies, it fails to distinguish between PWS and PWNS. Stuttering is described in situational terms based on external factors, rather than fundamental differences between PWS and PWNS, which seems to imply that stuttering is a transient phenomenon experienced by all speakers, rather than a disorder resulting from some difference between PWS and PWNS.

A final recent theory of stuttering, on which the current research is based, is the "Covert Repair Hypothesis of Disfluencies" (Postma & Kolk, 1992, 1993). The covert repair hypothesis states that disfluencies, which can be described as disruptions in the speech flow of both PWS and PWNS, are the "side effects" of interruptions in speech planning. These interruptions are thought to result from internal, prearticulatory error detection in, and subsequent repair of, the speech plan. In other words, as individuals speak, they monitor their speech plan. If errors in

the plan are detected, the speaker attempts to covertly correct the error before its overt appearance or production. Even if the error is corrected prior to production, it is believed that this "covert repair" disrupts the fluency of the speech output.

In applying this hypothesis to the difference between PWS and PWNS, Postma and Kolk believe that PWS are slower in their phonological encoding abilities. Based on a "connectionist" or "spreading-activation" model of spoken language (Dell, 1986, 1988), this slower phonological encoding leads to more errors encoded in the phonemic plans of PWS.

In brief, a "connectionist" or "spreading-activation" model of spoken language can be thought of as an interconnected network of information "nodes" organized in hierarchical tiers of semantic concepts, words, and phonemes. The entire system is in a perpetual state of fluctuating activation or "noise," partially due to sensory input. A spoken utterance begins with heightened activation of the nodes at the semantic level that represent the "basic idea" of the intended message. Activation spreads to the word level, where the desired word nodes of the message to be spoken receive activation for selection. Upon selection of the desired words, activation then spreads to the phonological level where the phoneme nodes required for construction of the desired words receive activation for selection.

It is important to note the distinction between "activation" and "selection." In this model, it is believed that these two processes occur independently of one another. Speakers can determine speed of

selection through adjustments in speech rate, but activation is beyond the speaker's control. Change in speech rate illustrates the relationship between activation and selection, in that, as a speaker talks more quickly it is more likely that speech errors will be produced. Errors represent instances when an unintended phoneme, rather than the intended phoneme, is selected to be part of the phonemic plan. This misselection is believed to result from selection having occurred prior to the target phoneme receiving activation sufficient to differentiate it from competing phonemes. Just as faster speech rate leads to increased phonological encoding errors, so too would slower activation. Phonological activation is the aspect of phonological encoding that is believed to be slower in PWS. If PWS commit more phonological encoding errors than PWNS, PWS will interrupt their speech planning more often as they detect and repair these phonological errors. These increased interruptions are believed to result in the greater number of disfluencies produced by PWS. Thus, stuttering is viewed as the “normal’ repair reaction to an abnormal phonetic plan” (Kolk & Postma, p.16).

If this assumption were true that PWS are slower than PWNS in their phonological encoding abilities, then reduction in speaking rate by PWS should lead to less stuttering. This should occur because the slower phonological encoding system is given added time to sufficiently activate the intended phonemes prior to selection, which should lead to fewer errors committed during phonological selection. It is, in fact, accepted

that reduced speech rate by PWS results in less stuttering (Culatta & Rubin, 1973; Perkins et al, 1976; Postma & Kolk, 1990).

Additional support for the covert repair hypothesis comes from evidence in the literature which supports the existence of a prearticulatory editing component in speech production. In his analyses of speech repairs, Levelt (1983) actually coined the phrase “covert repair,” which he defined as speech events containing either an interruption plus an editing term (e.g., “I want to, uh, go to bed”) or an interruption followed by a retracing of one or more words (e.g., “I want to, I want to go to bed”). Presence of “editing terms” in speech is believed to be an indication that internal editing of the speech plan is occurring. Levelt (1983) also cited the speed with which speakers can correct errors as further proof that editing occurs at the prearticulatory level. In addition to Levelt's findings, Garnsey and Dell (1984) review the literature supporting prearticulatory editing in terms of output biases in speech errors and psychophysiological indicators. With respect to output biases, for example, several studies have shown that errors of sound exchanges tend to create words rather than non-words. This abundance of meaningful speech errors is attributed to the existence of an internal editor which is more likely to detect obvious errors, such as non-words. For psychophysiological evidence, Motley, Camden, & Baars (1982) found heightened galvanic skin response (GSR) when a speaker was producing two-word phrases which would create sexual taboo words if their initial consonants were exchanged (e.g., hit shed - shit head, tool kit - cool tit). In addition, errors tended to be “safe” or nontaboo, such as *hit head* or

cool kit, rather than *shit shed*, *shit head*, *cool tit*, or *tool tit*. This increased GSR was interpreted as a response to the internal formulation and editing of the taboo word. Finally, Postma and Kolk (1992) demonstrated that speakers continued to correct themselves frequently even when auditory feedback was reduced through the use of white noise. Although auditory feedback was probably not completely eliminated, particularly with respect to bone conduction, they believe it reasonable to assume that persistence of self-repairing under noise was, to a large extent, a result of internal editing. These studies support the existence of a prearticulatory editing component in speech production, which is one of the central foundations of the covert repair hypothesis.

