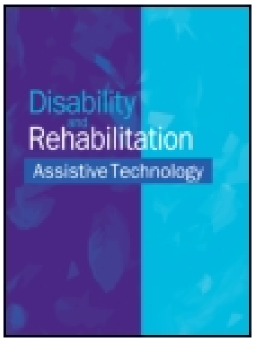

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PRODUCTS AND DEVICES

Effect of two layouts on high technology AAC navigation and content location by people with aphasia

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Abstract

Purpose: Navigating high-technology augmentative and alternative communication (AAC) devices with dynamic displays can be challenging for people with aphasia. The purpose of this study was to determine which of two AAC interfaces two people with aphasia could use most efficiently and accurately. *Method*: The researchers used a BCB′C′ alternating treatment design to provide device-use instruction to two people with severe aphasia regarding two personalised AAC interfaces that had different navigation layouts but identical content. One interface had static buttons for homepage and go-back features, and the other interface had static buttons in a navigation ring layout. Throughout treatment, the researchers monitored participants' mastery patterns regarding navigation efficiency and accuracy when locating target messages. *Results*: Participants' accuracy and efficiency improved with both interfaces given intervention; however, the navigation ring layout appeared more transparent and better facilitated navigation than the homepage layout. *Conclusions*: People with aphasia can learn to navigate computerised devices; however, interface layout can substantially affect the efficiency and accuracy with which they locate messages.

Keywords

AAC, aphasia, augmentative communication

History

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➤ Implications for Rehabilitation

- Given intervention incorporating errorless learning principles, people with chronic aphasia can learn to navigate across multiple device levels to locate target sentences.
- Both navigation ring and homepage interfaces may be used by people with aphasia.
- Some people with aphasia may be more consistent and efficient in finding target sentences using the navigation ring interface than the homepage interface. Additionally, the navigation ring interface may be more transparent and easier for people with aphasia to master – that is, they may require fewer intervention sessions to learn to navigate the navigation ring interface.
- Generalisation of learning may result from use of the navigation ring interface. Specifically, people with aphasia may improve navigation with the homepage interface as a result of instruction on the navigation interface, but not vice versa.

A substantial portion of people with aphasia have unmet communication needs that persist despite extensive rehabilitation efforts [1,2]. Unmet communication needs can lead to decreased participation in previously enjoyed activities, social isolation, poor vocational or educational outcomes, learned helplessness, and changes in family roles [3]. Traditionally, augmentative and alternative communication (AAC) systems have provided support for individuals who cannot meet their communication needs using natural speech alone. As such, the use of high-technology, computerised AAC devices by people with aphasia has been examined by various researchers (e.g. [4–9]).

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Computerised, dynamic display devices are appealing for AAC purposes, because they can hold vast amounts of information. This apparent advantage may actually be a disadvantage, however, when the amount of content makes finding information – that is, navigating the device – difficult. This may be the case for people with symbolic processing disorders such as those associated with aphasia [11]. Indeed, anecdotal reports suggest that people with aphasia experience challenges learning to navigate through and locate content quickly and accurately either with low-tech or high-tech AAC devices. Despite the importance of navigation, existing research about the use of AAC devices by people with aphasia has not specifically targeted this topic.

Fundamental to navigation challenges is the layout used to facilitate content location within AAC interfaces. Advancement of AAC as a communication support for people with aphasia is dependent on professionals designing organisational layouts that make the location of content transparent and easy to learn and then teaching people to use these layouts effectively and

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efficiently. One layout that may facilitate navigation and content location by people with aphasia involves using a set of static buttons to make an interface revert to key pages. Specific design features may vary, but systems incorporating this concept typically include a homepage button that allows immediate return to the first display level from all other pages as well as a go-back button that allows for sequential backward movement through a series of recent navigation activations. Figure 1 shows multiple pages from a high-tech AAC interface with static homepage and go-back buttons to facilitate navigation.

A second method of incorporating static buttons to facilitate content location by people with aphasia involves using a navigation ring. Beukelman et al. [8,10] introduced the concept of a navigation ring with their work on visual scene displays. In brief, a navigation ring is a collection of miniaturised images that appear on all interface pages as static buttons encompassing the outside edges of a high-tech AAC display. Selecting one of the navigation ring images causes the interface to open a page devoted to the associated topic. By having the navigation ring present on all interface pages, a person can switch seamlessly from one topic to another regardless of its location within an AAC device. Go-back and go-forward buttons may also be present to allow sequential movement within specific topics. Figure 2 shows multiple pages from a high-tech AAC interface that has a navigation ring layout to facilitate content location.

The purpose of this study was to investigate the effect of two organisational layouts on the efficiency and accuracy of AAC navigation and content location by two people with aphasia when using multi-level, high-tech AAC devices with touch-screen activation. For each participant, the researchers created two AAC interfaces that incorporated the use of static buttons and that contained identical, personalised content but had different layouts. Specifically, one interface had a navigation ring visible on all pages to facilitate navigation, and the other had homepage and go-back buttons visible on all pages except the homepage itself to facilitate navigation.

Method

Participants

Two adult males with aphasia secondary to single, left-hemisphere, cerebrovascular accidents participated in the research. Both were right-handed, were greater than 1 year post-stroke, and spoke US English as their primary language; one participant spoke only English, and the other was fluent both in Swedish and English. English was the sole language used for all post-stroke speech-language intervention and research sessions for both participants.

Both participants reported hearing within normal limits. Screening procedures also confirmed adequate visual scanning, motor control, and visual matching skills to perform the experimental tasks. Specifically, to assess the adequacy of visual scanning and motor control skills, a participant viewed a 27.9-cm touch-screen laptop monitor on which an *X* presented in 12-point, bold, Arial font appeared at a random location. Touching the *X* caused it to disappear and another one to appear at a different location on the screen. Locating and touching 10/10 *X*'s established sufficient visual scanning and motor control to perform the experimental tasks. For the visual matching screening, a participant viewed sentences in 22-point, bold, Arial font appearing on separate 7.6×12.7 cm stimulus cards. Each target sentence as well as 4 foil sentences also appeared in 22-point, bold, Arial font in random order on a separate piece of 21.6×27.9 centimeter paper placed in front of the participant. Foil sentences were roughly comparable in length to target sentences and included some of the same key words (e.g. target

