**Chapter 5: Experiment 3 - Longitudinal cognitive & linguistic aptitude in BSL-English interpreting students**

**5.2 METHODS**

*5.2.1 Participants  
n*=33 students enrolled in the degree ‘MA (Hons) British Sign Language (Interpreting, Translating and Applied Language Studies)’ at Heriot-Watt University (*n*=23 total) or the degree ‘BA (Hons) Interpreting (British Sign Language/English)’ at the University of Wolverhampton (*n*=10) were invited before course begin to take part in the longitudinal research study. Two consecutive year groups of Heriot-Watt students were tested; the first cohort beginning in September 2018 (*n*=11) and the second beginning in September 2019 (*n*=12). Across all cohorts, only *n*=2 participants were heritage signers of BSL and most had only limited exposure to BSL before their interpreting degree began (e.g. the fingerspelling alphabet) or an introductory course (see Table 1).

Table 1: Demographics of the three cohorts of BSL-English interpreting students who took part in the longitudinal study

|  |  |  |  |
| --- | --- | --- | --- |
| **Institution** | Heriot-Watt | Heriot-Watt | Wolverhampton |
| **Cohort** | 1st cohort | 2nd cohort | single cohort |
| **Cohort code** | HW18 | HW19 | WV19 |
| **Course begin** | September 2018 | September 2019 | October 2019 |
| ***N*** | 11 | 12 | 10 |
| **Mean age (yy;m)** | xx;x | xx;x | xx;x |
| **Mean previous BSL exposure (yy;m)** | xx;x | xx;x | xx;x |
| **Test timepoint one (pre-course)** | Mar ’18, in-person | Sep ’19, in-person | Oct ’19, in-person |
| **Test timepoint two (end of year 1)** | Mar ’19, in-person | May-Jun ’20, online | May-Jun ’20, online |
| **Test timepoint three (end of year 2)** | May-Jun ’20, online | Apr-Jun ’21 online | Apr-Jun ’21 online |

*5.2.2 Longitudinal study design*Participants were tested on a battery of cognitive and linguistic assessments at three yearly sessions, approximately one year apart. Timepoint one was before the university degree and thus, for most participants, before critical exposure to BSL had begun. Timepoint two was at the end of the first year of the course and the final timepoint three was at the second year of the course, before students begin their placement years, where BSL exposure is likely to be much more variable. Due to disruption related to the Covid-19 pandemic (e.g. lack of equipment or suitable space for remote participation at home) as well as students dropping out of their courses or not being interested in further participation at later test sessions, it was not possible to re-test all participants again at test sessions two and three. Furthermore, the online testing at later timepoints was spread out more than planned compared to pre-pandemic testing, which was carried out in-person on the Heriot-Watt and Wolverhampton university campuses.

*5.2.3 Description of Test Battery*The cognitive and linguistic aptitude test battery comprising the predictor variables is described in 5.2.3.1 below. Following that, the British Sign Language and interpreting assessments which make up the outcome variables are described in section 5.2.3.2.

*5.2.3.1 Predictor Variables*

*5.2.3.1.1 Dual N-Back*Participants at all three timepoints completed the Psychology Experiment Building Language (PEBL; Mueller, 2014; Mueller & Piper, 2014) test battery version of the dual n-back task (Jaeggi et al., 2008), which is a measure of multimodal working memory. In the task, participants must simultaneously recall a sequence of letters presented auditorily as well as the spatial location of a sequence of squares presented visually on a grid. Participants press a button when the letter or square location matches the letter or square location presented *n* trials ago. The task has one block of 1-back, one block of 2-back and one block of 3-back trials. Dependent measures were letter accuracy and spatial accuracy, as well as combined accuracy (average accuracy in both modalities).

*5.2.3.1.2 Corsi Blocks* Participants at all three timepoints completed the PEBL version of the Corsi block-tapping task (Corsi, 1972; Kessels et al., 2000), which is a measure of spatial working memory. In the task, participants must memorise the order in which a sequence of blocks change colour and then click the blocks in the same order. The sequence gets progressively longer as the task goes on. Dependent measures were block span, raw score, number of correct responses and memory span.

