# Supplementary materials

## Background Neuropsychology

Patients completed a series of background tests probing language, memory, and executive function. Each individual patients’ performance on these tests can be seen in Supplementary Table 1. Only one patient showed evidence of impaired word repetition using a subtest from the Psycholinguistic Assessments of Language Processing in Aphasia battery (PALPA; Kay et al., 1992). Four patients showed evidence of non-fluent speech when describing The Cookie Theft Picture, as consistent with the ‘very slow’ classification from Kerschensteiner et al. (1972). Four patients were impaired for category fluency (eight categories), while all seven were impaired for letter fluency (F, A, S). Six patients showed impairment for both forward and backward digit span (Wechsler Memory Scale III; Wechsler, 1997). One patient presented with impairments in visuospatial processing, as measured by subtests of the Visual Object and Space Processing Battery (VOSP; Warrington & James, 1991). Patients also completed several tests of executive function, including a subtest of the Test of Everyday Attention (Robertson et al., 1994), Raven’s Coloured Progressive Matrices (Raven, 1962), the Brixton Spatial Anticipation Test (Burgess & Shallice, 1997), and the Trial Making Test (Reitan, 1958). Three patients showed evidence of impairment on at least one of these tests.

As a measure of core semantic ability, participants completed the Cambridge Semantic Battery (Bozeat, Lambon Ralph, et al., 2000). Each individual patients’ performance on these tests can be seen in Supplementary Table 2. Four patients were impaired on the Picture Naming task [Mean (SD) = 82.4% (14.3)], in which they were required to verbally provide the name for a series of black and white line drawings. Though not a part of the Cambridge Semantic Battery, providing phonemic cues as to the correct target label improved all patients’ performance to ceiling or near-ceiling level [Mean (SD) = 99.1% (1.8)]. Four patients showed impaired performance on Word-Picture Matching [Mean (SD) = 97.1% (2.5)], in which they were required to match one of ten possible line drawings to a verbally provided probe word. The Camel and Cactus Test (CCT) was used a measure of ability to make thematic associations, requiring matching a probe word/picture to one of four possible targets. Four patients were impaired on the word version of the CCT [Mean (SD) = 84.4% (9.5)], while only two were impaired on the picture version [Mean (SD) = 90.0% (7.0)].

The ambiguity task (Noonan et al., 2010) required patients to make thematic associations between a probe word and one of three possible targets. Each probe word was a homonym with a dominant (e.g., PEN – PENCIL) and subordinate (e.g., PEN – PIG) association. The latter is believed to tax semantic control more than the former, due to the need to flexibly retrieve non-dominant semantic information (Thompson et al., 2017). Probe words were either presented with no cue, with a contextual cue alluding to the correct target meaning of the word (e.g., PEN – PIG: “the labourers cleaned out the pen”), or with a miscue, alluding to the incorrect interpretation (e.g., PEN – PIG: “he signed his name with a fountain pen”). In the no cue condition, patients performed better for dominant [Mean (SD) = 88.6% (8.1)] than subordinate trials [Mean (SD) = 63.8% (21.6)]. Relative to no cue, cued trials improved performance on subordinate [Mean (SD) = 80.0% (18.9)] but not dominant trials [Mean (SD) = 87.1% (12.7)]. Miscued trials considerably impaired accuracy on dominant [Mean (SD) = 72.9% (14.6)], but not subordinate trials [Mean (SD) = 60.0% (19.2)]. Contextual cues therefore improved accuracy on the most difficult trials, while contextual miscues impaired performance on the easiest trials.