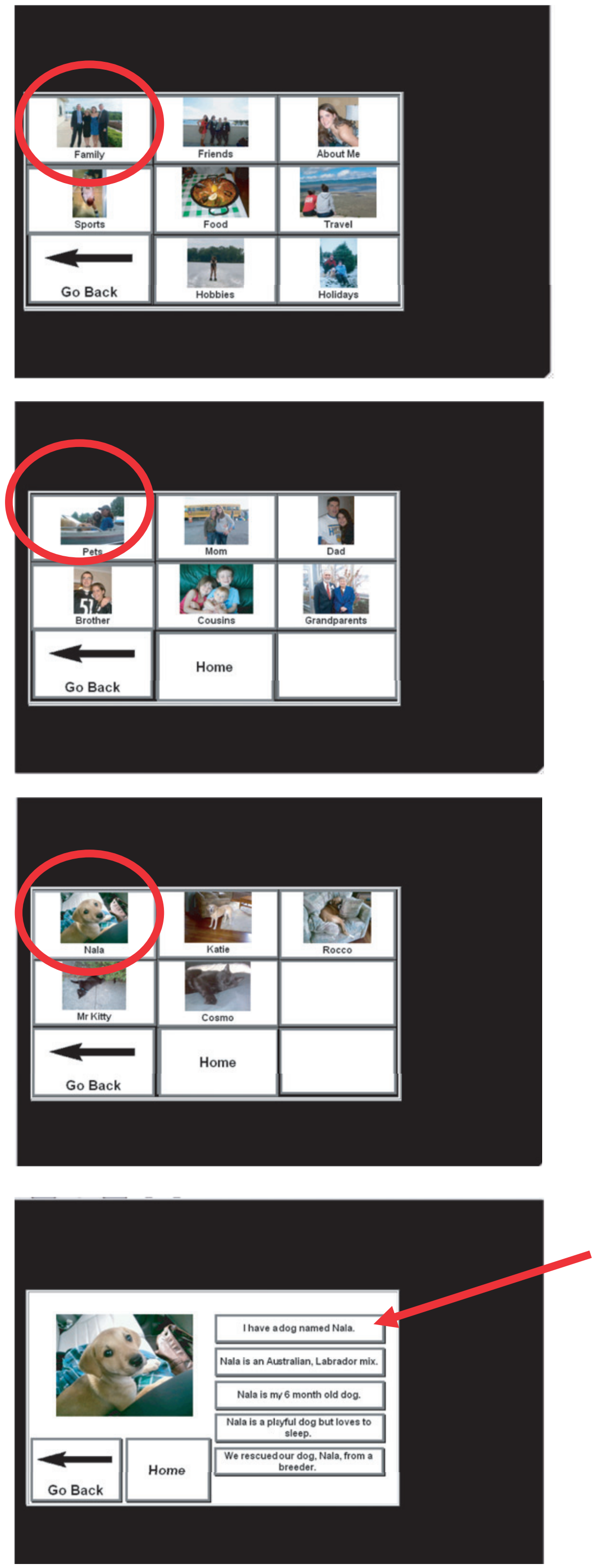

Figure 1. Example of levels 1, 2, 3, and 4 within a homepage layout interface.

sentence: *Mary joined us at the Tulip Festival*; foil sentence: *Mary went to the Tulip Festival with us*). Accurately selecting 5/5 sentences matching the ones printed on the stimulus cards established sufficient visual matching skills to perform the experimental tasks.

Both participants reported having experience with computers for occupations they held prior to acquiring aphasia but limited current use of computers. One participant used a computer for some speech therapy tasks, but he required assistance setting up

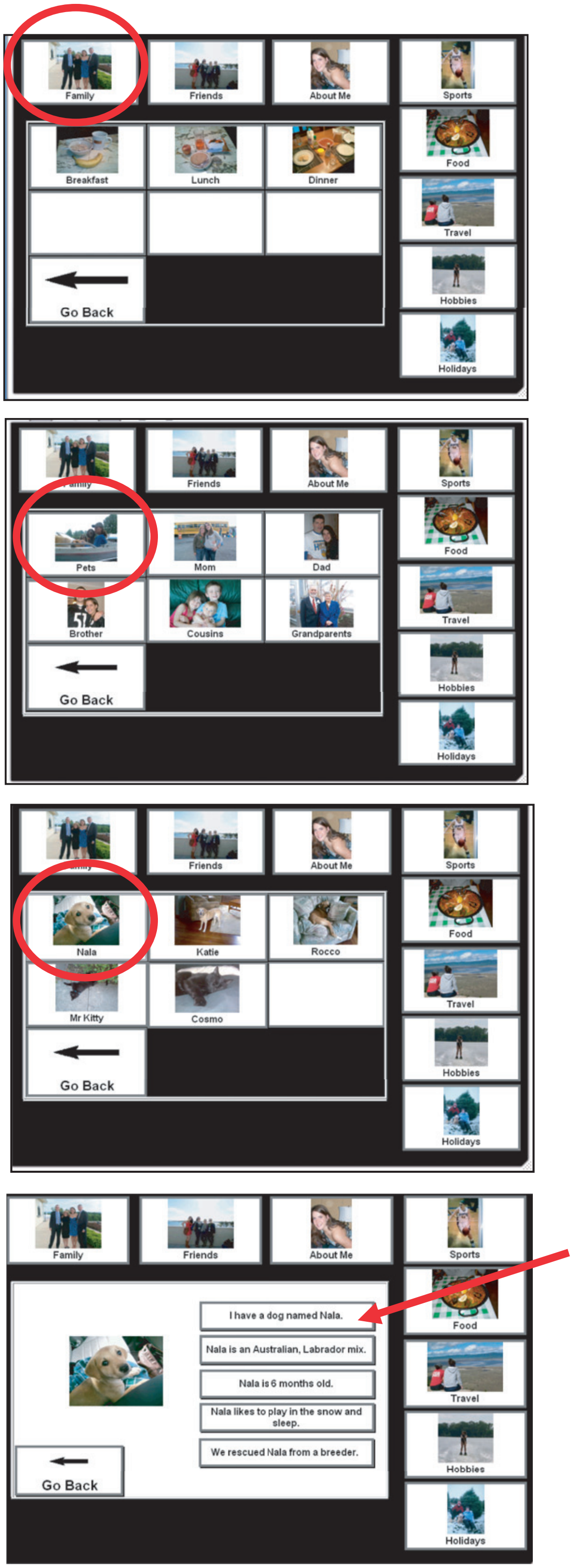

Figure 2. Example of levels 1, 2, 3, and 4 within a navigation ring layout interface.

the equipment for these activities. Neither participant regularly used mobile phones or other mobile touch screen devices following their strokes.