PWS vs. PWNS

In addition to potential differences in speech planning between PWS and PWNS, it is important to consider other potential differences between PWS and PWNS for purposes of both experimental design and interpretation of results. Andrews, Craig, Feyer, Hoddinott, Howie, and Neilson (1983) provide a review of differences between PWS and PWNS as part of their comprehensive review of stuttering literature. Differences were reported within the following categories: intelligence, speech and language development, central auditory functioning, and sensory-motor performance.

Four studies reviewed by Andrews et al. (1983) which compare CWS (mean age 10) with CWNS found CWS to score significantly (half a standard deviation) lower on intelligence tests, with this difference being

evident in both verbal and nonverbal tests. Accordingly, CWS were shown to be approximately six months delayed educationally.

Intelligence testing, however, is controversial and beyond the scope of this study. In addition, these studies compared children, whereas our study will be comparing adults. Admittedly, between group differences may exist, in the proposed study, relative to intelligence. However, it is likely that the use of adults perceived to be of comparable intelligence levels will make potential between group differences in intelligence negligible. In addition, the nature of the experimental task is believed to further reduce the potential role of intelligence.

Of seven studies reviewed by Andrews et al. (1983) which addressed speech and language development, six supported the finding that CWS are approximately six months delayed in achieving their speech milestones. Nippold (1990), however, points out potential problems with these results, such as small differences between PWS and PWNS, as well as lack of control for intelligence, family patterns, and gender as contributing factors. She cautions readers to question the validity of these studies on the basis of most data having been collected through the subjective method of parental interview.

Eight studies reviewed by Andrews et al. (1983) reported that CWS do not perform as well as CWNS on certain language tests, although effects of intelligence were not controlled. Again, Nippold (1990) challenges findings involving syntax and morphology, semantics, and word finding as being inconsistent. She does concede that some PWS may have greater difficulty in the areas of semantics and word finding.

However, rather than suggesting major deficits in these areas, she attributes differences in semantic abilities to the variability which exists among CWS and believes assessment of word finding skills to be complicated by stuttering behaviors of avoidance, circumlocution, hesitation, and blocking.

Seven studies reviewed by Andrews et al. (1983) showed CWS to possess three times greater risk of articulation disorders than CWNS. Louko, Edwards, and Conture (1990) reviewed the stuttering literature and found the percentage of CWS and also exhibit articulation problems to range from 16% to 67-96%, with most studies reporting between 20% and 40%, while the percentage of individuals in the general population with articulation or phonological disorders is 2-6%. Results of their study confirmed these figures. Upon comparing a group of CWS with a group of CWNS, 40% (12 of 30) of CWS exhibited disordered phonology, as opposed to 7% (2 of 30) of CWNS. Clearly, there is evidence supporting a relationship between stuttering and articulation or phonological disorders. However, relative to the proposed study, we believe that use of adults as subjects, rather than children, will eliminate potential problems associated with articulation, as well as the previously mentioned speech and language development.

Studies of central auditory function reviewed by Andrews et al. (1983) found PWS to have difficulties with stimulus recognition/recall in complex auditory tasks. Again, it is believed that the nature of the proposed experimental task, voice reaction to visual stimuli, will make

potential between group differences in central auditory function negligible.

Finally, in studies of sensory-motor performance, several deficits were reported by Andrews et al. (1983) in PWS. In 17 studies measuring voice reaction time in response to auditory stimuli, 11 reported PWS to be slower. In seven examinations of voice reaction time to visual stimuli, five found PWS to be slower. Six studies reported PWS to be slower in manual reaction to auditory stimuli. However, Andrews and his associates attribute some of these negative findings to inadequate power resulting from small sample sizes. In addition, the authors performed three sets of studies measuring manual and voicing reaction to pure tones, as well as an auditory discrimination task, and onset/offset of voicing in response to a tone. In none of these three studies were the authors able to find a significant reaction time deficit in PWS. As stated previously, the task required in the proposed study is that of voice reaction time to visual stimuli. The literature is inconclusive with respect to potential reaction time differences between PWS and PWNS. Part of the motivation behind the proposed study is to examine this potential between-group difference.

In summary, a number of studies have attempted to illustrate differences between PWS and PWNS. Differences have been documented in the areas of speech and language development, central auditory functioning, sensory-motor performance, and general intelligence. Differences in phonological encoding, particularly with respect to internal activation of phonemes, are in the early stages of

investigation and have yet to be thoroughly demonstrated. The proposed study will attempt to measure if differences in phonological encoding exist between PWS and PWNS.

