Eliciting Information on Differential Sensation of Heat in Those With and Without Poststroke Aphasia Using a Visual Analogue Scale

Nicol Korner-Bitensky, PhD; Eva Kehayia, PhD; Nicole Tremblay, PhD; Barbara Mazer, PhD; Fanny Singer, MSc; Jill Tarasuk, MSc

Background and Purpose—Aphasia can result in an inability to communicate the presence, location, or intensity of pain. Although visual analogue scales (VASs) exist, it is unknown whether they are useful in assessing pain in individuals with aphasia. The objective was to determine whether those with poststroke aphasia could respond differentially to thermal stimuli of varying intensities using a standardized VAS.

Methods—Five groups of participants were assessed: those without stroke, those with stroke but without aphasia, and 3 groups with varying degrees of aphasia. A 10-cm vertical VAS was used to measure responses to varying thermal intensities delivered on the participant’s forearm.

Results—Across all 5 groups, a similar proportion demonstrated ability to discriminate between 2 temperatures ($\chi^2 = 1.899; P = 0.75$). When presented with 4 temperatures, all groups performed more poorly, yet with similar success rates across groups ($\chi^2 = 0.1267; P = 0.88$). The repeated-measures ANOVA revealed no effect of group but a significant effect of temperature ($P < 0.0001$).

Conclusion—A VAS may be useful in clinical identification of differing intensities of stimuli in a substantial proportion of those with aphasia. (Stroke. 2006;37:471-475.)

Key Words: aphasia  ■  pain  ■  stroke

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From the Faculty of Medicine (N.K.-B., E.K., B.M.), School of Physical and Occupational Therapy, McGill University, Montreal, Quebec, Canada; Centre de Recherche Interdisciplinaire en Réadaptation du Montréal Métropolitain (N.K.-B., E.K., B.M., F.S., J.T.), Jewish Rehabilitation Hospital Site, Laval, Quebec, Canada; and Centre Intégré Sur le Cancer du Sein (N.T.), Pavillon Le Royer, Montréal, Québec, Canada.

Correspondence to Nicol Korner-Bitensky, PhD, School of Physical and Occupational Therapy, McGill University, 3630 Promenade Sir-William-Osler, Montreal, Quebec, H3G 1Y5 Canada. E-mail nicol.korner-bitensky@mcgill.ca

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During the course of the study, a further subgrouping of those with severe aphasia was created to differentiate between those with severe comprehension and expressive deficits, and specifically, those with Broca’s aphasia with severe verbal apraxia. These individuals presented with higher-level abstract concepts, as well as carrying out conversation without an interlocutor. Severe included those with Wernicke’s aphasia, global aphasia, and Broca’s aphasia, with severe verbal apraxia. This decision was based on feedback from the collaborating SLP who pointed out that these 2 subgroups appeared to perform differently on the experimental tasks. Sample sizes in these 2 groups were increased so each could be studied independently.

Eligible subjects were approached for consent, and those who agreed signed a consent form: a proxy signed for those with aphasia. The study received approval from the hospital ethics board.

### Measures

For patient participants, information on sociodemographic variables including age, sex, language(s) spoken, and stroke-specific sequelae was abstracted from the chart. For controls, information was elicited at the time of recruitment.

#### Instrument and Stimulus Presentation

Thermal stimuli were generated by a thermal stimulator (Virginia State University, Petersburg). This computer-controlled device delivers thermal stimulation of different intensities using a hand-held contact thermode 1 cm in diameter. The stimulator maintains the desired temperature at the specified intensity regardless of the participant’s skin temperature. Two design issues were considered in the use of this tool with this population. In studies of normal individuals, temperature ranges from nonpainful to painful have been used, with those between 45°C and 51°C described as painful. The second design issue centered around the temperatures to use; in studies of normal individuals, painful stimuli with temperature increments as small as 1°C are discernable. Thus, increments of ≥3°C were used.