Participant 1 (P1) was 50 years old and 17 months post-stroke at the start of the research study. He had completed 16 years of education and had worked as an accountant prior to acquiring aphasia. As indicated by his scores on the Aphasia Quotient (AQ) portion of the *Western Aphasia Battery – Revised (WAB-R)* [11], *the Cognitive Linguistic Quick Test (CLQT)* [12], *and the Communication Activities of Daily Living – 2nd edition (CADL-2)* [13], he displayed a severe nonfluent aphasia (see Table 1). The researchers also computed a modified *CADL-2* score to determine P1's facility in switching among modalities [14]. His modified score of 25% indicated that he switched modalities on 3 of 12 opportunities. P1 also performed the Map Search Subtest of the *Test of Everyday Attention (TEA)* [15] and achieved a percentile score ranging from 6.7 to 12.2 on version B. This score suggests impaired attention when performing visual search tasks. Subjective observation of P1's performance of the Map Search Subtest revealed slowed speed of processing visual stimuli. Results of the *CLQT* showed mild impairments in attention and executive functions but severe impairments in memory and language. Additionally, P1 received a severe impairment rating on his performance of the clock drawing subtest. Overall his *CLQT* Composite score indicated moderate impairments in cognitive functions (2.4/5); his visual spatial skills were within normal limits.

Participant 2 (P2) was 60 years old and 15 months post-stroke at the beginning of the study. He had 16 years of education and worked as an engineer until shortly before acquiring aphasia. His AQ score on the *WAB-R*, *CLQT* score, and *CADL-2* score appear in Table 1. He demonstrated a moderate Wernicke's aphasia with moderate to severe impairments in the areas of auditory comprehension, repetition, and naming. P2's modified *CADL-2* score of 18% indicated that he successfully switched modalities on 2 of 11 opportunities. He achieved a percentile score ranging from 43.3 to 56.6 on the Map Search Subtest of the *TEA* suggesting attention for visual search tasks was within normal limits. Results of the *CLQT* confirmed attention and visual spatial abilities within normal limits. Areas of deficit included severe impairments in memory and language. P2 received a rating of severe impairment on the clock drawing subtest. Overall, his *CLQT* Composite score indicated mild impairments in cognitive functions (2.6/5).

Both participants received group and individual speech-language therapy at a university clinic concurrently with their participation in the research. However, therapy sessions did not address the use of high-technology AAC devices. Both participants also had access to their AAC devices outside of experimental sessions, but this access was restricted to only the particular interface being used in the current phase of the research study. For example, while P1 was using the navigation ring layout for experimental sessions, he had access to that layout for everyday activities. The researchers specifically instructed family members and clinicians not to provide assistance with message location anytime a participant attempted to use his AAC device outside of experimental sessions. P1 reported reviewing the device content for about 1–2 h per week for the first 3 weeks of the study and then discontinued its use outside of experimental sessions until the conclusion of the study. P2 reported reviewing the device content for about 1 h at a time during 5 or 6 days each week for the duration of the study. Neither individual attempted to use his device to communicate with other people while participating in the research.

The current study was approved by the institution review board at Duquesne University and the University of Nebraska-Lincoln. Both participants completed appropriate consent procedures to participate in this study.

Materials

AAC interfaces

The researchers used a Maestro© by Dynavox for development and presentation of two AAC interfaces personalised to each

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Table 1. Participant standardised testing results.

	Western Aphasia Battery – Revised	Cognitive Linguistic Quick Test							Test of Everyday Attention	Communication Activities of Daily Living – 2nd ed.	
Participant	Aphasia Quotient (100)	Composite score (severity)	Attention score (severity)	Memory score (severity)	Executive Functions score (severity)	Language score (severity)	Visuospatial Skills score (severity)	Clock Drawing score (severity)	Map Search score (percentile)	Score (100)	Modified score (percentile)
1	24.4	2.4 (moderate)	178 (mild)	78 (severe)	20 (mild)	4.5 (severe)	88 (WNL)	6 (severe)	6 (6.7–12.2%)	62	3/12 (25%)
2	50.3	2.6 (mild)	187 (WNL)	67 (severe)	23 (mild)	1 (severe)	97 (WNL)	0 (severe)	10 (43.4–56.6%)	62	2/11 (18%)

participant. The Maestro is a dynamic display computerised device with a 27.9-cm screen. Both AAC interfaces designed for a specific participant contained identical content but incorporated different layouts to facilitate navigation. The content included pictures and corresponding labels representing superordinate, ordinate, and subordinate exemplars relating to 8 semantic categories as well as written sentences providing further information about each subordinate item. Pictures were on average 2×3 centimeters in size, and all corresponding labels appeared below the pictures in 10-point, bold, Arial font. The pictorial and written content appeared on both interfaces in matching grid formats across identical levels. Hence, for a particular participant, the two interfaces differed from one another only in that one had a navigation ring layout and the other had a homepage layout.

Device personalisation was accomplished using stimulus pictures and sentences relating to a specific participant. Hence, the superordinate, ordinate, subordinate, and written sentence stimuli differed for each participant. Each superordinate category subsumed two to six ordinate categories. For example, the ordinate exemplars for the *family* category might be *siblings*, *children*, *spouse*, and *pets*. In turn, each ordinate category subsumed two to six subordinate items. For the *pets* category, subordinate exemplars might include a picture and name of each pet a participant owned. Each subordinate item had two to five written sentences associated with it to provide additional information. For example, the sentences associated with a person's cat might be: (a) *We have a cat named Cosmo*; (b) *My cat, Cosmo, sleeps on my bed*; (c) *We adopted Cosmo from a cat shelter*; (d) *Like most cats, Cosmo likes to sneak outside*; and (e) *Cosmo is a black and white cat.*

The eight pictures and corresponding labels associated with the superordinate categories always appeared on the Level 1 screen of each AAC interface. For the navigation ring interface, the pictures and corresponding labels appeared in 5×3-cm placeholders arranged in a pre-determined order around the upper and right-hand edges of the screen (see Figure 2); the remainder of the screen was blank the first time it appeared and, on subsequent trials, contained a grid with content from the last-viewed page. For the homepage interface, the eight superordinate category pictures and words appeared in 5×3 centimeter placeholders comprising a 9×15 centimeter grid (see Figure 1).

Touching a superordinate item appearing on a Level 1 screen of the navigation ring interface caused the appearance of the associated Level 2 screen. The Level 2 screen displayed a copy of the navigation ring in the same size and location as it appeared previously. In addition, the center portion of the Level 2 screen displayed the associated ordinate level items in a grid format as well as a go-back button in the lower right-hand corner (see Figure 2). Touching an ordinate level item on a Level 2 screen caused the interface to display the associated Level 3 screen; touching a navigation ring item caused the interface to display the Level 2 screen associated with the newly selected superordinate level item; and touching the go-back button caused the interface to display the previously viewed screen. Level 3 screens were identical to the Level 2 screens with the exception that subordinate rather than ordinate level items appeared (see Figure 2). Level 4 screens displayed the navigation ring and the go-back button in their standard locations, an enlarged, 3×4 cm version of the subordinate item selected on the previous screen, and the sentences providing additional information about the selected subordinate picture. As shown in Figure 2, a photograph representing the subordinate item always appeared on the left portion of the screen, and the sentences appeared in separate rows to the right of the subordinate picture. Touching a sentence on a Level 4 screen caused the device to speak that utterance.