Studies Related to the Covert Repair Hypothesis

Recent studies have begun to investigate the potential difference in speech planning between PWS and PWNS. Wijnen and Boers (1994) compared nine PWS to nine PWNS in a “phonological priming” experiment, utilizing a paradigm developed by Meyer (1990, 1991). Both groups were comprised of eight men and one woman ranging from 20 to 35 years of age. All PWS had been diagnosed by speech therapists and still considered themselves to be PWS. The PWS also reported that their stuttering had started between three and ten years of age. Each of the PWS had received treatment for at least one year and up to ten; some of the PWS were still receiving treatment. The PWS were instructed not to use fluency-enhancing techniques (e.g. reduction of speaking rate, easy-onset, prolongation) and, when asked following the experiment, they confirmed that the nature of the task prevented the use of fluency-enhancing measures. Finally, of the nine PWS, three each were classified as severe, moderate, and mild, based on a subjective rating of fluency during a short interview prior to the experiment.

For the experimental task, subjects were required to produce, as quickly as possible, one of five possible response words based on the visual presentation of a corresponding semantically-related cue word. Indirect phonological priming was attempted by specifying the response

words under three conditions: heterogeneous, in which the five possible responses were phonemically unrelated, and two homogeneous cases, one in which the five response words shared the same initial consonant (C-prime: e.g. "cat"/"cup") and one in which the five response words shared both the same initial consonant and subsequent vowel (CV-prime: e.g. "cat"/"cap"). While the PWNS demonstrated shorter speech onset latencies with each increase in the size of the prime, most PWS did not show reduction in speech onset until the CV-prime was given. The authors interpreted these results as an indication that in PWS "the encoding of noninitial parts of syllables, particularly the (stressed) vowel, is delayed" (p. 1) and argue that repetition or prolongation of initial syllables is the result of attempting to produce the syllable prior to specification of the vowel in the articulatory plan.

Whereas Postma and Kolk believe phonological encoding merely to be slower in PWS as compared to PWNS, Wijnen and Boers specify the syllable nucleus/vowel as a point of particular difficulty. A potential criticism of the Wijnen and Boers interpretation is that the nucleus should be examined independent of the onset prior to identifying it as the location of the impairment. A question that the proposed study will address is the effect of priming the rhyme (VC) of a one syllable word (CVC) without priming the initial consonant/onset (e.g. "sun"/"gun") , in order to gain a greater understanding of the role played specifically by the nucleus. The rationale given by Wijnen and Boers for their experiment is if they could influence phonological encoding to reduce the specific problem, the behavior of PWS would approximate that of

individuals who do not stutter, but if they interfered without affecting the specific problem no positive effect would be obtained. One could argue, however, that lack of effect with the C-prime may have been due to degree of impairment, rather than location, and it was simply a case of requiring a larger prime.

A more critical difference between the Wijnen and Boers study and the proposed study lies in the task. The proposed task provides a relatively direct measure of the effect of a phonologically-related prime on the encoding process. Unlike the task of Wijnen and Boers, in which subjects are required to repeatedly reactivate the phonological representations of responses, the proposed study measures the influence of a prime on the target in discrete trials based on a single activation. This difference between tasks also reduces the potential for strategic planning or guessing which exists in the Wijnen and Boers task due to the subjects learning all possible responses and the relationship between potential responses before being required to produce the responses.

Other studies have addressed differences between PWS and PWNS during speed of activation tasks. Bosshardt (1990) and Postma, Kolk, and Povel (1990), both found PWS to be slower than PWNS in silent reading tasks, suggesting that speech planning is slower in PWS. More recently, Bosshardt & Fransen (1996) addressed the question of which specific premotor process(es), phonological encoding, lexical access, and/or semantic coding, are responsible for the slower performance of PWS as compared to PWNS. Specifically, they conducted a study to compare speed of premotor processes in PWS versus PWNS

during a silent reading task. An experimental group of 14 PWS was matched with 14 PWNS based on educational level and estimated daily reading time.

Subjects were presented with a visual cue word. Following reception of the cue word, subjects controlled the visual presentation of prose text on a word-by-word basis. Subjects read the prose text silently while monitoring for a target word which was identical to, rhymed with, or was categorically related to the cue word. The text was either normal prose, syntactically correct but semantically abnormal, or random in word order, so as to study the influence of syntax on monitoring time. The experimenters measured speed of phonological encoding as the difference between identical and rhyme monitoring and speed of semantic coding as the difference between identical and categorical monitoring. Only the difference between identical and category was found to be significant between groups. This confirmed the authors' expectation that PWS exhibit slower semantic coding. Results did not support the belief that PWS are slower in phonological encoding.

Summary

The review of the literature indicates that there are potential differences between PWS and PWNS. These differences may include intelligence, speech and language development, central auditory functioning, and sensory-motor performance (Andrews et al., 1983); and speech planning/phonological encoding (Kolk & Postma, in press; Postma & Kolk, 1992, 1993; Wijnen & Boers, 1994). Several theories have

