Word Finding Difficulty As A Post-Polio Sequelae

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ABSTRACT

Seventy-nine percent of respondents to the 1990 National Post-Polio Survey reported difficulty "thinking of words I want to say," with 37% reporting frequent, moderate-to severe word finding difficulty. In this study, 33 polio survivors were administered the Post-Polio Fatigue Questionnaire, Animal Naming and FAS Tests, and tests of attention and information processing speed. Plasma prolactin was also measured as a marker for brain dopamine secretion. Subjects reporting high fatigue severity and word finding difficulty had clinically abnormal or significantly lower Animal Naming Test scores as compared to subjects with low symptom severity. Impaired performance on the most difficult tests of attention and information processing speed were also associated with lower scores on the word finding tests. A significant negative correlation between Animal Naming Test scores and plasma prolactin suggests that a decrement in brain dopamine secretion is related to reduced animal naming ability. These data support the hypothesis that decreased dopamine secretion, possibly secondary to poliovirus damage to the basal ganglia, may underlie not only fatigue and impaired attention but also word finding difficulty in polio survivors.

INTRODUCTION

As many as 76% of the 1.8 million North American polio survivors report Post-Polio Sequelae (PPS), unexpected and often disabling symptoms that include overwhelming fatigue, muscle weakness, pain and dysphagia (1,2,3,4). Of all PPS, fatigue is the most commonly reported and most debilitating symptom. In the 1985 National Post-Polio Survey, 91% of respondents reported new or increased fatigue, 41% reported fatigue interfering with performing or completing their work and 25% reported fatigue interfering with self-care activities (5). Importantly, polio survivors differentiate between physical tiredness and what they describe as "brain fatigue" that they associate with cognitive difficulties. In the 1990 National Post-Polio Survey, between 70% and 96% of respondents with fatigue reported difficulty with concentration, focusing attention, mind wandering, memory, thinking clearly and word-finding, with 77% percent reporting moderate to severe difficulty with these problems (6). Of these cognitive symptoms, word finding difficulty was least expected. Of all polio survivors surveyed, 79% reported difficulty "thinking of words I want to say," with 37% reporting frequent, moderate-to-severe word finding difficulty 6. Further, the frequency and severity of word finding difficulty were significantly correlated with all of the other subjective cognitive difficulties listed above ($r = .22$ to $.55$; $p < .01$).

Clinically, polio survivors report a "tip-of-the-tongue phenomenon" characterized by difficulty naming familiar objects and people (sometimes even family members), difficulty that increases as fatigue worsens. This complaint is similar to that in Parkinson's disease patients, who also report "tip-of-the-tongue" word finding difficulty well as "excessive" and sometimes disabling fatigue (7,8,9). Parkinson's patients and polio survivors are similar in that both have damage to the basal ganglia and dopamine producing neurons (6,10,11,12).

The reports of an association between word finding difficulty, subjective cognitive difficulties and fatigue supports the hypothesis that a common pathophysiology underlies the symptoms of post-polio "brain fatigue" (6,12,13). This study was undertaken to objectively document polio survivors' word

finding difficulty and to identify its relationship to fatigue, neuropsychologic processes requiring cortical activation and a peripheral marker for brain dopamine secretion.

METHODS

Subjects. Subjects were recruited from treated patients and via local post-polio support groups. Potential subjects completed and mailed in a polio and medical history form and the Post-Polio Fatigue Questionnaire 6. On the Questionnaire, respondents rated their typical daily fatigue severity and difficulty with word finding on 6 point scales ranging from "none" through "severe." A phone interview was conducted and individuals were excluded if they were over 59 years old, had any medical or psychological condition that could cause fatigue or cognitive impairment (e.g., major depressive episode, thyroid disease, cerebrovascular or cardiac disease, anemia, respiratory insufficiency, sleep apnea or hypopneas, lupus or diabetes) or if they were taking medications that could cause fatigue or cognitive impairment (e.g., antidepressants or benzodiazepines). Subjects were interviewed when they reported for testing and their medical and psychiatric symptoms and history were confirmed. Thirty-three subjects were selected, giving a power of >.80 at a two-tailed alpha level of $p < .05$.

Eighteen females and 15 males participated, ages 38 to 59 years (Table 1). The average subject was hospitalized when she contracted polio in 1950 at age 5 and had one limb permanently weakened. The subjects' demographic data are consistent with the profile of North American polio survivors seen in the National Post-Polio Surveys (5,6).