Touching a superordinate item appearing within the grid layout of a Level 1 screen of the homepage interface caused the appearance of the associated Level 2 screen. The Level 2 screen displayed the ordinate level items associated with the selected superordinate category as well as the go-back button and a homepage button located in the lower right-hand corner of the screen (see Figure 1). Touching an ordinate level item caused the interface to display the associated Level 3 screen; touching the go-back button caused the interface to revert to the previously viewed screen; and touching the homepage button caused the interface to revert to the original Level 1 screen showing the superordinate items. Level 3 screens were identical to the Level 2 screens with the exception that subordinate rather than ordinate items appeared in the grid layout (see Figure 1). Level 4 screens displayed only the enlarged, 3×4 centimeter photograph of the subordinate item selected on the previous Level 3 screen, the associated sentences, the go-back button, and the homepage button (see Figure 1). As with the navigation ring interface, touching a sentence on a Level 4 screen of the homepage interface caused the device to speak that utterance.

Contextual prompts and stimulus cards

Additional materials included stimulus cards and contextual prompts for presentation to participants during each intervention or probe task trial. Stimulus cards were laminated, 7.6×12.7 cm cards, each of which displayed one target sentence typed in 22-point, bold, Arial font. Contextual prompts were utterances said by the examiner at the time of presentation of each stimulus card to provide clues about the location of a given target sentence on a participant's AAC device. The purpose of contextual prompts was to guide participants in their selection of appropriate superordinate, ordinate, and subordinate items when attempting to locate a specific stimulus sentence. For example, when instructed to find the sentence*, Cosmo is a black and white cat*, the examiner said the contextual prompt, ''Tell me about your cat, Cosmo,'' to cue the participant that the target sentence related to the superordinate category of *family* and the ordinate category of *pets*.

Video recording equipment

The researchers used a digital camera to video record all experimental sessions. The camera captured an image of the AAC device screen. The video recordings provided a means by which the researchers could track the series of activations a participant made to locate each target sentence.

Research design and procedures

The researchers used a single-participant, phase change design (BCB′C′) for each study participant [16,17]. The omission of an A (i.e. baseline) phase was because the participants had no exposure to either AAC interface prior to its introduction either in the B or C phase; hence, establishing a baseline level of performance was not feasible or logical [16]. After developing two versions of personalised AAC interfaces – one using a navigation ring and the other using a homepage layout – for each participant, a facilitator provided a maximum of 5 experimental sessions for each of the research design phases (i.e. B, C, B′, C′). The experimental sessions occurred one to two times weekly over a 3-month period. The order of presentation of the navigation ring and homepage interfaces was alternated across participants such that P1 first used the navigation ring interface and then the homepage interface, while P2 first used the homepage interface and then the navigation ring interface.

Participants completed a probe task and an intervention task during each session. The probe task occurred first and served as a means of evaluating a participant's performance accuracy and efficiency using either the navigation ring or the homepage interface, whichever he was using during the intervention portion of that session. For the probe task, the facilitator presented the participant with the AAC interface and a series of 10 randomly selected stimulus cards and their corresponding contextual prompts. For each probe task trial, the stimulus card with the written target sentence remained in the participant's view for reference purposes. The participant navigated to, located, and selected each target sentence to play it aloud. If, for any trial, a participant made 15 activations without successfully locating a target sentence or spent more than 60 s without making a selection, the facilitator asked whether he wished to continue searching or wished to go on to the next trial. The facilitator provided no guidance or feedback about navigation accuracy during probe task performance. Additionally, the interface was not set back to the homepage between trials; hence, a participant's navigation to the target phrase for trial 2 began from wherever the interface was set at the conclusion of trial 1.

The second portion of each experimental session involved engagement in 30 min of intervention activities to teach participants to navigate their personalised AAC interfaces. The facilitator used backward chaining with vanishing cues [18,19] for this purpose. The backward chaining procedure involved presentation of a target sentence accompanied by systematic provision of verbal cues and device-use demonstration. For the first target sentence, the facilitator demonstrated the most efficient means of navigating from the homepage of the interface to the desired target sentence while she simultaneously verbalised her thought processes for each selection. On trial 2, the facilitator gave verbal cues and demonstrated navigating from the currently visible page to the step just before selection of the second target sentence. The participant then attempted to complete the final step. If this attempt was successful, trial 3 entailed the facilitator completing all steps prior to the last two steps before selection of the target sentence. If, on the other hand, the participant was unsuccessful in his attempt to complete the final step of trial 2, the facilitator repeated the procedures from trial 1 with the trial 3 target sentence. Subsequent trials progressed in a similar fashion. Hence, whenever a participant was successful in completing a trial, the facilitator presented the subsequent trial with omission of one additional step; whenever a participant was unsuccessful in completing a trial, the facilitator presented the next trial with inclusion of one additional step. The purpose of this procedure was to increase gradually the steps a participant performed independently and accurately until he could perform interface navigation without any facilitator support.

The criterion for demonstrating navigation mastery was achievement of two consecutive probe sessions using a single AAC interface with at least 9 of the 10 trials navigated with the maximally efficient route. If a participant reached this criterion before completing 5 sessions within a treatment phase of the BCB′C′ design, he advanced to the next treatment phase at the start of the next session. If a participant did not reach this criterion, he completed all 5 sessions within a treatment phase before switching to the alternate AAC interface.

Data analysis

The researchers video recorded performance of all probe tasks for data analysis purposes. While reviewing the video recordings, a researcher wrote down the series of activations a participant made when attempting to locate and play each target sentence. For interjudge reliability purposes, a second researcher independently reviewed one-fourth of the video recordings and also wrote down the series of activations. Point-by-point comparison of the activation sequences recorded by each researcher revealed interjudge reliability to be 99.97% for P1 and 99.68% for P2.

Analysis of the activation sequences yielded three scores: two accuracy scores and one Navigation Efficiency Score. To calculate these scores, the researchers first determined the sequence and number of activations needed to navigate most efficiently from the screen on which search for the previous probe item ended to selection of a subsequent target sentence. The sequence and number of activations differed for each probe item based on the AAC interface being used and the last screen activated on the previous trial. Using this information, the researchers classified all responses a participant made into one of three categories: (a) those completed with maximal efficiency (i.e. successful location of the target sentence without extraneous activations), (b) those completed with less-than-maximal efficiency (i.e. successful location of the target sentence but with extraneous activations), and (c) those not completed successfully (i.e. failure to locate the target sentence).