been proposed which incorporate differences between PWS and PWNS in attempt to explain how stuttering occurs. Currently, no theory has been able to completely account for stuttering. A recent theory, the covert repair hypothesis of disfluencies, seeks to explain differences between PWS and PWNS by claiming that PWS are slower in their phonological encoding abilities (Postma & Kolk, 1993). Experimental procedures by Wijnen and Boers (1994), Bosshardt (1990), and Postma et al. (1990) support the covert repair hypothesis. The studies by Bosshardt (1990) and Postma et al. (1990), however, do not employ a speaking task. Wijnen and Boers (1994) attribute the difference between PWS and PWNS to the syllable nucleus without testing the nucleus independent of the onset. In addition, the relatively high error rate of 21% calls into question whether or not the task was being performed properly. The proposed study will attempt to add support to the covert repair hypothesis while eliminating some of the potential biases found in the Wijnen and Boers (1994) study. The research question proposed for this study is: "Is there a significant difference in speech onset latencies between PWS and PWNS across three conditions in which CV, VC, or no part of a one syllable (CVC) word is primed prior to naming of the target?" Based on the current literature, the experimental hypothesis would support finding significant differences across conditions between PWS and PWNS. The null hypothesis is that no significant differences exist across conditions between PWS and PWNS.

CHAPTER III

METHOD

Subjects

Six PWS ages 27 to 47 were recruited from both the Portland State University Speech and Hearing Clinic and a stuttering support group that meets on campus. All PWS were native speakers of English and diagnosed as a PWS by an ASHA certified speech-language pathologist (SLP). In addition, all PWS still considered themselves to be a PWS through self-report/interview. PWS were also asked to rate/report their severity of stuttering. It was deemed unnecessary to perform a formal evaluation of severity because PWS were not being selected on the basis of severity. Also, because the task itself was lengthy, time required of the subjects was kept to a minimum. Whether or not a subject has received or is receiving speech intervention and, if so, for how long, was considered irrelevant because the task required of the subjects, responding as quickly as possible, was assumed to prevent the use of fluency-enhancing techniques, such as reduction of speaking rate, easy-onset, or prolongation. Profiles of the six PWS follow in TABLE 1.

The control group consisted of 20 PWNS ages 18 to 37 recruited from a Portland State University undergraduate voice and diction class taught by this author. Data gathered from these control subjects had been used for a previous study on which this author served as research assistant. All PWNS were native speakers of English. All participants were free of apparent or reported mental, visual, and language deficiencies.

Table 1
PROFILES OF PWS

<u>Subject #</u>	<u>Age</u>	<u>Education</u>	<u>Gender</u>	<u>Severity</u>	<u>Treatment?</u>
1	27	Grade 16	Female	Mild	Not Currently
2	47	Grade 18	Male	Mild	Not Currently
3	29	Grade 18	Male	Mild-Mod.	Not Currently
4	41	Grade 18	Male	Mild	Not Currently
5	38	Grade 18	Male	Mild-Mod.	Not Currently
6	40	Grade 10	Male	Moderate	Currently

Stimuli

The experimental stimuli consisted of 72 line drawings depicting common objects from Snodgrass and Vanderwart (1980) and several different picture books of line drawings. The pictures were digitized for computer presentation and enlarged to approximate size uniformity. The names of the pictured objects were all monosyllabic words of the form CVC. The 72 stimuli consisted of 18 pairs of words that share the same onset and nucleus, but have different codas (Onset-Related stimuli; e.g., "coat"/"comb") and 18 pairs of words that share the same nucleus and coda, but have different onsets (Rhyme-Related stimuli; e.g., "sun"/"gun").

Design

The experimental design consisted of two within-subject factors: Prime Type (Related or Unrelated) and Prime Location (Onset-Related and Rhyme-Related). Stimuli consisted of 18 pairs of onset-related stimuli and 18 pairs of rhyme-related stimuli, for a total of 36 related

prime-target pairs. Two stimulus sets were constructed in such a manner that the stimuli comprising the prime-target pairs were reversed across sets (e.g., set 1: "coat"-"comb", set 2: "comb"-"coat"). The unrelated prime-target pairs were constructed in the following manner. The 72 stimuli, which comprise 36 related pairs, were divided into 9 groups consisting of 2 pairs of onset-related and 2 pairs of rhyme-related stimuli. Within each of the 9 groups, in addition to appearing as both a related prime and target with the other member of the pair, each stimulus item appeared as an unrelated prime with each of the other six stimulus items from the group in one set and target in the other set. This yielded 24 unrelated pairs per group across the two stimulus sets, resulting in a total of 216 unrelated pairs from 9 groups in each of two stimulus sets, for a total of 432 unrelated pairs. Combined with the 72 related pairs, the result was 252 trials per stimulus set, or 504 total trials for the experiment.

Apparatus

Stimuli were presented on a Macintosh Classic located in the basement of Neuberger Hall. A custom software program written using PsyScope controlled the presentation and timing of the stimuli. Connected to the Macintosh Classic for collecting naming latencies to the targets were a Shure SM 57 microphone and a Carnegie-Mellon University button box containing a voice activated relay and a crystal oscillator that produced measurements to within ± 1 ms. Sensitivity of the microphone was adjustable to compensate for voice intensity differences between subjects.