The synonym judgement task (Samson et al., 2007) required participants to match a probe word to a possible synonym, presented alongside two foils. In each trial, one of these foils acted as either a strong (e.g., probe: DESERT, target: WILDERNESS, distractor: SAND) or weak (e.g., probe: HAZARD, target: DANGER, distractor: LIGHT) thematic distractor. Strong thematic distractors should impair performance to a greater extent than weak distractors, as SA patients are strongly influenced by irrelevant but competing information (Jefferies, 2013). Overall, the sample performed better on weak distractor trials [Mean (SD) = 78.9% (11.6)] than strong distractor trials [Mean (SD) = 53.1% (21.2)]. Each patient showed this expected pattern, with the exception of P4 (the least impaired patient).

The object use task (Corbett et al., 2011) provides a non-verbal measure of semantic control. Herein, patients are required to identify the appropriate object, of six possible options, to perform a given action (e.g., “Crack a nut”). The target objects could be either be ‘canonical’ such that they are typically used to complete this action (e.g., NUT CRACKER), or an ‘alternative’ object which could be used to complete the action if necessary (e.g., HAMMER). Alternative trials should require greater semantic control as they require access to non-dominant information about the target object, and inhibition of dominant information (e.g., that hammers are typically used in construction). Overall, the sample performed better on canonical [Mean (SD) = 92.7% (8.2)] than on alternative trials [Mean (SD) = 69.1% (21.6)]. This was true for all seven patients.

### *Supplementary Table 1. Patient performance on background neuropsychological testing.*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Test | Max | Cut-off  | Patients Mean (SD) | P15 | P16 | P6 | P12 | P10 | P11 | P4 | # Impaired |
| *Non-semantic language tests* |
| PALPA 9 real word repetition  | 80 | 73 a | 67.1 (26.6) | 74 | 79 | 79 | 75 | 77 | 79 | **7** | 1 |
| Cookie theft (words/minute) | - | 50 b | 48.6 (23.3) | **16** | 55 | **37** | 80 | **37** | 77 | **38** | 4 |
| Category Fluency (8 categories) (words/minute) | - | 7.75 | 6.70 (3.22) | **3.8** | **3.5** | **3.3** | 11.3 | **7.1** | 9.4 | 8.6 | 4 |
| Letter Fluency (F, A, S) (words/minute) | - | 7.27 | 3.29 (0.93) | **2.7** | **2.7** | **2** | **4.3** | **3** | **4.3** | **4** | 7 |
| *Verbal working memory* |
| Digit Span Forward | 8 | 5.54 | 3.86 (1.22) | **2** | **3** | **4** | **4** | **4** | **4** | 6 | 6 |
| Digit Span Backward | 7 | 3.66 | 1.86 (1.46) | **0** | **2** | **0** | **2** | **3** | **2** | 4 | 6 |
| *Visuospatial processing* |
| VOSP dot counting | 10 | 8 | 9.57 (0.79) | 8 | 10 | 10 | 9 | 10 | 10 | 10 | 0 |
| VOSP position discrimination | 20 | 18 | 19.3 (1.89) | **15** | 20 | 20 | 20 | 20 | 20 | 20 | 1 |
| VOSP number location | 10 | 7 | 9.43 (0.98) | 8 | 10 | 10 | 10 | 10 | 10 | 8 | 0 |
| VOSP cube analysis | 10 | 6 | 8.71 (1.80) | **5** | 10 | 9 | 10 | 10 | 9 | 8 | 1 |
| *Executive and spatial processing* |
| TEA: counting without distraction | 7 | 4.2 | 6.00 (0.89) | 6 | 7 | NT | 6 | 7 | 5 | 5 | 0 |
| TEA: counting with distraction | 10 | 2.6 | 5.50 (3.39) | 3 | 10 | NT | 9 | 6 | **2** | 3 | 1 |
| Raven's coloured matrices  | 36 | 28 a | 32.1 (2.91) | **27** | 36 | 30 | 32 | 33 | 34 | 33 | 1 |
| Brixton spatial anticipation | 54 | 28 | 30.6 (8.14) | **18** | 31 | **23** | 32 | 30 | 41 | 39 | 2 |
| Trial Making Test A  | 24 | 24 a | 23.7 (0.49) | **23** | 24 | **23** | 24 | 24 | 24 | 24 | 2 |
| Trial Making Test B  | 23 | 17.4 a | 18.9 (6.18) | 20 | 22 | **5** | 20 | 22 | 22 | 21 | 1 |