Both accuracy scores ranged from 0 to 10 points. The Maximally efficient Accuracy Score reflected the number of trials within each probe for which a participant demonstrated maximally efficient navigation. The Combined Accuracy Score reflected the number of trials within each probe for which a participant successfully navigated to and selected a target sentence regardless of the presence or absence of extraneous activations.

The Navigation Efficiency Score only included data from successfully completed trials. The researchers calculated this score by summing a participant's activations across all successfully completed trials within a probe session and computing the ratio between that sum and the minimal number of activations needed to complete those navigations. This procedure yielded a real number of 1.00 or greater. A Navigation Efficiency Score of 1.00 indicated that a participant utilised the most efficient navigation method on all successful trials within a probe session, and higher scores indicated less efficient navigation.

The researchers graphed the Maximally efficient Accuracy Score, Combined Accuracy Score, and the Navigation Efficiency Score across probe sessions to allow for visual inspection of each participant's data. Specifically, the researchers used six features of single-participant designs to examine within and between phase patterns: (1) level, (2) trend, (3) variability, (4) immediacy of the effect, (5) overlap, and (6) consistency of data patterns across similar phases [17]. The researchers relied on the visual analysis because significant variability in participants' performance precluded the use of parametric statistics. Finally, the researchers used two measures of effect size for the Combined Accuracy and Maximally efficient Accuracy Scores: the non-overlap of all pairs (NAP) [20] and percentage of non-overlapping data (PND) [21] to provide information about the magnitude of treatment effect. Established guidelines for interpreting NAP scores exist: 0–65% indicates a weak effect, 66–92% indicates a medium effect, and 93–100% indicates a large or strong effect [20]. Similarly, guidelines exist for interpreting PND calculations: scores above 90% indicate a high level of effectiveness, those between 70% and 90% indicate a fair level of effectiveness, those between 50% and 70% represent questionable effectiveness, and scores below 50% indicate unreliable effectiveness [22]. Interpretation of the Navigation Efficiency Score was limited to visual analysis because an appropriate effect size measure does not exist to capture data that should decrease across phases but does not always do so. Percentage of reduction data analyses [23] were computed for phases in which the efficiency decreased across phases and is available from the authors upon request.

Results

Results for P1 and P2 appear separately. Included is information about each participant's progression through the intervention phases of the study and his Combined Accuracy, Maximally efficient Accuracy, and the Navigation Efficiency Scores achieved when attempting to locate target messages on the navigation ring and homepage interfaces.

Participant 1

P1 used the navigation ring interface during the first and third intervention phases (i.e. B and B′ phases) and the homepage interface during the second and fourth intervention phases (i.e. C and C′ phases). He completed a total of 18 intervention sessions, with 5 for the B phase, 5 for the C phase, 3 for the B′ phase, and 5 for the C′ phase. Hence, P1 reached criterion only one time during the course of the project – that is, during his second exposure to the navigation ring interface.

Figure 3. P1's Maximally efficient and Combined Accuracy Scores across probes and study phases.

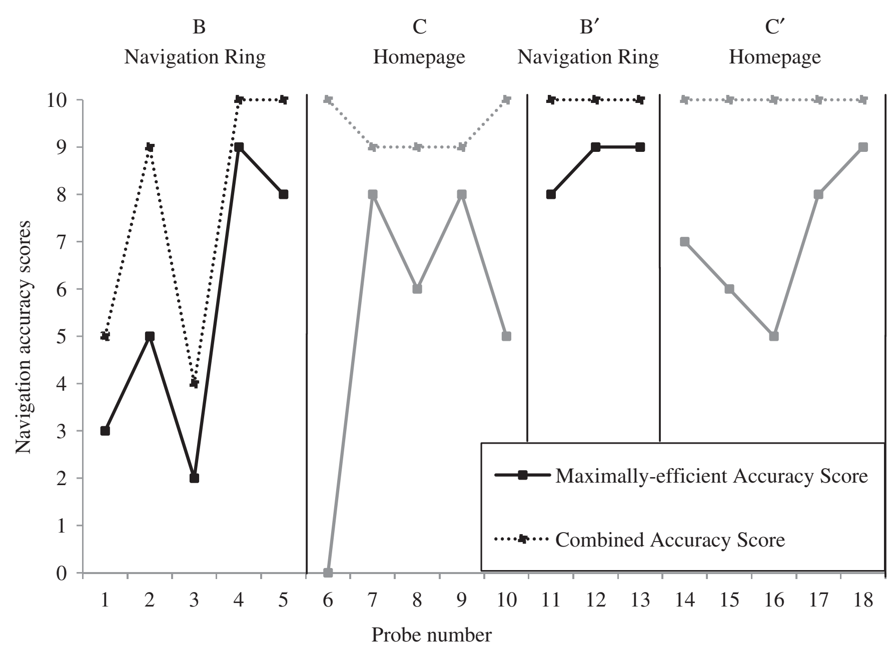


Table 2. Effect size computations for combined accuracy and maximally efficient accuracy scores.

	NAP				PND	
Participant 1	B to C Ring to Homepage	C to B′ Homepage to Ring	B′ to C′ Ring to Homepage	B to C Ring to Homepage	C to B′ Homepage to Ring	B′ to C′ Ring to Homepage
Combined Accuracy Score	62%	80%[a]	50%	0%	0%	0%
Maximally efficient Accuracy Score	74%[a]	93%[b]	50%	0%	66%[c]	0%
Participant 2	Homepage to Ring	Ring to Homepage	Homepage to Ring	Homepage to Ring	Ring to Homepage	Homepage to Ring
Combined Accuracy Score	86%[a]	44%	60%	60%[c]	0%	0%
Maximally efficient Accuracy Score	0%	42%	92%[a]	100%[d]	0%	60%[c]

NAP: [a]medium effect, [b]large effect; PND: [c]questionably effective, [d]highly effective.