Procedure

Each subject was tested individually. The subject was seated approximately two feet in front of the computer monitor in a dimly lit room. Because it was critical that subjects correctly name the primes and targets, they were first shown each of the 72 pictures with the corresponding name written below the picture. Presentation of the pictures with names was arranged such that no two successive pictures/names were semantically or phonologically related. Also, the spacing between the related primes and targets was maximized to prevent subjects from observing the relationships. Subjects were asked to look at each picture and read the name aloud. The experimenter pushed the spacebar to control the onset of each picture-name display. The experimenter then presented the pictures in the same order without the names, in order to verify that the subject had learned the names of the pictures. Subjects would not have been allowed to proceed to the experimental portion until they demonstrated ability to name the pictures correctly, however, none of the subjects experienced difficulty learning the picture names.

When the subject had learned the names of the pictures, the experimenter presented some practice trials prior to the experimental trials. The practice trials utilized pictures that were different from the experimental trials in order to eliminate any potential bias which could arise from practicing trials which would later appear during the experimental portion. Subjects encountered the following series of events for each trial: A) fixation cross centered on the screen for 500 ms;

B) prime picture centered on the screen; C) onset of pronunciation to name the prime cleared the picture and began a 650 ms response-stimulus interval (RSI); D) target picture centered on the screen; E) onset of pronunciation to name the target cleared the picture and began a 750 ms inter-trial interval (ITI). Subjects were told to name each picture as quickly and as accurately as possible. When the subject was comfortable performing the practice trials, the 504 experimental trials were presented in 2 blocks of 252 trials. There were four breaks spread throughout each block of 252 trials to allow potential for brief rest periods of up to several seconds. Completion of the entire task, including learning and testing of the picture names, required approximately one hour and fifteen minutes.

Analysis

The dependent variable measured was response time, as measured by the timed difference between the onset of visual presentation of the target word picture and verbal initiation of the corresponding name. The independent variables manipulated were subject type (PWS vs. PWNS), prime type (related vs. unrelated), and prime location (onset vs. rhyme).

The dependent measure of response time was measured in milliseconds. Response times were tabulated by the hardware/software combination described previously and stored in a spreadsheet for future analysis. A three-way analysis of variance (subject type, prime type, and prime location) was performed to answer the research question, "Is there

a difference in the speech onset latencies between PWS and PWNS across various levels of phonological priming?"

CHAPTER IV

RESULTS AND DISCUSSION

RESULTS

The purpose of this study was to test the covert repair hypothesis of disfluencies, as it is applied to the difference between PWS and PWNS, by eliminating some of the potential biases found in previous studies. Specifically, the question addressed was: "Is there a significant difference in speech onset latencies between PWS and PWNS across three conditions in which CV, VC, or no part of a one syllable (CVC) word is primed prior to naming of the target?" A recent study by Wijnen and Boers (1994) claims that in PWS "the encoding of noninitial parts of syllables, particularly the (stressed) vowel, is delayed" (p. 1). If this is the case, results of this study should reflect differences between the two groups (PWS vs. PWNS) across the varied phonological priming contexts.

Analysis

The following were eliminated prior to analysis: word naming errors, including disfluencies, and trials on which the voice-activated relay was tripped too soon, due to interjections prior to the prime/target, or too late/not at all, due to lack of vocal intensity. Word naming errors totaled 3% of trials for PWS and 2% for PWNS, while voice-activation failures occurred on 3% of trials for PWS and 1% for PWNS. The low error rates are an indication that the subjects were engaged and performing the task to the best of their abilities. In addition, any responses which produced a naming latency greater than 2.5 SDs from

the overall mean for each subject were omitted prior to analysis to ensure that a small number of outlying responses would not skew the results in a false direction. These omissions totaled 2% of trials for PWS and 3% for PWNS. In all, a total of 8% of trials were eliminated for PWS and 6% for PWNS; thus, the analyses of naming latencies were based on 92% of responses from PWS and 94% from PWNS.

Mean naming latencies were computed based on overall differences between the two groups (PWS vs. PWNS), group differences relative to prime (related vs. unrelated), and group differences relative to location of prime (onset vs. rhyme). The mean naming latencies are shown in Table 2.

Table 2
MEAN NAMING LATENCIES (MSEC)

	<u>MEAN</u>	<u>STD. DEV.</u>	<u>STD. ERROR</u>
<u>GROUP</u>			
PWNS	676.237	73.838	5.837
PWS	684.400	118.765	17.142
<u>GROUP * PRIME</u>			
PWNS, RELATED	690.969	81.476	9.109
PWS, RELATED	699.304	140.124	28.603
PWNS, UNRELATED	661.505	62.412	6.978
PWS, UNRELATED	669.496	93.411	19.067
<u>GROUP * PRIME * LOCATION</u>			
PWNS, RELATED, ONSET	717.743	85.019	13.443
PWS, RELATED, ONSET	726.526	144.669	41.762
PWNS, UNRELATED, ONSET	674.367	61.463	9.718
PWS, UNRELATED, ONSET	675.939	93.726	27.056
PWNS, RELATED, RHYME	664.196	68.907	10.895
PWS, RELATED, RHYME	672.082	136.045	39.273
PWNS, UNRELATED, RHYME	648.643	61.427	9.712
PWS, UNRELATED, RHYME	663.054	96.795	27.942

Statistical analysis of these results was performed using a one between (subject type) and two within (prime type and location) mixed factor ANOVA. Results of this analysis are shown in Table 3.