 *Note.* Scores are number of correct responses unless otherwise specified. NT = unavailable for testing; TEA = Test of Everyday Attention, elevator counting subtest; VOSP = Visual Object and Space Processing battery. Cut-offs for impairment correspond to two standard deviations below control mean performance, with impaired scores underlined and in bold. These are taken from control norms from respective tests manuals, unless otherwise specified (see below). Patients ordered (from left to right) from most to least semantically impaired (see Supplementary Tables 2 and 3).

a Cut-offs taken from control testing at the University of York. Number of controls: Raven’s = 20; Trail Making Test = 14.

b Cut-off reflects the ‘very slow’ classification taken from Kerschensteiner, Poeck and Brunner (1972).

### *Supplementary Table 2. Patient performance on the Cambridge Semantic Battery and tests of semantic control.*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Test | Max | Cut-off | Patient Mean (SD) | P15 | P16 | P6 | P12 | P10 | P11 | P4 | # Impaired |
| *Semantic composite score* |  |  |  | -.89 | .13 | .34 | .92 | .96 | 1.26 | 1.32 | - |
| *Cambridge Semantic Battery* |
| Picture Naming (no cues) | 64 | 59 | 52.7 (9.16) | **51** | **38** | **50** | 63 | 62 | 59 | **46** | 4 |
| Picture Naming (with cues) | 64 | - | 63.4 (1.13) | 63 | 61 | 64 | 64 | 64 | 64 | 64 | - |
| Word-Picture Matching | 64 | 62.7 | 62.1 (1.57) | **59** | 63 | **62** | **62** | **62** | 64 | 63 | 4 |
| Word CCT | 64 | 56.6 | 54.0 (6.11) | **45** | **47** | **52** | 59 | 60 | 59 | **56** | 4 |
| Picture CCT | 64 | 52.7 | 57.6 (4.47) | **51** | **52** | 57 | 59 | 61 | 62 | 61 | 2 |
| *Ambiguity task* |
| Miscued dominant | 30 | 30  | 21.9 (4.38) | **21** | **14** | **19** | **25** | **26** | **22** | **26** | 7 |
| Miscued subordinate | 30 | 26.6 | 18.0 (5.77) | **13** | **11** | **15** | **18** | **19** | **22** | 28 | 6 |
| No cue dominant | 30 | 28.4 | 26.6 (2.44) | **22** | **26** | **26** | 30 | **28** | **27** | **27** | 6 |
| No cue subordinate | 30 | 27.6 | 19.1 (6.47) | **12** | **11** | **17** | **26** | **19** | 28 | **21** | 6 |
| Cued dominant | 30 | 30 | 26.1 (3.81) | **24** | **20** | **23** | 30 | **29** | **28** | **29** | 6 |
| Cued subordinate | 30 | 28.8 | 24.0 (5.66) | **15** | **17** | 28 | 29 | **25** | **26** | 28 | 4 |
| *Synonym with distractors* |
| Strong | 42 | 35.4 | 22.3 (8.92) | **13** | **25** | **23** | **13** | **17** | **27** | 38 | 6 |
| Weak | 42 | 40.4 | 33.1 (4.88) | **24** | **33** | **30** | **35** | **39** | **35** | **36** | 7 |
| *Object use* |
| Alternative | 37 | 33.67 | 25.6 (8.00) | **9** | **27** | **22** | **29** | **29** | **31** | **32** | 7 |
| Canonical | 37 | 35.9 | 34.3 (3.04) | **28** | **34** | **35** | **35** | 37 | **34** | 37 | 5 |