Procedure. Subjects were asked to eat their usual morning meal and to limit themselves to two 8 oz. cups of a caffeine containing beverage prior to testing. Subjects arrived between 8:15 AM and 2:45 PM whereupon the experimental procedure was described and the subjects gave written informed consent. Subjects were then taken to the hospital's hematology laboratory where venous blood was drawn. Plasma prolactin was assayed by a commercial laboratory using CIBA-Corning ACS immunochemiluminometric kits. Prolactin was used as an indirect measure of brain dopamine. Since dopamine is the endogenous prolactin inhibiting hormone, a reduction in brain dopamine is inferred from an elevation in plasma prolactin 14. Premenopausal women were studied during their luteal phase to control for the effects of ovulation on prolactin. Blood also was drawn by finger-stick for a study of blood glucose and post-polio fatigue (data to be presented elsewhere). Subjects were asked to report their fatigue on a 6 point scale (from "none" through "severe") before taking tests of attention, information processing speed and word finding that were given in the following order: The Paced Auditory Serial-Addition Test assessed complex attention and information processing speed by requiring subjects to listen to 60 digits presented by a tape recording at a speed of one digit every 1.6 seconds, and to add the first digit to the one following it, say the sum, and then add the next digit to the last one presented (e.g., 3 and then 5 are presented, and the subject says, "8;" the next presented digit is "4" and the subject says, "9") (15); The Double Letter Cancellation Test required subjects to cross-out two specified letters on a sheet filled with various other letters in the shortest possible time to assess selective and sustained attention 16; The Trail Making Tests assessed visual scanning and visual motor speed by requiring subjects to draw a line to sequentially connect circles containing 25 ascending numbers (Trails A) or sequentially but alternately connect circles containing ascending numbers and the letters of the alphabet (Trails B) in the shortest possible time 17; Subjects were asked to name as many animals (Animal Naming Test) and words beginning with F, A and S (FAS Test) as they could in one minute 18; The Gordon Diagnostic System continuous performance test measures focused and sustained attention. The continuous performance test required subjects to watch for numbers, each presented for 2 seconds, on a 1 cm. x 2 cm. LED display flanked by two identical LED displays (19). Subjects were instructed to press a button only when the number "9" appeared immediately following the number "1" as the two flanking LED

displays also presented numbers including "9" and "1" (the distractibility task) or when the flanking displays were dark (the vigilance task). Each task lasted for 6 minutes. The number of times the button was pressed when a "9" appeared immediately following a "1" were summed and displayed as "correct" responses. All neuropsychological tests were administered and scored according to accepted procedures. Data analysis. Statview 4.5 was used to perform statistical analyses (20). Descriptive statistics (Table 1) and Pearson product-moment intercorrelations (Table 2) were calculated for all variables. Since a Post-Polio Fatigue Questionnaire severity rating of "moderate" is considered clinically significant, subjects who reported less than moderate severity of daily fatigue, of fatigue at the time of testing or of difficulty with daily word finding were designated as having "low" symptom severity; subjects reporting moderate or higher severity of fatigue or of difficulty with word finding were designated as having "high" symptom severity. Independent groups t-tests were then used to compare a Animal Naming and FAS Test scores between low and high symptom severity subjects (Table 3) (11).

RESULTS

Descriptive Statistics. Subjects had resting plasma prolactin values ranging from 2.7 to 16.3 ng/ml. These values were typical of resting prolactin levels measured in healthy individuals and are within the normal range (14,21). There were no significant correlations between prolactin and time of blood drawing, age or gender as has been reported in other studies 21 (Table 2). The mean Animal Naming Test score was 19.8, just above the 18 words expected for a normal adult. The mean FAS Test score was 40.8 words which was at the 78th percentile. The mean Cancellation Test and Trail Making Test scores were within normal limits. The mean continuous performance test vigilance task score was 29.5, just above the lower limit of normal, while the mean continuous performance test distractibility task and Paced Auditory Serial-Addition Test scores were clinically abnormal. Correlations. The mean Animal Naming Test score was significantly negatively correlated with plasma prolactin and the Trail Making Test score (Part B), and significantly positively correlated with the continuous performance test vigilance score and the Paced Auditory Serial-Addition Test scores. The mean FAS Test score was significantly negatively correlated with the Trail Making Test score (Part B) and significantly positively correlated with the Paced Auditory Serial-Addition Test score. These correlations indicate that poorer performance on the word findings tests was associated with a higher plasma level of prolactin (Animal Naming Test), a longer time to complete the Trail Making Test (Animal Naming and FAS Tests) and fewer correct responses on the continuous performance test (Animal Naming and FAS Tests) and the Paced Auditory Serial Addition Test (Animal Naming Test).