Table 3
ANOVA SUMMARY

Source	Sum of Squares/Mean Square	F-Value	P-Value
Group	2460.447	.050	.8249
Group * Prime	1.085	.001	.9797
Grp * Prime * Location	435.432	.793	.3820

Although mean response latencies were slower for PWS than for PWNS under all conditions, the differences between groups were not statistically significant at the .05 alpha level. Overall differences in mean response latencies between the two groups produced a p-value of .8249. Between-group differences based on prime yielded a p-value of .9797. Finally, between-group differences based on prime and location produced a p-value of .3820.

Based upon the above analysis, the null hypothesis: "No significant difference exists in speech onset latencies between PWS and PWNS across three conditions in which CV, VC, or no part of a one syllable (CVC) word is primed prior to naming of the target" could not be rejected. For this group of experimental subjects there was not a significant difference in speech onset latencies between PWS and PWNS across the varied phonological priming conditions.

DISCUSSION

Data gathered from this study was used to determine if there was a significant difference in speech onset latencies between PWS and PWNS across three conditions in which CV, VC, or no part of a one syllable (CVC) word is primed prior to naming of the target. Results indicated that there is not a significant difference in mean onset latencies between the two groups.

Two factors support the results of this study. First, the small number of errors committed by the subjects is an indication that the subjects were fully-engaged and performing the task to the best of their abilities. This allows for a high level of confidence that accurate data has been obtained. Conversely, Wijnen and Boers (1994) encountered error rates of 25% for PWS and 17% for PWNS, for an overall error rate of 21%.

The task itself is also a strength of this study. Unlike the Wijnen and Boers task, in which subjects repeatedly reactivate phonologically-related responses, the task from this study measures the influence of a prime on the target in discrete trials based on a single activation. This provides a more pure measure of the effect of a phonologically-related prime on the encoding/speech process. This task difference also reduces the potential for strategic planning or guessing which is highly likely in the Wijnen and Boers task due to the subjects learning all possible responses and the relationships between potential responses prior to producing the responses. It should be noted, however, that although the task is a relative strength of this study, it is possible that none of these

studies, this present study included, are sufficiently isolating phonological encoding. Speech onset latency presumably encompasses more than phonological encoding.

Calculation of mean response latencies yielded large measures of standard deviation and standard error (see Table 1). In addition, it was noted that removal of one PWS, whose times were noticeably slower than the remainder of the group, would produce different between-group results: mean response latencies would appear *faster* for PWS than for PWNS. These are indications that the sample size of PWS must be increased to obtain more meaningful results. It is interesting to note, however, that the outlying PWS is the only member of the experimental group currently receiving treatment. It is known that part of this subject's treatment stresses reduction of speech rate. Although all subjects were instructed, and periodically reminded, to perform the task as quickly and as accurately as possible, this subject may have focused more on accuracy as a result of habits recently acquired in treatment.

CHAPTER V

SUMMARY AND IMPLICATIONS

SUMMARY

The research question addressed in this study was: "Is there a significant difference in speech onset latencies between PWS and PWNS across three conditions in which CV, VC, or no part of a one syllable (CVC) word is primed prior to naming of the target?" The results of this study can be applied to the covert repair hypothesis of disfluencies, as it relates to the difference between PWS and PWNS.

A recent study by Wijnen and Boers (1994) claims that in PWS "the encoding of noninitial parts of syllables, particularly the (stressed) vowel, is delayed" (p. 1). If this is the case, results of this study should reflect differences between the two groups (PWS vs. PWNS) across the varied phonological priming contexts.

Six PWS age 27 to 47 were recruited from both the Portland State University Speech and Hearing Clinic and a stuttering support group that meets on campus. All PWS were native speakers of English and diagnosed as a PWS by an ASHA certified speech-language pathologist (SLP). In addition, all PWS still considered themselves to be a PWS through self-report/interview. Only one of the six PWS was currently receiving treatment.

The control group consisted of 20 PWNS age 18 to 37 recruited from Portland State University. All PWNS were native speakers of English.

All subjects performed a picture naming task designed to measure speech onset latencies across varied phonological priming contexts. Subjects were tested individually by being seated in front of a computer monitor and naming line drawings of common objects as they appeared on the screen. Subjects were asked to name the pictures as quickly and as accurately as possible. The task consisted of 504 experimental trials, presented in two blocks of 252 trials.

Following completion of the task, all naming errors, apparatus malfunctions, and extreme outliers were omitted prior to statistical analysis. Mean speech onset latencies of the PWS were then compared to data compiled from a group of 20 PWNS age 18 and older. Statistical analysis was performed using a one between and two within mixed factor ANOVA. Results showed no significant differences in speech onset latencies between the two groups across the varied phonological priming conditions. Thus, the null hypothesis: "No significant difference exists in speech onset latencies between PWS and PWNS across three conditions in which CV, VC, or no part of a one syllable (CVC) word is primed prior to naming of the target" could not be rejected.