*Note.* Scores are number of correct. CCT = Camel and Cactus Test. Cut-offs for impairment are taken from testing at the University of York and correspond to two standard deviations below mean control performance, with impaired scores underlined and in bold. Number of controls: Cambridge Semantic Battery = 10, Ambiguity task, Synonym with distractors, Object use = 8. Semantic composite score (further explained in Supplementary Table 3) reflects regression scores derived from principal components analysis, including tests with high control demands [CTT words, CCT pictures, Ambiguity task (no cue: dominant + subordinate), Object use task (alternative + canonical), Synonym with distractors (strong + weak)]. Lower composite scores reflect greater impairment. Patients ordered (from left to right) from most to least impaired.

### *Supplementary Table 3. Pattern matrix for principal components analysis (PCA) of performance on semantic tests with oblique rotation.*

|  |  |  |
| --- | --- | --- |
| Task | Component 1 (Eigenvalue = 4.03) | Component 2 (Eigenvalue = 1.52) |
| CCT words | **.876** | .083 |
| CCT pictures | **.896** | -.078 |
| Picture naming | .089 | **.877** |
| Word-picture matching | -.062 | **.916** |
| Ambiguity task | **.900** | .057 |
| Synonym judgement task | **.903** | -.154 |
| Object use task | **.801** | .156 |

*Note.* Strong loadings for each component are in bold. This PCA was conducted on a larger sample of semantic aphasia patients from our group (Souter et al., Unpublished results; N = 17, including the seven in the current manuscript). The semantic control composite used in the current analysis reflects regression scores taken from Component 1, for which the strong loadings include performance on tests with high semantic control demands.

## Experimental Stimuli

### *Supplementary Table 4. Identity codes for Study 1 and Study 2 stimuli, taken from the IASLab Face Set.*

|  |  |
| --- | --- |
| Study 1 | Study 2 |
| Emotion | Stimulus | Emotion | Stimulus |
| Anger | F1ang\_o\_st | Anger | F06ang\_c\_st |
| F02ang\_o\_st | F07ang\_c\_st |
| F08ang\_o\_st | F22ang\_c\_st |
| M1ang\_o\_st | F23ang\_c\_st |
| M3ang\_o\_st | F29ang\_c\_st |
| M11ang\_o\_st | F32ang\_c\_st |
| Disgust | F1disg\_c\_st | M07ang\_c\_st |
| F02disg\_c\_st | M08ang\_c\_st |
| F8disg\_c\_st | M11ang\_c\_st |
| M1disg\_c\_st | M13ang\_c\_st |
| M3disg\_c\_st | M16ang\_c\_st |
| M11disg\_c\_st1 | M17ang\_c\_st |
| Fear | F1fear\_c\_st | Happiness | F06hap\_c\_st |
| F02fear\_c\_st | F07hap\_c\_st |
| F8fear\_c\_st | F22hap\_c\_st |
| M1fear\_c\_st | F23hap\_c\_st |
| M3fear\_c\_st | F29hap\_c\_st |
| M11fear\_c\_st | F32hap\_c\_st |
| Happiness | F1hap\_c\_st | M07hap\_c\_st |
| F02hap\_c\_st3 | M08hap\_c\_st |
| F8hap\_c\_st | M11hap\_c\_st |
| M1hap\_c\_st | M13hap\_c\_st |
| M3hap\_c\_st | M16hap\_c\_st |
| M11hap\_c\_st | M17hap\_c\_st |
| Neutral | F1neut\_o\_st | Sadness | F06sad\_c\_st |
| F02neut\_o\_st | F07sad\_c\_st |
| F08neut\_o\_st | F22sad\_c\_st |
| M1neut\_o\_st | F23sad\_c\_st |
| M3neut\_o\_st | F29sad\_c\_st |
| M11neut\_o\_st | F32sad\_c\_st |
| Sadness | F1sad\_o\_st | M07sad\_c\_st |
| F02sad\_o\_st | M08sad\_c\_st |
| F08sad\_o\_st | M11sad\_c\_st |
| M1sad\_o\_st | M13sad\_c\_st |
| M3sad\_o\_st | M16sad\_c\_st |
| M11sad\_o\_st | M17sad\_c\_st |