### Characteristics of the Cohort (n=90) by Group

<table>
<thead>
<tr>
<th></th>
<th>Controls No Stroke (n=18)</th>
<th>Stroke No Aphasia (n=20)</th>
<th>Mild to Moderate Aphasia (n=23)</th>
<th>Aphasia Severe Expressive Deficits (n=12)</th>
<th>Aphasia Severe Comprehension and Expressive Deficits (n=17)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender n (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>9 (50.0%)</td>
<td>8 (40.0%)</td>
<td>11 (47.8%)</td>
<td>2 (16.7%)</td>
<td>10 (58.8%)</td>
</tr>
<tr>
<td>Male</td>
<td>9 (50.0%)</td>
<td>12 (60.0%)</td>
<td>12 (52.2%)</td>
<td>10 (83.3%)</td>
<td>7 (41.2%)</td>
</tr>
<tr>
<td>Age (y)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean (±SD)</td>
<td>65.1 (±18.3)</td>
<td>73.7 (±18.3)</td>
<td>74.4 (±12.6)</td>
<td>73.8 (±9.4)</td>
<td>75.1 (±12.0)</td>
</tr>
<tr>
<td>Range</td>
<td>(37–86)</td>
<td>(48–86)</td>
<td>(35–89)</td>
<td>(59–85)</td>
<td>(43–90)</td>
</tr>
<tr>
<td>Diagnosis n (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left hemisphere</td>
<td>N/A</td>
<td>9 (45.0%)</td>
<td>20 (87.0%)</td>
<td>11 (91.7%)</td>
<td>17 (100.0%)</td>
</tr>
<tr>
<td>Right hemisphere</td>
<td>N/A</td>
<td>10 (50.0%)</td>
<td>1 (4.3%)</td>
<td>0 (0%)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>1 (5.0%)</td>
<td>2 (8.7%)</td>
<td>1 (8.3%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time since stroke</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean days (±SD)</td>
<td>N/A</td>
<td>33.3 (±25.0)</td>
<td>93.7 (±251.6)</td>
<td>34.8 (±31.7)</td>
<td>85.4 (±138.9)</td>
</tr>
<tr>
<td>Range</td>
<td>(6–90)</td>
<td>(8–1109)</td>
<td>(3–125)</td>
<td>(7–464)</td>
<td></td>
</tr>
<tr>
<td>Paralysis,* n (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hemiplegia</td>
<td>N/A</td>
<td>6 (30.0%)</td>
<td>3 (13.0%)</td>
<td>7 (58.3%)</td>
<td>7 (41.2%)</td>
</tr>
<tr>
<td>Hemiparesis</td>
<td>9 (45.0%)</td>
<td>16 (69.5%)</td>
<td>5 (41.7%)</td>
<td>10 (58.8%)</td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>5 (25.0%)</td>
<td>4 (17.5%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td></td>
</tr>
<tr>
<td>Dysarthria, n (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>0 (00.0%)</td>
<td>1 (5.0%)</td>
<td>0 (00.0%)</td>
<td>1 (8.3%)</td>
<td>0 (00.0%)</td>
</tr>
<tr>
<td>No</td>
<td>18 (100.0%)</td>
<td>19 (95.0%)</td>
<td>23 (100.0%)</td>
<td>11 (91.7%)</td>
<td>17 (100.0%)</td>
</tr>
</tbody>
</table>

*Hemiplegia is total paralysis of the arm, leg, and trunk on the same side of the body. Hemiparesis is weakness on 1 side of the body.

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thyroid conditions, or severe arthritic conditions. Each was interviewed to ascertain sufficient visual ability, comprehension of French or English, and cognitive status to participate.

Participants with stroke who were receiving inpatient or outpatient rehabilitation were recruited from a McGill University hospital. Those with a diagnosis of a unilateral lesion, as indicated by the medical summary, were eligible. Those with previous strokes affecting the contralateral side were excluded, as were those with skin conditions that might alter the perception of heat (diabetes, severe arthritic conditions) and those with insufficient cognitive status to understand the purpose, as determined by the report of the stroke pathologist (SLP), classified participants into those with and without aphasia. Participants with aphasia were classified into 2 groups (mild to moderate and severe) based on their clinical functioning and results of diagnostic tools such as the Boston Diagnostic Aphasia Examination administered by the treating SLP. Mild to moderate included those with Broca’s aphasia, Anomic aphasia, and Conduction aphasia, who clinically experienced difficulties comprehending higher-level abstract concepts, as well as carrying out conversation without an interlocutor. Severe included those with Wernicke’s aphasia, global aphasia, mixed nonfluent aphasia, and Broca’s aphasia with severe verbal apraxia. These individuals presented with serious difficulties in carrying out conversation without an interlocutor, whereas some had a significant loss of speech or auditory comprehension.

During the course of the study, a further subgrouping of those with severe aphasia was created to differentiate between those with severe expressive deficits but not auditory comprehension deficits, more specifically, those with Broca’s aphasia with severe verbal apraxia versus those with severe comprehension and expressive deficits, and more specifically, those with Wernicke’s aphasia, mixed nonfluent aphasia, and global aphasia. This decision was based on feedback from the collaborating SLP who pointed out that these 2 subgroups appeared to perform differently on the experimental tasks. Sample sizes in these 2 groups were increased so each could be studied independently.