IMPLICATIONS

Central to the covert repair hypothesis of disfluencies is the belief that PWS are slower than PWNS in their phonological encoding abilities (Kolk & Postma, in press; Postma & Kolk, 1992, 1993). This belief is supported by Bosshardt (1990) and Postma et al (1990), as well as Wijnen and Boers (1994). Through experimental studies, Bosshardt (1990) and

Postma et al (1990) both found PWS to be slower than PWNS in silent reading tasks, suggesting that speech planning is slower in PWS. Wijnen and Boers (1994) found PWS to demonstrate longer speech onset latencies than PWNS relative to "phonological priming" and interpreted their results to indicate that in PWS "the encoding of noninitial parts of syllables, particularly the (stressed) vowel, is delayed" (p.1). One of the purposes of this study was to prime the vowel/rhyme (VC) of a one syllable (CVC) word, independent of the initial consonant, and compare the resulting speech onset latencies to those of other location-based primes (onset-CV) and unrelated primes in order to test the significance of the role played by the (stressed) vowel. The results of this study are in opposition to these prior studies. This study showed no significant differences between groups (PWS vs. PWNS) relative to the vowel/syllable rhyme. These differing results may be due to: the experimental task, the relative severity of the PWS, and/or the sample size.

If PWS are significantly slower than PWNS in their phonological encoding abilities, that difference should be apparent in a speech production task, such as the picture naming employed by this study. This is because phonological encoding is a component of speech production. Postma and Kolk believe that the increased disfluencies of PWS, compared to PWNS, are a result of phonological encoding errors committed by a slower phonological encoding system as it attempts to maintain the same rate as that of a faster phonological encoding system (PWNS). They point to the phenomenon of slower speech rate in PWS

producing fewer disfluencies as support for this claim. Assuming a difference in speed of phonological encoding does exist between the two groups, one variable which should appear if the slower group approximates the speed of the faster group is speech production errors/disfluencies. If PWS are slower than PWNS in their phonological encoding abilities, PWS should produce more errors/disfluencies at a given speech rate. The results of this study reflect no significant difference in speech onset latencies between PWS and PWNS and an identical number of errors combined with outlying latencies (5%). Therefore, the results of this study do not support the belief that PWS are slower than PWNS in their phonological encoding abilities.

A potential clinical implication of these results relates to rate control therapy for PWS. One common component of stuttering therapy involves reduction of speech rate. Based on the results of this study, one might conclude that PWS are not significantly slower than PWNS in speech planning and, therefore, do not need to reduce their speech rate. However, even if the two groups are comparable in speech planning, it may be that a difference exists in another area, such as motor skills, that would still make it beneficial for PWS to reduce their speaking rate. Also, as the heterogeneity of stuttering becomes more evident, one should exercise caution in applying any between group (PWS vs. PWNS) difference to an individual case of stuttering, which is a potential problem with interpreting these, or any other, research findings.

Although the results of this study do not support the covert repair hypothesis of disfluencies as it is applied to the difference between PWS

and PWNS, two points should be noted. First, the small sample size of PWS in this study limits the power of the results. Although the differences produced between the two groups were not significant, there does appear to be a trend because PWS exhibited slower speech onset latencies across all conditions. Second, the speed of phonological encoding may be related to severity of stuttering. The PWS in this study were mild to moderate in severity, whereas the nine subjects in the Wijnen and Boers study were divided equally between mild, moderate, and severe. Future studies should incorporate larger experimental groups and inclusion of PWS demonstrating greater severity of stuttering. These additions would increase the power and applicability of the results.