Note: The complete set of pictorial stimuli used in this study cannot be made directly available by the author. The full database of stimuli can be requested for download through <https://www.affective-science.org/face-set.shtml>.[[1]](#footnote-1)

## Descriptive Statistics

### *Supplementary Table 5. Percent of all participants’ responses corresponding to each error type across Study 1 tasks.*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |   | P4 | P6 | P10 | P11 | P12 | P15 | P16 | Comparison Group Mean (SD) |
| Emotion free Sort | # piles | 6 | 4 | 4 | 4 | 5 | 5 | 7 | 5.7 (1.35) |
| NEG-NEUT | 5.56% | 0% | 0% | 0% | 0% | 0% | 2.78% | 3.82% (3.76) |
| POS-NEUT | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% (0) |
| NEG-NEG | 36.11% | 52.78% | **66.67%** | 47.22% | 44.44% | **61.11%** | 27.78% | 26.42% (17.76) |
| NEUT-NEG | 5.56% | **16.67%** | **16.67%** | 13.89% | 13.89% | **16.67%** | 5.56% | 5.14% (5.52) |
| POS-NEG | 0% | 0% | 0% | 0% | 0% | **2.78%** | 0% | 0.08% (0.48) |
| NEG-POS | 0% | 0% | 0% | 2.78% | **5.56%** | **5.56%** | 0% | 0.86% (2.34) |
| NEUT-POS | 0% | 0% | 0% | **2.78%** | **2.78%** | 0% | 0% | 0.42% (1.01) |
| % total errors | 47.22% | 69.44% | **83.33%** | 66.67% | 66.67% | **86.11%** | 36.11% | 36.74% (21.98) |
|  | % correct | 52.78% | 30.56% | **16.67%** | 33.33% | 33.33% | **13.89%** | 63.89% | 63.26% (21.98) |
| Number anchored sort | # piles | 6 | 6 | 5 | 6 | 6 | 6 | 6 | 6 (0) |
| NEG-NEUT | 0% | 5.56% | 0% | 0% | 5.56% | 0% | 0% | 4.23% (3.95) |
| POS-NEUT | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% (0) |
| NEG-NEG | 38.89% | 41.67% | 30.56% | **55.56%** | **44.44%** | **55.56%** | 41.67% | 20.49% (13.41) |
| NEUT-NEG | **16.67%** | 5.56% | 11.11% | **16.67%** | 2.78% | **16.67%** | **16.67%** | 4.72% (4.93) |
| POS-NEG | 0% | 0% | 0% | 0% | 2.78% | 2.78% | 0% | 0% (0) |
| NEG-POS | 0% | 0% | **5.56%** | 0% | 0% | 2.78% | 0% | 0.51% (1.47) |
| NEUT-POS | 0% | **2.78%** | **5.56%** | 0% | **2.78%** | 0% | 0% | 0.43% (1.27) |
| % total errors | 55.56% | 55.56% | 52.78% | **72.22%** | 58.33% | **77.78%** | 58.33% | 30.38% (17.02) |
|  | % correct | 44.44% | 44.44% | 47.22% | **27.78%** | 41.67% | **22.22%** | 41.67% | 69.62% (17.02) |
| Word anchored sort | # piles | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 (0) |
| NEG-NEUT | 8.33% | 13.89% | 5.71% | 11.11% | 8.33% | **19.44%** | 5.56% | 7.00% (6.31) |
| POS-NEUT | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0.08% (0.48) |
| NEG-NEG | 13.89% | **30.56%** | **40.00%** | 27.78% | 25.00% | 27.78% | **36.11%** | 16.26% (6.96) |
| NEUT-NEG | **8.33%** | **8.33%** | 2.86% | 0% | 0% | **8.33%** | 0% | 2.61% (2.86) |
| POS-NEG | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% (0) |
| NEG-POS | 0% | 0% | 0% | 0% | **5.56%** | 0% | 2.78% | 0.76% (1.88) |
| NEUT-POS | 0% | 0% | 0% | **2.78%** | 0% | 0% | 0% | 0.08% (0.48) |
| % total errors | 30.56% | **52.78%** | **48.57%** | 41.67% | 38.89% | **55.56%** | 44.44% | 26.80% (10.87) |
|  | % correct | 69.44% | **47.22%** | **51.43%** | 58.33% | 61.11% | **44.44%** | 55.56% | 73.20% (10.87) |
| Face anchored sort | # piles | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6% (0) |
| NEG-NEUT | 8.33% | 11.11% | 11.11% | 5.56% | 8.33% | 11.11% | 11.11% | 5.39% (3.92) |
| POS-NEUT | 0% | 0% | 0% | 0% | **5.56%** | 0% | 0% | 0.08% (0.48) |
| NEG-NEG | 13.89% | **33.33%** | **33.33%** | 22.22% | **33.33%** | **44.44%** | **38.89%** | 15.24% (8.37) |
| NEUT-NEG | 8.33% | **11.11%** | 5.56% | 8.33% | **5.56%** | 0% | 2.78% | 3.96% (3.87) |
| POS-NEG | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% (0) |
| NEG-POS | 0% | 2.78% | 0% | 0% | 2.78% | 0% | **5.56%** | 0.42% (1.57) |
| NEUT-POS | 0% | **2.78%** | 0% | 0% | **5.56%** | 0% | **2.78%** | 0.08% (0.48) |
| % total errors | 30.56% | **61.11%** | **50.00%** | 36.11% | **61.11%** | **55.56%** | **61.11%** | 25.17% (11.72) |
|  | % correct | 69.44% | **38.89%** | **50.00%** | 63.89% | **38.89%** | **44.44%** | **38.89%** | 74.83% (11.72) |