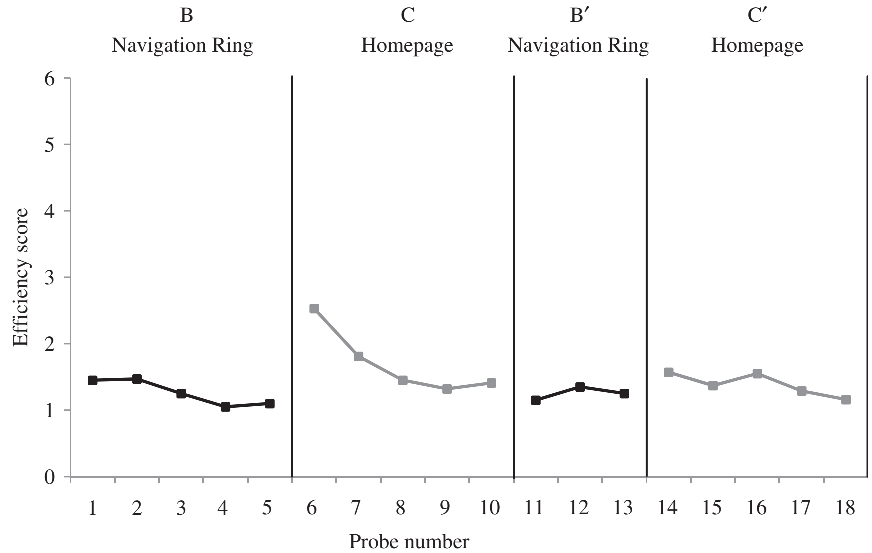


Figure 4. P1's Navigation Efficiency Scores across probes and study phases.

P1's Combined Accuracy Scores ranged from 4 to 10 across all probe administrations (see Figure 3). Even when completing the first probe of the B phase – that is, the probe occurring prior to any training with or exposure to either AAC interface – P1 was successful in locating 5 of the 10 target sentences. By the fourth B phase probe administration, P1 located 10 of 10 target sentences, and he continued to succeed in navigating to and selecting either 9 or 10 target sentences on all subsequent probe measures regardless of which AAC interface he used.

Although P1's Maximally efficiency Accuracy Score level was generally higher or equal when using the navigation ring versus the homepage layout, he demonstrated considerable variability in navigating with maximal efficiency – that is, in navigating without making extraneous activations – during performance of probes. A visual display of his Maximally efficient Accuracy Scores across sessions and phases appears in Figure 3 and shows that his greatest variability occurred during his first exposure to each AAC interface (i.e. phases B and C). Specifically, his Maximally efficient Accuracy Score level was 5 (range = 2–9) during the B phase and was 6 (range = 0–8) during the C phase. Higher levels of Maximally efficient Accuracy Scores and less variability occurred during the B′ (level = 9; range = 8–9) and C′ (level = 7; range = 5–9) phases. In general, P1 demonstrated a pattern of increasing numbers of maximally efficient navigations as he progressed through the study phases. The trend lines of the Maximally efficient Accuracy Scores across the phases indicated a less steep slope for the homepage versus navigation ring layout, although both trend lines demonstrated increasing scores.

Effect size calculations confirmed the visual analysis and descriptive information presented above. NAP and PND scores for each phase are reported in Table 2. Across the two scores, P1's NAP indicated a medium to large effect for use of the navigation ring interface and no effect to a medium effect for use of the home page interface. PND effect size measures were smaller for both conditions and only revealed a questionable effective for the navigation ring interface.

P1's Navigation Efficiency Scores ranged from 1.05 to 2.53, with a smaller efficiency score range for the navigation ring interface (i.e. 1.05 to 1.47) than for the homepage interface (i.e. 1.16 to 2.53). As evident in Figure 4, P1's Navigation Efficiency Scores associated with successful trials earned when using the navigation ring interface (B phase: level = 1.25, range = 1.05–1.47; B′ phase: level = 1.35; range = 1.15–1.41) were slightly lower (i.e. thus reflecting greater navigational efficiency) than his scores earned when using the homepage interface (C phase: level = 1.45, range = 1.31–2.53; C′ phase: level = 1.37; range = 1.16–1.57).

Participant 2

P2 used the homepage interface during the first and third intervention phases (i.e. B and B′ phases) and the navigation ring interface during the second and fourth intervention phrases (i.e. C and C′ phases). He completed a total of 20 intervention sessions, never reaching criterion to end a research phase prior to the completion of 5 sessions.

Figure 5. P2's Maximally efficient and Combined Accuracy Scores across probes and study phases.

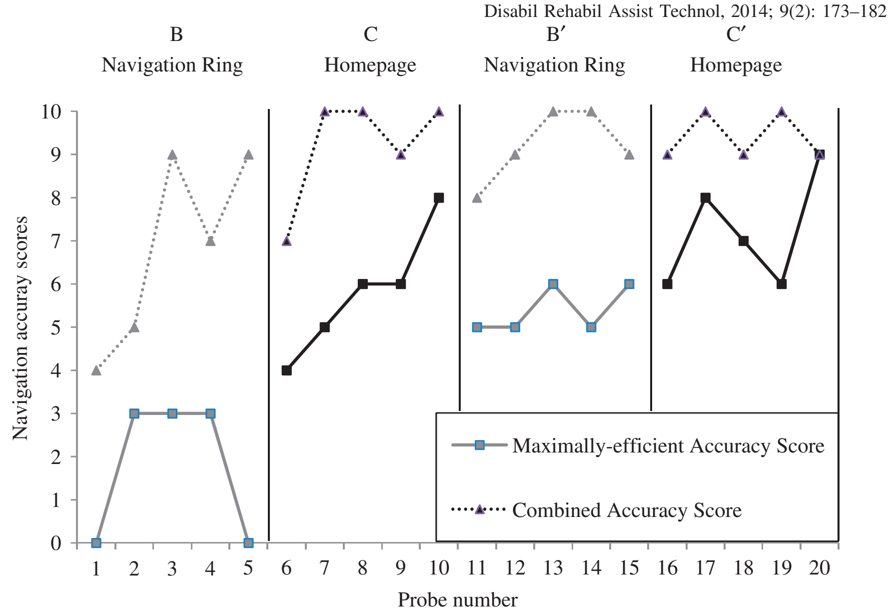
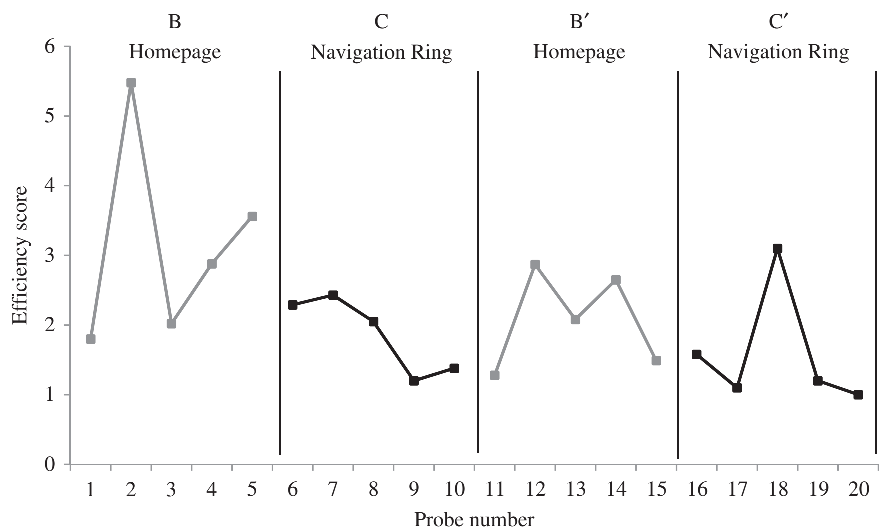


Figure 6. P2's Navigation Efficiency Scores across probes and study phases.