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STIMULUS SET 1

cheek cheese	rope cheese	robe cheese	sun cheese	gun cheese	dish cheese	fish cheese
rope robe	cheek robe	cheese robe	sun robe	gun robe	dish robe	fish robe
sun gun	cheek gun	cheese gun	rope gun	robe gun	dish gun	fish gun
dish fish	cheek fish	cheese fish	rope fish	robe fish	sun fish	gun fish
coat comb	leash comb	leaf comb	jar comb	bar comb	pan comb	van comb
leash leaf	coat leaf	comb leaf	jar leaf	bar leaf	pan leaf	van leaf
jar bar	coat bar	comb bar	leash bar	leaf bar	pan bar	van bar
pan van	coat van	comb van	leash van	leaf van	jar van	bar van
sail safe	can safe	cap safe	wreath safe	teeth safe	mug safe	bug safe
can cap	sail cap	safe cap	wreath cap	teeth cap	mug cap	bug cap
wreath teeth	sail teeth	safe teeth	can teeth	cap teeth	mug teeth	bug teeth
mug bug	sail bug	safe bug	can bug	cap bug	wreath bug	teeth bug
cage cane	bed cane	bell cane	tire cane	fire cane	pig cane	wig cane
bed bell	cage bell	cane bell	tire bell	fire bell	pig bell	wig bell
tire fire	cage fire	cane fire	bed fire	bell fire	pig fire	wig fire
pig wig	cage wig	cane wig	bed wig	bell wig	tire wig	fire wig
dog doll	root doll	roof doll	whip doll	ship doll	bee doll	knee doll
root roof	dog roof	doll roof	whip roof	ship roof	bee roof	knee roof
whip ship	dog ship	doll ship	root ship	roof ship	bee ship	knee ship
bee knee	dog knee	doll knee	root knee	roof knee	whip knee	ship knee
cork corn	bows corn	bowl corn	face corn	vase corn	mop corn	top corn
bows bowl	cork bowl	corn bowl	face bowl	vase bowl	mop bowl	top bowl
face vase	cork vase	corn vase	bows vase	bowl vase	mop vase	top vase
mop top	cork top	corn top	bows top	bowl top	face top	vase top
rake rain	bat rain	bag rain	girl rain	pearl rain	dice rain	mice rain
bat bag	rake bag	rain bag	girl bag	pearl bag	dice bag	mice bag
girl pearl	rake pearl	rain pearl	bat pearl	bag pearl	dice pearl	mice pearl
dice mice	rake mice	rain mice	bat mice	bag mice	girl mice	pearl mice
cake cave	sheet cave	sheep cave	chair cave	hair cave	bone cave	phone cave
sheet sheep	cake sheep	cave sheep	chair sheep	hair sheep	bone sheep	phone sheep
chair hair	cake hair	cave hair	sheet hair	sheep hair	bone hair	phone hair
bone phone	cake phone	cave phone	sheet phone	sheep phone	chair phone	hair phone
shell shed	cup shed	cuff shed	ring shed	wing shed	hat shed	bat shed
cup cuff	shell cuff	shed cuff	ring cuff	wing cuff	hat cuff	bat cuff
ring wing	shell wing	shed wing	cup wing	cuff wing	hat wing	bat wing
hat bat	shell bat	shed bat	cup bat	cuff bat	ring bat	wing bat

STIMULUS SET 2

cheese cheek	robe cheek	rope cheek	gun cheek	sun cheek	fish cheek	dish cheek
robe rope	cheese rope	cheek rope	gun rope	sun rope	fish rope	dish rope
gun sun	cheese sun	cheek sun	robe sun	rope sun	fish sun	dish sun
fish dish	cheese dish	cheek dish	robe dish	rope dish	gun dish	sun dish
comb coat	leaf coat	leash coat	bar coat	jar coat	van coat	pan coat
leaf leash	comb leash	coat leash	bar leash	jar leash	van leash	pan leash
bar jar	comb jar	coat jar	leaf jar	leash jar	van jar	pan jar
van pan	comb pan	coat pan	leaf pan	leash pan	bar pan	jar pan
safe sail	cap sail	can sail	teeth sail	wreath sail	bug sail	mug sail
cap can	safe can	sail can	teeth can	wreath can	bug can	mug can
teeth wreath	safe wreath	sail wreath	cap wreath	can wreath	bug wreath	mug wreath
bug mug	safe mug	sail mug	cap mug	can mug	teeth mug	wreath mug
cane cage	bell cage	bed cage	fire cage	tire cage	wig cage	pig cage
bell bed	cane bed	cage bed	fire bed	tire bed	wig bed	pig bed
fire tire	cane tire	cage tire	bell tire	bed tire	wig tire	pig tire
wig pig	cane pig	cage pig	bell pig	bed pig	fire pig	tire pig
doll dog	roof dog	root dog	ship dog	whip dog	knee dog	bee dog
roof root	doll root	dog root	ship root	whip root	knee root	bee root
ship whip	doll whip	dog whip	roof whip	root whip	knee whip	bee whip
knee bee	doll bee	dog bee	roof bee	root bee	ship bee	whip bee
corn cork	bowl cork	bows cork	vase cork	face cork	top cork	mop cork
bowl bows	corn bows	cork bows	vase bows	face bows	top bows	mop bows
vase face	corn face	cork face	bowl face	bows face	top face	mop face
top mop	corn mop	cork mop	bowl mop	bows mop	vase mop	face mop
rain rake	bag rake	bat rake	pearl rake	girl rake	mice rake	dice rake
bag bat	rain bat	rake bat	pearl bat	girl bat	mice bat	dice bat
pearl girl	rain girl	rake girl	bag girl	bat girl	mice girl	dice girl
mice dice	rain dice	rake dice	bag dice	bat dice	pearl dice	girl dice
cave cake	sheep cake	sheet cake	hair cake	chair cake	phone cake	bone cake
sheep sheet	cave sheet	cake sheet	hair sheet	chair sheet	phone sheet	bone sheet
hair chair	cave chair	cake chair	sheep chair	sheet chair	phone chair	bone chair
phone bone	cave bone	cake bone	sheep bone	sheet bone	hair bone	chair bone
shed shell	cuff shell	cup shell	wing shell	ring shell	bat shell	hat shell
cuff cup	shed cup	shell cup	wing cup	ring cup	bat cup	hat cup
wing ring	shed ring	shell ring	cuff ring	cup ring	bat ring	hat ring
bat hat	shed hat	shell hat	cuff hat	cup hat	wing hat	ring hat