Note: With the exception of ‘# piles’ and ‘% correct’, all metrics reflect the percent of all responses which classified as the corresponding error type. Cases where patients were impaired relative to comparison participants (based on Singlims analysis) are underlined and in bold. NEG-NEUT = errors in which negative faces were put in a pile of predominantly neutral faces; POS-NEUT = refers to errors in which positive faces were put in a pile of predominantly neutral faces; NEG-NEG = errors in which one type of negative face was put in a pile consisting predominantly of another negative face, or negative faces which were sorted together into a pile with no one dominant expression; NEUT-NEG = errors in which neutral faces were put in a pile of predominantly negative faces; POS-NEG = errors in which positive faces were put in a pile of predominantly negative faces; NEG-POS = errors in which negative faces were put in a pile of predominantly positive faces; NEUT-POS = errors in which neutral faces were put in a pile of predominantly positive faces.

### *Supplementary Table 6. Percent of all participants’ responses corresponding to each error type across tasks from Lindquist et al. (2014).*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |   | EG | FZ | CP | Comparison Group Mean  |
| Emotion free sort | # piles | 3 | 4 | 4 | 7.82 (SD = 2.99) |
| NEG-NEUT | 1.66% | 0% | 0% | 2.88% |
| POS-NEUT | 0% | 0% | 0% | 0.13% |
| NEG-NEG | **46.67%** | **44.44%** | **36.11%** | 21.72% |
| NEUT-NEG | 5.83% | 0% | 0% | 2.8% |
| POS-NEG | 0% | 0% | 0% | 0.27% |
| NEG-POS | 1.66% | 0% | 2.77% | 0.55% |
| NEUT-POS | **5.83%** | 0% | 0% | 1.69% |
| % total errors | **61.66%** | 44.44% | 38.89% | 30.04% |
|  | % correct | **38.34%** | 55.56% | 61.11% | 69.96% |
| Number anchored sort | # piles | NT | 5 | 6 | NT |
| NEG-NEUT | NT | 0% | 2.86% | NT |
| POS-NEUT | NT | 0% | 0% | NT |
| NEG-NEG | NT | 33.33% | 34.29% | NT |
| NEUT-NEG | NT | 0% | 0% | NT |
| POS-NEG | NT | 0% | 0% | NT |
| NEG-POS | NT | 2.78% | 0% | NT |
| NEUT-POS | NT | 2.78% | 2.86% | NT |
| % total errors | NT | 38.89% | 39.0% | NT |
|  | % correct | NT | 61.11% | 61.0% | NT |
| Word anchored sort | # piles | NT | 8 | 6 | NT |
| NEG-NEUT | NT | 0% | 5.71% | NT |
| POS-NEUT | NT | 0% | 0% | NT |
| NEG-NEG | NT | 27.78% | 31.48% | NT |
| NEUT-NEG | NT | 0% | 0% | NT |
| POS-NEG | NT | 0% | 0% | NT |
| NEG-POS | NT | 2.78% | 0% | NT |
| NEUT-POS | NT | 0% | 0% | NT |
| % total errors | NT | 30.56% | 36.0% | NT |