*5.2.3.1.3 Kirklees Reading Assessment*

Participants at all three timepoints completed the revised Kirklees version of the Vernon Warden Reading Test (Hedderly, 1996; Warden, 1956), which is a measure of English reading comprehension. In the task, participants must complete 42 sentences by selecting the most appropriate word to fill a gap from the five options provided. Participants were given ten minutes to complete the task, which was completed via pen and paper at face-to-face testing sessions and using a digitised version at online testing sessions. Dependent measures were ceiling score, raw score, and accuracy.

*5.2.3.1.4 KBIT-2 Matrices subtest*

Participants at all three timepoints completed the Kaufman Brief Intelligence Test-2 (KBIT-2; Kaufman & Kaufman, 2004) Matrices subtest, which is a measure of non-verbal reasoning. In this task, participants are presented with visual stimuli with a specific rule or relationship, which participants must understand and then select the picture or pattern from the options provided that best fits that relationship or rule. Participants were given ten minutes to complete the task, which was completed via pen and paper at face-to-face testing sessions and using a digitised version and spreadsheet answer key at online testing sessions. Dependent measures were ceiling score, raw score, and accuracy.

*5.2.3.1.5 Digit Span*At sessions one and three, a subset of participants, the HW19 and WV19 groups (*n*=22) completed the PEBL test battery version of the Digit Span task (Croschere et al., 2012), which is a measure of auditory working memory capacity. In this task, participants must remember a sequence of numbers presented auditorily number-by-number, and then type in the sequence of numbers as it was heard. The sequence of numbers gets progressively longer as the task goes on. Dependent measures were memory span, accuracy, and the total time taken for the task.

*5.2.3.1.6 3D Mental Rotation*

At all timepoints, a subset of participants, the HW19 and WV19 groups (*n*=22), completed a 3D block rotation task comprising 96 three-dimensional stimuli from Ganis & Kievit (2015). HW18 participants also completed this task at session 3 only. The task is a measure of mental rotation around a vertical axis, where participants must decide whether two shapes presented side-by-side on screen are identical or mirror images by mentally rotating them as quickly and accurately as possible. Dependent measures were accuracy and reaction time for correct trials.

*5.2.3.1.7 2D Mental Rotation*

At all timepoints, HW18 participants completed the simple 2D PEBL mental rotation task (Shepard & Metzler, 1988; Berteau-Pavy et al., 2011). The HW19 and WV19 groups also completed this task at session 3. In this task, participants must decide if two shapes presented side-by-side on screen are the same or different by mentally rotating them. Dependent measures were accuracy and reaction time for correct trials.

*5.2.3.1.8 Barratt Impulsiveness Scale*At sessions two and three, a subset of participants, the HW19 and WV19 groups (*n*=22), completed the Barratt Impulsiveness Scale, version 11 (BIS-11; Patton et al., 1995), which is a measure of impulsiveness. Stone (2017) included this task in his SLI aptitude study as a measure of risk-taking and found that interpreting students were significantly more likely to take risks than students who were rehoused in a Deaf Studies programme (due to choice or poor BSL/interpreting exam performance). In the BIS-11, participants are asked to complete a questionnaire of 30 questions, where they self-rate their behaviour and preferences on a four-point scale from ‘rarely/never’ to ‘almost always/always’. The BIS-11 has three second-order factors (attentional; motor; non-planning) and six first-order factors (attention; cognitive instability; motor; perseverance; self-control; cognitive complexity). Dependent measures were total overall score and second-order factor totals.