The range of P2's Combined Accuracy Scores across all probe measures was 4 to 10, identical to that of P1; however, his performance was more variable than that of P1, and he required a greater number of intervention sessions before consistently locating at least 9 of the 10 target sentences during probes (see Figure 5). Prior to receiving any instruction, P2 navigated to 4 of 10 target sentences using the homepage interface. Given instruction, his performance improved to a Combined Accuracy Score of 9 by the third probe administration and remained between 7 and 10 for all subsequent probes regardless of which AAC interface he used.

P2 demonstrated less success than P1 in navigating with maximal efficiency during performance of probes. A visual display of his Maximally efficient and Combined Accuracy Scores across sessions and phases appears in Figure 5 and shows that he achieved his highest Maximally efficient Accuracy Scores when using the navigation ring interface during the C and C′ phases. In general, P2 demonstrated a pattern of increasing numbers of maximally efficient navigations as he progressed through the study phases, but his scores were consistently higher when using the navigating ring interface (C phase: level = 6, range = 4 to 8; C′ phase: level = 7, range = 6 to 9) than the homepage interface (B phase: level = 3, range = 0 to 3; B′ phase: level = 5, range = 5 to 6). In fact, P2's Maximally efficient Accuracy Score of 4 obtained during probe 6 – the first navigation ring interface probe that occurred following B phase intervention using the homepage interface but before any intervention with the navigation ring interface itself – was higher than any of his previous accuracy scores.

Effect size calculations confirmed the visual analysis and descriptive information presented above. NAP and PND scores for each phase are reported in Table 2. P2's NAP indicated no effect to a medium effect for the navigation ring interface across the two scores, but no effect for the homepage interface. The PND effect size indicated no effect to high effectiveness for the navigation ring interface and no effect for the home page interface.

P2's Navigation Efficiency Scores ranged from 1.00 to 5.48, with a smaller efficiency score range for the navigation ring interface (i.e. 1.00–2.43) than for the homepage interface (i.e. 1.28–5.48). As evident in Figure 6, P2's Navigation Efficiency Scores associated with successful trials earned when using the navigation ring system (C phase: level = 2.05, range = 1.20–2.43; C′ phase: level = 1.2; range = 1.00–3.10) were lower than his scores earned when using the homepage interface (B phase: level = 2.88, range = 1.80–5.48; B′ phase: level = 2.08; range = 1.28–2.87).

Discussion

The study purpose was to determine the effect of two static-button AAC layouts – a navigation ring interface and a homepage interface – on navigation accuracy and efficiency by two individuals with chronic aphasia. Given intervention incorporating errorless learning principles, both participants improved in navigating across multiple interface levels to locate target sentences using both types of layouts; in fact, P1 obtained Combined Accuracy Scores of 9/10 or 10/10 with both layouts after having completed only 3 instruction sessions with one of the interfaces (i.e. the navigation ring layout), and P2 consistently obtained Combined Accuracy Scores at this level after only completing 6 instructional sessions with the homepage layout and 1 instructional session with the navigation ring layout. Thus, both a person with nonfluent aphasia (i.e. P1) and a person with fluent aphasia (i.e. P2) were successful in learning to navigate both interfaces.

The two study participants were more consistent and efficient in finding target sentences using the navigation ring interface than the homepage interface. For example, P1's introduction to the homepage layout in the first C phase probe resulted in a higher score (thus indicating less efficient navigation) than he earned on any of his previous probes using the navigation ring layout; not until performance of his third probe using the homepage layout did P1 achieve a score comparable to that obtained in his first probe using the navigation layout, thus suggesting that the navigation ring layout was more transparent to him than the homepage layout. Similarly, P2's Maximally efficient Accuracy Score was higher prior to his receiving any instruction with the navigation ring layout (i.e. the first probe of the C phase) than that achieved during any of the previous five B Phase probes using the homepage layout interface. Further evidence that the navigation ring layout was more transparent and easier for the two participants to master came from the fact that using the navigation ring layout appeared to generalise to improved navigation with the homepage layout, whereas the opposite did not occur. This phenomenon was evident when P2 achieved a Maximally efficient Accuracy Score at the start of the B′ phase roughly comparable to his mean score achieved in the C phase but exceeding his highest score earned in the B phase. Together, these findings suggest that static buttons comprising a navigation ring are relatively transparent to people with aphasia and may facilitate faster mastery than a layout limited to static homepage and go-back buttons.

Research relating to the success and efficiency with which people search for information within computer software programs or websites may help explain why the navigation ring layout was more transparent and easier for the two participants with aphasia to learn than the homepage layout. In many ways, navigating a dynamic display AAC interface is similar to navigating some computer software applications or multilayer websites. As such, principles for developing user-friendly software and website interfaces may be applicable to AAC layouts. For example, two of Molich & Nielson's [24] principles – that (a) users need a relatively easy way to make 'emergency exits' (p. 339) without backtracking after making navigation mistakes and that (b) interfaces should promote reliance on recognition rather than recall memory by making important options visible at all times – reflect features central to the navigation ring concept. Similarly, one of Poulson and Nicolle's [25] guidelines for developing an AAC-enabled World Wide Web is that critical parts of websites should be static rather than dynamic. Again, this notion is consistent with the concept of using static buttons to form a navigation ring on AAC devices for people with aphasia.

Issues relating to Lasker and Bedrosian's [26] AAC Acceptance Model may provide important considerations for continued research about the use of AAC devices by people with aphasia. Specifically, Lasker and Bedrosian contend that AAC acceptance involves consideration of three factors: the technology, the person, and the milieu in which AAC is used. The current study represents an examination of one aspect of the technology factor, but in no way is it an exhaustive investigation of this facet. Other technology factors that may affect AAC use by people with aphasia include message representation and the use of visuographic stimuli to identify categories. Previous researchers have found these to be important considerations regarding the accuracy, efficiency, and preferences of people either with TBI or aphasia when attempting to identify or locate target information within AAC interfaces [8,27]. Additionally, examination of factors such as the amount and type of content included, the use of written versus pictorial formats to represent content, and the placement of various types of static and changing content on AAC layouts will further contribute to the knowledge about technological aspects of AAC acceptance by people with aphasia.