|  | % correct | NT | 69.44% | 64.0% | NT |
| Face anchored sort | # piles | 6 | 6 | 6 | NT |
| NEG-NEUT | 0% | 0% | 5.71% | NT |
| POS-NEUT | 0% | 0% | 0% | NT |
| NEG-NEG | 0% | 19.44% | 17.14% | NT |
| NEUT-NEG | 0% | 0% | 0% | NT |
| POS-NEG | 0% | 0% | 0% | NT |
| NEG-POS | 0% | 0% | 0% | NT |
| NEUT-POS | 0% | 0% | 0% | NT |
| % total errors | 0% | 19.44% | 22.0% | NT |
|  | % correct | 100% | 80.56% | 78.0% | NT |

Note: With the exception of ‘# piles’ and ‘% correct’, all metrics reflect the percent of all responses which classified as the corresponding error type. Cases where patients were impaired relative to comparison participants (using a modified t test; Crawford & Howell, 1998) are underlined and in bold. NT = ‘not tested’. NEG-NEUT = errors in which negative faces were put in a pile of predominantly neutral faces; POS-NEUT = refers to errors in which positive faces were put in a pile of predominantly neutral faces; NEG-NEG = errors in which one type of negative face was put in a pile consisting predominantly of another negative face; NEUT-NEG = errors in which neutral faces were put in a pile of predominantly negative faces; POS-NEG = errors in which positive faces were put in a pile of predominantly negative faces; NEG-POS = errors in which negative faces were put in a pile of predominantly positive faces; NEUT-POS = errors in which neutral faces were put in a pile of predominantly positive faces.

## Identity Sort Task Performance

### *Supplementary Table 7. Output for Study 1 mixed effects linear regression for performance on the identity sort task, looking at the effect of group and emotion.*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Estimate | Lower 95% CI | Upper 95% CI | Likelihood Ratio Test |
| Intercept | 4.36 | 1.19 | 7.53 | - |
| Group | 3.61 | -0.29 | 7.51 | χ(1) = 3.14, *p* = .077 |
| Emotion | - | - | - | χ(5) = 0.53, *p* = .991 |
| Group by Emotion  | - | - | - | χ(5) = 0.25, *p* = .998 |

Note: CI = confidence interval. Model run in R using lme4 package (version 1.1-25; Bates et al., 2015). As this is a logistic model, estimate coefficients reflect log transformation of odds ratios (Larsen et al., 2000). Overall emotion effect and group by emotion interaction do not include an estimate value, as these effects are not provided by the overall model. The respective likelihood ratio test results were obtained by comparing the full model to nested versions in which all condition main effects or interactions were removed.