Eligible subjects were approached for consent, and those who agreed signed a consent form: a proxy signed for those with aphasia. The study received approval from the hospital ethics board.
Visual Analogue Scale
A 10-cm vertical VAS with 2 descriptors was used, the bottom descriptor being no heat and the top being intense heat. The words were presented in large font in English or French. To indicate a response, the participant moved a vertically sliding indicator along the 10-cm scale; the numbers were not visible to the participant as they were on the reverse side. The vertical presentation was chosen to minimize the potential for error in those with hemianopsia or visual inattention. To help the SLP explain the task, black-and-white pictures were constructed depicting stimuli of varying heat. These were pilot tested with aphasic and nonaphasic patients to identify those that best clarified the task requirements. Pictures were presented in a vertical layout. For example, pictures of steaming coffee consisted of 4 cups incrementally showing: no steam, some steam, more steam, and a lot of steam. The pictorial analogue scale was rarely used because most participants, with the exception of 4, successfully used the VAS.

Procedure
Participants were tested in a quiet room. The evaluator was an experienced SLP, accustomed to interacting with stroke clients and trained in the administration of the study protocol. Each thermal stimulus was applied using light pressure for 5 seconds, with an interval of 60 seconds before the next. Participants completed 3 series of tasks over a 30-minute period. For each task, thermal stimuli were presented in random order on the ventral surface of the forearm ipsilateral to the brain lesion. The same dermatomal location was not stimulated for ≥5 minutes to avoid sensitization. Each of the 3 tasks was preceded by 5 practice trials. On rare occasions when a participant showed signs of fatigue, a second session was scheduled.

Task 1 (No-Heat Versus Intense Heat Detection Task)
This task consisted of 10 stimuli presentations, 5 of no heat (28°C; subthreshold) and 5 of intense heat (44°C), presented in random order, where the participant was required to provide a simple verbal or nonverbal yes/no answer to a question: “Did you feel heat?” This type of response is considered to be the most basic and minimal function available even in those with severe aphasia.

Task 2 (Mild Heat Versus Intense Heat Differentiation Task)
During this task, 2 heat temperatures were presented in random order, 5 at 37°C and 5 at 44°C, and participants indicated perceived intensity using the VAS.

Task 3 (4-Temperature Differentiation Task)
The task consisted of a series of stimuli of 4 intensities, 28°C, 37°C, 40°C, and 44°C, each presented 5 times in random order. The 2 extreme stimuli, 28°C and 44°C, were never presented in sequence. Participants indicated perceived intensity using the VAS.

Sample Size Considerations
Sample size was based on a number of considerations. Previous research by a coinvestigator (N.T.) demonstrated that even with increments of temperature of 1°C, there were substantial differences in mean responses and relatively narrow SEs in young and old participants in groups as small as 10 when using noxious heat.

Given that similar tests have never been conducted in those with stroke, variability in responses was unknown. In designing the current study, increments of ≥3°C were used to facilitate understanding of the task in those with language difficulties, to account for potentially greater difficulty with temperature discrimination when nonpainful stimuli were presented, and to accommodate for a potential reduction in thermal discrimination associated with stroke. Thus, it was anticipated that a sample size equal to that of the previous study would be sufficient to identify mean differences in VAS reporting to the 4 stimuli if temperature differentiation was present in those with aphasia. The introduction of a nonstroke control group also allowed exploration of response patterns to specific temperatures because such information was not available from previous studies.

Data Analysis
In the analyses of task 1, the responses of each participant were analyzed using descriptive statistics to determine the number of times the participant correctly indicated whether the stimulus was heat. Individuals with ≥7 of 10 correct answers were considered to have completed task 1 successfully because this was considered substantially better than chance. χ² analyses were used to compare the proportions achieving task 1 successfully across the 5 groups.

In task 2, a mean VAS score was generated for each participant for each of the 2 temperatures. If the mean VAS response of the 5 37°C stimuli was lower than the mean VAS of the 5 44°C stimuli, the participant was considered to have successfully completed task 2. χ² analyses were used to compare the proportions of individuals successfully completing task 2 across the 5 groups. Then, for each group of participants, 2 mean VAS scores were calculated, 1 for the 37°C stimuli and the other for the 44°C stimuli. Repeated-measures ANOVA was used to study the effect of group and temperature on the dependent variable, score on the VAS.

In task 3, for every participant, a mean VAS score was generated for the 5 trials performed at each of the 4 temperatures. χ² analyses were again used to compare the proportions who successfully completed the task across the 5 groups. Successful completion of task 3 was defined as the 4 means reflecting the intensity of the 4 temperatures in a hierarchical way. Repeated-measures ANOVA was used to study the effect of group and temperature on the VAS. The descriptive data analyses and plots were performed using SAS System for Windows V8.

Results
A total of 696 admissions were reviewed, from which 485 potentially eligible participants were identified. Of these, 64 were discharged before recruitment, and 291 were identified as belonging to a group in which recruitment was complete. The remaining 130 were approached: 95 (73%) agreed to participate (either directly or through proxy consent), and 5 did not complete any phase of the study protocol, primarily for logistic reasons, and thus, 90 participants were included in the analyses.