*5.2.3.1.9 MLAT Number Learning subtest*At timepoint one, a subset of participants, the HW19 and WV19 groups (*n*=22), completed the Number Learning subtest of the Modern Language Aptitude Test (MLAT; (Carroll & Sapon, 1959; Carroll et al., 2010), which is a measure of ‘auditory alertness’ and the memory component in auditory language comprehension. This subtest was found to be predictive of students’ exam results by Stone (2017), where it was argued that the task directly or indirectly relates to how the phonological structure of signs is encoded. In the Number Learning test, participants are taught a number system in a made-up language through auditory input and tested by being asked to translate new combinations of numbers from the made-up language back into English numerals. The test features 43 items.e th The dependent measure was response accuracy.

*5.2.3.1.10 Summarising task*A subset of participants, the HW19 and WV19 groups (n=22), completed a Summarising Task at timepoint one. Being able to comprehend and summarise academic spoken English before interpreting it into ‘chunks’ of BSL is an important skill for interpreting students. Therefore a task was created for the study where students had to listen to a TED talk on climate change and food (Ebi, 2019) while being allowed to take notes. Afterwards students had to suggest a title for the presentation and summarise the talk in five key bullet points, to assess their spoken English comprehension and summarising ability. Dependent measures are accuracy of the five bullet points.

*5.2.3.2 Outcome Variables*

*5.2.3.2.1 Copy-Sign Task*All students at timepoints one and two completed a copy-sign task, which was a measure of BSL reception and production. The task consists of ten BSL signs and three short BSL sentences which were presented twice by a Deaf L1 signer and were then to be repeated to the camera by the students as accurately as possible. Accuracy of BSL production was coded by FW, with one mark for each phonological parameter (handshape, movement, location, orientation, non-manual features) articulated correctly.

*5.2.3.2.2 British Sign Language Sentence Reproduction Test*All students at timepoint 3 (and HW19 students at timepoint 2) were tested on the first half (i.e. the first 22 items) of the British Sign Language Sentence Reproduction Test (BSL-SRT; Cormier et al., 2012). At timepoint 3, students were tested on the full BSL-SRT (i.e. all 44 items). The test involves viewing BSL sentences of increasing difficulty and reproducing them as accurately as possible to the camera. The test is therefore an assessment of both BSL comprehension and production. Accuracy of BSL production, which was coded by FW, with one mark for each sentence reproduced correctly

*5.2.3.2.3 Town Map task*All students at timepoint 3 (and HW19 students at timepoint 2) were tested on a Town Map task which was created for the study. This is a test of spatial signing in BSL. Participants had to study a town map for 3 minutes which then disappeared and then describe the location of five places in the town from memory, in BSL. At timepoint 2, the map remained on the screen. Accuracy of BSL production was coded by FW, with one mark for each location described successfully on the map.

*5.2.3.2.4 Consecutive Interpreting task*HW19 and WV19 students at timepoint 3 were asked to complete a consecutive interpreting task where they had to interpret a four-minute story signed by a L1 Deaf signer about receiving their Covid-19 vaccine, from BSL into English. Students were allowed to pause the video to ‘chunk’ their interpreting as they saw fit, this ‘chunking’ skill was also part of the assessment of the interpretation. This task was assessed by two SLI educators.

*5.2.3.2.5 Simultaneous Interpreting task*HW19 and WV19 students at timepoint 3 were asked to complete a simultaneous interpreting task, where they had to interpret an instructional video in English explaining the procedure for visiting a Covid-19 ward in a hospital. This task was assessed by two SLI educators.

*5.2.3.2.6 British Sign Language module grades*Module marks from British Sign Language modules were collected from both semesters for the first two years of the course after these had been moderated. For HW18 and HW19 students, these comprised two first-year intensive practical modules in BSL and two second-year modules in Advanced BSL. For WV19 students, marks were made up of the first-year modules ‘Intermediate BSL Enhancement for Interpreters A, B and C’ and the second-year modules ‘Advanced BSL Enhancement for Interpreters A, B and C’.

*5.2.3.2.7 BSL-English interpreting module grades*Module marks from second-year interpreting modules were also collected after these had been moderated. For HW18 and HW19 students, these comprised the ‘Introduction to Translation and Interpreting skills’ module and for WV19 students, the modules ‘Consecutive Interpreting 1 and 2’.