The second aspect of AAC acceptance proposed by Lasker & Bedrosian [26] pertains to the person using the technology. The vast heterogeneity displayed by people with chronic aphasia regarding linguistic, cognitive, and physical functioning complicates the determination of when and how various AAC supports can serve to facilitate communicative interactions. The current study was limited by inclusion of only two participants who differed substantially in their cognitive and linguistic strengths and challenges. Despite this diversity, however, both were successful in learning to navigate the AAC interfaces presented to them. Several factors may have contributed to this including the use of errorless learning procedures during intervention sessions, the personalisation and relevance of the AAC content, and the general acceptance of AAC by the participants and their families. Further investigation of the contributions of each of these factors will be important to the continued advancement and implementation of effective communication supports for people with aphasia.

Finally, Lasker & Bedrosian's [26] AAC Acceptance Model highlights the importance of the milieu in which AAC strategies and devices are implemented. The value of AAC for people with aphasia lies in the potential support it provides to communicating with multiple people about multiple topics and in multiple settings [28]. Future researchers need to investigate whether the benefits provided by relatively transparent and easy-to-learn navigation supports – such as the navigation ring layout used in the current research – translate into a greater number of successful communication interactions both with familiar and unfamiliar partners and to meet a variety of purposes than exists for people with aphasia who do not use AAC supports. This type of investigation will require researchers to examine naturally occurring communication attempts rather than relying solely on decontextualised and nonfunctional experimental tasks, as was used in the current study.

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Declaration of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this article.

References

1. Holland A, Beeson P. Finding a new sense of self: what the clinician can do to help. A reply to Brumfitt's losing one's sense of self following stroke. Aphasiology 1993;7:569–91.

2. LaPointe L. Foundations: adaptation, accommodation, aristos. In: LaPointe L, ed. Aphasia and related neurogenic language disorders. 3rd ed. New York: Thieme; 2005:1–18.
3. Simmons-Mackie N, Kagan A. Application of the ICF in aphasia. Seminars in speech and language 2007;28:244–53.
4. Hough MS, Johnson RK. Use of AAC to enhance linguistic communication skills in an adult with chronic severe aphasia. Aphasiology 2009;23:215–30.
5. Johnson RK, Hough MS, King KA, et al. Functional communication in individuals with chronic severe aphasia using augmentative communication. Augment Alternat Commun 2008;24:269–80.
6. Koul RK, Corwin M, Hayes S. Production of graphic symbols sentences by individuals with aphasia: efficacy of a computer-based augmentative and alternative communication intervention. Brain Language 2005;92:58–77.
7. Lasker J, LaPointe L, Kodras J. Helping a professor with aphasia resume teaching through multimodal approaches. Aphasiology 2005;19:399–410.
8. McKelvey M, Dietz A, Hux K, et al. Performance of a person with chronic aphasia using a visual scene display prototype. J Med Speech Language Pathol 2007;15:305–17.
9. Nicholas M, Sinotte MP, Helm-Estabrooks N. C-Speak Aphasia alternative communication program for people with severe aphasia: importance of executive functioning and semantic knowledge. J Neuropsychol Rehabil 2011;21:322–66.
10. Dietz A, McKelvey M, Beukelman D. Visual scene display: new AAC interface for persons with aphasia. Perspect Augment Alternat Commun 2006;15:13–17.
11. Kertesz A. The Western aphasia battery-revised. San Antonio (TX): Harcourt Assessment, Inc.; 2006.
12. Helm-Estabrooks N. Cognitive linguistic quick test. San Antonio (TX): The Psychological Corporation; 2001.
13. Holland A, Frattali C, Fromm D. Communication activities of daily living. 2nd ed. Austin (TX): PRO-ED; 1999.
14. Purdy M, Koch A. Prediction of strategy usage by adults with aphasia. Aphasiology 2006;20:337–48.
15. Robertson IH, Ward T, Ridgeway V, Nimmo-Smith I. The test of everyday attention. Bury St. Edmunds, England: Thames Valley Test Company; 1994.
16. Gast DL. Single subject research methodology in behavioral sciences. New York: Routledge; 2010.
17. Kratochwill TR, Hitchcock J, Horner RH, et al. (2010). Single-case designs technical documentation. 2010; Available from What Works Clearinghouse: http://ies.ed.gov/ncee/wwc/pdf/wwc_scd.pdf [last accessed 6 Oct 2012].
18. Glisky EL, Schacter DL. Acquisition of domain-specific knowledge in patients with organic memory disorders. J Learn Disabil 1988;21: 333–9.
19. Glisky EL, Schacter DL, Tulving E. Computer learning by memory-impaired patients: acquisition and retention of complex knowledge. Neuropsychologia 1986;24:313–28.
20. Parker RI, Vannest K. An improved effect size for single-case research: nonoverlap of all pairs. Behavior Therapy 2009;40:357–67.
21. Scruggs TE, Mastropieri MA. Summarizing single-subject research issues and applications. Behav Modificat 1998;22:221–42.
22. Scruggs TE, Mastropieri MA, Cook S, Escobar C. Early intervention for children with conduct disorders: a quantitative synthesis of single-subject research. Behav Disord 1986;11:260–71.
23. O'Brien S, Repp AC. Reinforcement-based reductive procedures: a review of 20 years of their use with persons with severe or profound retardation. J Assoc Persons Severe Handicaps 1990;15:148–59.
24. Molich R, Nielsen J. Improving a human-computer dialogue. Commun ACM 1990;33:338–48.
25. Poulson D, Nicolle C. Making the Internet accessible for people with cognitive and communication impairments. Universal Access Info Soc 2004;3:48–56.
26. Lasker JP, Bedrosian JL. Promoting acceptance of augmentative and alternative communication by adults with acquired communication disorders. Augmentat Alternat Commun 2001;17:141–53.
27. Wallace S, Hux K, Beukelman DR. Navigation of a dynamic screen AAC interface by survivors of severe traumatic brain injury. Augmentat Alternat Commun 2010;26:242–54.
28. Hux K, Weissling K, Wallace S. Communication-based interventions: augmentative and alternative communication for people with aphasia. In: Chapey R, ed. Language intervention strategies in aphasia and related neurogenic communication disorders. 5th ed. Philadelphia, PA: Lippincott Williams, & Wilkins; 2008:814–36.