The Table describes the characteristics of the group. As expected, those with aphasia were more likely to have experienced a left hemisphere lesion. Of all participants, 6 were left-handed.

In task 1, controls were the most likely to succeed, with a success rate of 94% (17 of 18). Seventy-five percent (15 of 20) of the group with stroke (no aphasia) succeeded; 65% (15
of 23) of those with mild to moderate aphasia, 67% (8 of 12) of those with aphasia–severe expressive deficits, and 59% (10/17) of those with aphasia–severe comprehension and expressive deficits. χ² analysis revealed no significant difference in success rates across the 5 groups (χ²=6.776; df=4; P=0.15; 2 cells have counts <5) but significant differences when comparing those without aphasia (controls and stroke–nonaphasia combined) to those with aphasia (χ²=4.71; df=1; P=0.03).

While designing the protocol, it was decided that those who did not complete task 1 would not proceed to task 2. However, the SLP performing the evaluations suggested that the first task was rather abstract, and that once 2 temperature sensations were introduced, it might be easier to understand the requirements of the task.

In task 2 (Figure 1), there were no significant differences in the proportions that distinguished between the 2 temperatures among the 5 groups (χ²=1.899; df=4; P=0.75) nor between those with and without aphasia (χ²=0.139; df=1; P=0.71). Two participants could not attempt the task: 1 in the aphasia–severe expressive group and 1 in the aphasia–severe comprehension and expressive group. Both had been unsuccessful in task 1, and the SLP deemed it too stressful to continue. The mean of the responses to the 44°C stimuli was higher than to the 37°C stimuli across all groups (Figure 2). The results of the 2-way repeated-measures ANOVA indicated no differences among groups on VAS scores (F=0.643; df=4, 83; P=0.63) but a significant main effect of temperature (F=82.128; df=1, 86; P<0.0001), indicating that all groups differentiated between the 2 heat intensities. No interaction was found between group×temperature (P=0.27), indicating that the 5 groups differentiated each temperature similarly.

In task 3, in which the goal was to indicate the magnitude of the thermal stimuli for 4 temperatures, fewer participants were successful: 50% of controls, 45% of those with stroke no aphasia, 52% of those with mild-to-moderate aphasia, 36% of those with aphasia–severe expressive, and 56% of those with aphasia–severe comprehension and expressive. χ² analysis found no differences in success among the 5 groups (χ²=1.267; df=4; P=0.88) or between those with and without aphasia (χ²=0.06; df=1; P=0.81). The repeated-measures ANOVA revealed no main effect of group (F=0.885; df=4, 83; P=0.48) but a significant main effect of temperature (F=39.348; df=3, 84; P<0.0001; Figure 3), indicating that all groups differentiated among the 4 heat intensities. There was no temperature×group interaction (P=0.86). Participants in all groups predominantly used the lower end of the VAS scale for all temperatures, rarely scoring any temperature above the 5-cm mark on the 10-cm VAS.

Discussion

Pain is a potential deterrent to participation in therapy and daily life activities. This study arose from our previous work that demonstrated that those with aphasia receive less pain medication than those without aphasia.7 Although the current study was based on thermal stimuli and not pain, it does suggest that with limited training, a substantial portion of those with severe aphasia may be able to share information on

![Figure 2](image-url)  
**Figure 2.** Means and SDs by group for temperatures 37°C and 44°C.

![Figure 3](image-url)  
**Figure 3.** Mean VAS scores over 4 temperatures by group.
varying intensities of stimuli using a VAS. The group with severe comprehension and expressive deficits did as well as the other groups when it came to differentiating 4 temperatures. These individuals were on average 3 months after stroke and had all received extensive rehabilitation during which they learned various nonverbal means of communication. This, in all likelihood, facilitated their comprehension of the requested task.

The differences in success among groups were most pronounced in task 1, which we originally thought would be the easiest. In task 2 a high proportion of those with severe aphasia were able to use a VAS correctly. This finding is in contrast to the work of Price, Curless, and Rogers, albeit using different stimuli, who found individuals with stroke, with the exception of those experiencing mild stroke, were unable to use a VAS to identify varying pressure inflations on a sphygmomonometer cuff.

Although our study provides laboratory-based results with an experienced SLP eliciting the VAS responses, the findings are encouraging in that they suggest a plausible next step: the planning of a study investigating the usefulness of a VAS to assist individuals with aphasia who cannot express their pain. The sample size used was sufficient to answer the main question regarding the ability of individuals with aphasia to discriminate between various temperatures but was insufficient to detect some between-group differences that may have existed. Future work, focused on a larger sample of only those with aphasia and further classified according to important clinical manifestations, is warranted.

In summary, nonverbal methods to elicit information on pain have become commonplace in other groups who have difficulty communicating, including neonates and young children and the frail elderly. Those with poststroke aphasia will benefit from similar attention to their needs for pain identification.

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References


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