*5.2.4 Test Procedure*

*5.2.5 Statistical Analysis*Missing data were imputed using the {mice} package in R. An exploratory factor analysis was first performed to address collinearity. From these, latent variables were constructed, and a multi-level model was performed.

**References**

Berteau-Pavy, D., Raber, J., & Piper, B. J. (2011). Contributions of age, but not sex, to mental rotation performance in a community sample. In *PEBL Technical Report Series*. http://sites.google.com/site/pebltechnicalreports/home/pebl-technical-report-2011-02

Carroll, J. B., & Sapon, S. M. (1959). *Modern Language Aptitude Test* (p. 27). Psychological Corporation.

Carroll, J. B., Sapon, S. M., Reed, D. J., & Stansfield, C. W. (2010). *Modern Language Aptitude Test: Manual*. Second Language Testing Foundation.

Cormier, K., Adam, R., Rowley, K., Woll, B., & Atkinson, J. (2012). *The BSL Sentence Reproduction Test: Exploring age-of-acquisition effects in British deaf adults* [Conference Presentation]. 34th Annual Meeting of the German Association of Linguistics, Frankfurt am Main.

Corsi, P. M. (1972). *Human memory and the medial temporal region of the brain*.

Croschere, J., Dupey, L., Hilliard, M., Koehn, H., & Mayra, K. (2012). The effects of time of day and practice on cognitive abilities: Forward and backward Corsi block test and digit span. *PEBL Technical Report Series*.

Ebi, K. (2019, April). *How climate change could make our food less nutritious* [Conference Presentation]. TED2019, Vancouver, BC. https://www.ted.com/talks/kristie\_ebi\_how\_climate\_change\_could\_make\_our\_food\_less\_nutritious

Ganis, G., & Kievit, R. (2015). A New Set of Three-Dimensional Shapes for Investigating Mental Rotation Processes: Validation Data and Stimulus Set. *Journal of Open Psychology Data*, *3*(1). https://doi.org/10.5334/jopd.ai

Hedderly, R. (1996). Vernon-Warden Reading Test (Revised). *Dyslexia Review*, *7*(2).

Jaeggi, S. M., Buschkuehl, M., Jonides, J., & Perrig, W. J. (2008). Improving fluid intelligence with training on working memory. *Proceedings of the National Academy of Sciences of the United States of America*, *105*(19), 6829–6833. https://doi.org/10.1073/pnas.0801268105

Kaufman, A. S., & Kaufman, N. L. (2004). *Kaufman Brief Intelligence Test, Second Edition*. Pearson, Inc.

Kessels, R. P., Van Zandvoort, M. J., Postma, A., Kappelle, L. J., & De Haan, E. H. (2000). The Corsi block-tapping task: Standardization and normative data. *Applied Neuropsychology*, *7*(4), 252–258.

Mueller, S. T. (2014). *PEBL: The Psychology Experiment Building Language (Version 0.14) [Software]. Available from http://pebl. sourceforge.net*.

Mueller, S. T., & Piper, B. J. (2014). The Psychology Experiment Building Language (PEBL) and PEBL Test Battery. *Journal of Neuroscience Methods*, *222*, 250–259. https://doi.org/10.1016/j.jneumeth.2013.10.024

Patton, J. H., Stanford, M. S., & Barratt, E. S. (1995). Factor Structure of the Barratt Impulsiveness Scale. *Journal of Clinical Psychology*, *51*(6), 768–774. https://doi.org/10.1002/1097-4679(199511)51:6<768::AID-JCLP2270510607>3.0.CO;2-1

Shepard, S., & Metzler, D. (1988). *Mental Rotation: Effects of Dimensionality of Objects and Type of Task*. 9.

Stone, C. (2017). Sign language interpreter aptitude: The trials and tribulations of a longitudinal study. *Translation & Interpreting*, *9*(1), 16.

Warden, V. B. (1956). *Construction and standardisation of a reading test* [Unpublished MA thesis]. University of London.