## Response Time Analysis

### *Supplementary Table 8. Output for Study 2 mixed effects linear regression for response time, observing effects of group and specific condition comparisons.*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Estimate | Lower 95% CI | Upper 95% CI | Likelihood Ratio Test |
| Intercept | 4.60 | 4.18 | 5.03 | - |
| Group | -1.07 | -1.58 | -0.57 | χ(1) = 13.2, *p* < .001\* |
| Condition | - | - | - | χ(3) = 11.8, *p* = .008\* |
| Group by Condition  | - | - | - | χ(3) = 6.54, *p* = .088 |

 *Note*. \* reflects significance at the .05 threshold. CI = confidence interval. Model was run in R using lmerTest package (version 3.1-3; Kuznetsova et al., 2017). Overall condition effect and group by condition interaction do not include an estimate value, as these effects are not provided by the overall model. The respective likelihood ratio test results were obtained by comparing the full model to nested versions in which all condition main effects or interactions were removed.

### *Supplementary Table 9. Post-hoc pairwise contrasts of the Study 2 response time mixed effects logistic regression, comparing the estimated mean response time across conditions within the patient and comparison groups.*

|  |  |  |
| --- | --- | --- |
| Contrast | Patients | Comparison Participants |
| No cue – cue | t = 2.60, *p* = .046\* | t = -0.63, *p* = .921 |
| No cue – miscue across-valence | t = 1.67, *p* = .347 | t = 0.55, *p* = .947 |
| No cue – miscue within-valence | t = -0.67, *p* = .908 | t = -2.99, *p* = .015\* |
| Cue – miscue across-valence | t = -0.92, *p* = .792 | t = 1.18, *p* = .640 |
| Cue – miscue within-valence | t = -2.94, *p* = .018\* | t = -2.43, *p* = .072 |
| Miscue across-valence – miscue within-valence | t = -2.12, p = .149 | t = -3.46, p = .003\* |

*Note*. \* reflects significance at the .05 threshold. P-values were corrected using the Tukey HSD method for multiple comparisons. Contrasts were run using the emmeans package in R.

Interpretation

Participants’ mean response times across all conditions can be seen below in Supplementary Figure 1. As the current data was collected remotely over Zoom, factors such as poor internet speed may have in some cases influenced response time. These results should therefore be interpreted cautiously. The response time mixed effects logistic regression (Supplementary Table 7) was run in R (R Core Team, 2020) using the lmerTest package (Kuznetsova et al., 2017). Likelihood ratio tests were used to look for significant main effects or interactions of condition and group. These tests compare two nested models using the chi-square distribution, to determine whether removing a specific predictor (e.g., effect of group) significantly changes the overall model. Comparison participants demonstrated faster response times than patients. An overall main effect of condition was observed. Post-hoc pairwise comparisons (Supplementary Table 8) were run using the emmeans package in R (Lenth, 2020). Patients showed a significantly faster response time in the cue trials in relation to both the no cue baseline and the miscue within-valence trials. Comparison participants did not show an effect of cue trials but showed slower response time during miscue within-valence trials relative to both the no cue baseline and miscue across-valence trials. These results suggest beneficial effects of relevant cueing on response time in patients but not comparison participants, suggesting facilitation of emotion concept information in SA patients. Both groups showed some evidence of slowed response time on miscue within-valence trials, which present with the highest semantic control demands by requiring inhibition of a conceptually association emotion state.



### *Supplementary Figure 1: Mean response time in the Cue, No cue, Miscue across-valence, and Miscue within-valence conditions, for each individual patient and for the mean patient and comparison participant response times. Patients are ordered (left to right) from the most to least semantically impaired, based on their semantic control composite score. Errors bars created using standard error of the mean. \* = impaired performance based on Singlims analysis.*

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