Group Comparisons. When the Post-Polio Fatigue Questionnaire symptom ratings were used to group subjects, those with high severity of daily fatigue, of fatigue at the time of testing and of difficulty with word finding had significantly lower Animal Naming Test scores, with scores in the latter two groups being clinically abnormal. There were no differences in FAS Test scores between the low and high groups for any of the symptoms.

DISCUSSION

Polio survivors' subjective fatigue-related difficulty "thinking of words I want to say" was corroborated by significantly lower or clinically abnormal Animal Naming Test scores in subjects with high severity of fatigue and word finding difficulty. Their impaired performance on the most difficult tests of attention and information processing speed, which is the neuropsychologic hallmark of post-polio fatigue, was also associated with lower scores on word finding tests. Further, the significant negative correlation between Animal Naming Test scores and plasma prolactin suggests that a decrement in brain dopamine secretion is related to reduced animal naming ability (13). These findings are reminiscent of deficits in Parkinson's disease whose neuropathology results directly from reduced dopamine production within the basal ganglia. Parkinson's patients also report "tip-of-the-tongue" word finding

difficulty and have impaired performance on tests attention and word finding, including the Trail Making and Animal Naming Tests (7,22,23). Tomer, et al. found that Parkinson's patients had scores on Animal Naming (x=17) and FAS (x=39) Tests that were nearly identical to those of the high symptom severity post-polio subjects (24). In another study of Parkinson's patients, Animal Naming Test improved when subjects were cued with categories (i.e., telling subjects where the animals to be named lived), their mean score increasing from 18 to 26 words (25). The cuing inherent in the FAS Test, which provides a letter to prompt word recall, may make it less sensitive to impairments of word finding and explain why Animal Naming Test scores (and not FAS Test scores) were related to prolactin levels and symptom severity. Randolph, et al. attributed Parkinson's patients' impaired animal naming ability to "disruption of prefrontal function at the level of the basal ganglia (that) may involve an interruption of the basal ganglia-thalamocortical pathways." Lesions of neurons comprising these pathways - the putamen, globus pallidus and thalamus - have been associated with impairment of naming ability (25,26,27). Object naming is impaired after left-sided electrical stimulation of the thalamus while putamenal lesions in the non-dominant hemisphere have been suggested to impair "activation and execution of automatic speech programs." (28,29) Neurons within the basal ganglia-thalamocortical pathways are known to be damaged by the poliovirus, as are the dopamine producing neurons whose input to the basal ganglia is necessary for these pathways to stimulate the cortex (6,10,11,12). Damage within these pathways and to dopamine-producing neurons is thought to cause the decreased cortical activation hypothesized to be responsible for polio survivors' "brain fatigue" and its associated cognitive symptoms 30. Slowing of right hemisphere electroencephalographic (EEG) activity in polio survivors, an indicator of decreased cortical activation, was significantly positively correlated with both daily fatigue severity and plasma prolactin, which were themselves significantly positively correlated (31). The present findings of lower Animal Naming Test scores in subjects with high fatigue, and the correlation of Animal Naming Test scores with plasma prolactin, suggest that a decrease in dopamine secretion may participate not only in fatigue and impaired cortical activation, but also in word finding difficulty. A reduction in dopaminergic input to and stimulation of the putamen has been suggested to prevent "activation (of) movements to express already formulated language in speech" and may thereby give rise to "tip-of-the-tongue" word finding difficulty in both polio survivors and Parkinson's patients. This suggestion is supported by the finding that bromocriptine, a direct-acting dopamine-2 receptor agonist, increased Animal Naming Test scores in nonfluent aphasic adults (32,33) and reduced subjective difficulties with fatigue, attention and word finding in polio survivors with severe daily fatigue (34).

Our clinical experience, that word finding difficulty decreases when polio survivors reduce fatigue by decreasing physical overexertion and emotional stress, is supported by the correlation of subjective fatigue with word finding difficulty (2,5). Polio survivors with "brain fatigue" and associated cognitive symptoms must be encouraged to employ all conservative techniques that have been found to be effective in treating fatigue to also treat their word finding difficulty, including energy conservation, work simplification, pacing activities, frequent rests and the use of assistive devices. Only when these techniques have been consistently applied and found to be insufficient to reduce fatigue and improve word finding should a trial of bromocriptine be attempted (35,36,37).

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