Chapter 8
Measures of Expressive Language

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Expressive language is critical for the interaction of the individual with the environment. It represents the individual's ability to demonstrate knowledge and share information, make their needs and wants known, and share in social interactions. It also supports our executive functions, such as planning, organization, and self-control. Limitations in overall language functioning affect long-term academic outcomes, and expressive skills represent one component of this broad skill area (Young et al. 2002). While other tasks within the Toolkit also measure expressive skills (e.g., Writing Fluency), the focus of this chapter will be the measurement of linguistic fluency.

Linguistic Fluency

Category and letter naming tasks represent commonly used measures of semantic and phonological fluency. Recent research has suggested that these two types of tasks may be processed using a combination of shared and separate neural structures (Grogan et al. 2009). The ability to search, retrieve, and verbalize words quickly and fluently is governed by executive functioning, the self-regulatory, or control system that governs cognitive, behavioral, and emotional activity (Anderson 2008; Denckla 1996). The two tasks differ in that the words which begin with a specific letter on phonemic fluency tasks are not necessarily related, whereas category fluency accesses a sequence of related concepts, which are more quickly accessible (Schwartz et al. 2003). The single category presented on semantic fluency

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D. Morere and T. Allen (eds.), *Assessing Literacy in Deaf Individuals: Neurocognitive Measurement and Predictors*, DOI 10.1007/978-1-4614-5269-0_8,

tasks activates a network of multiple exemplars, the search of which is dependent on organization of semantic memory (Raboutet et al. 2010).

Verbal fluency as a whole reflects the manner in which we process previously learned information and the aspects of memory required to recall and retrieve that information at a later time. Memory studies often proceed with the assumption that while hearing individuals access verbal (or linguistic) memory through acoustic, phonological, and articulatory codes, deaf individuals function primarily through nonverbal (or nonlinguistic) memory (Marschark and Mayer 1998).

American Sign Language (ASL) is conveyed through a combination of facial expressions and other non-manual components, and manual signs involving configurational handshapes, spatial locations, and movements. It has been suggested that ASL may be processed and rehearsed using a sign-based "phonological loop" (or sign loop) analogous to the auditory memory-based loop used by hearing individuals (Wilson and Emmorey 1997).

Verbal fluency tasks, such as the Controlled Oral Word Association (COWA) test, are commonly used neuropsychological measures of executive function (Lezak et al. 2004). The COWA test measures the number of words an individual can report within a specified amount of time when prompted by a specific letter. A related task reflects semantic fluency, using the prompt of a general category. Thus, the two types of verbal fluency measures generally used involve lexical or phonemic fluency (words beginning with a specific letter, typically F, A, and S) and semantic, or categorical, fluency (words found in a specific category such as "animals" and "foods"). Both tasks involve the ability to spontaneously produce words within a 1-min time constraint (Bechtoldt et al. 1962; Benton 1967; Spreen and Benton 1969).

Verbal, or linguistic, fluency involves multiple cognitive processes, including (but not limited to) attention and initiation, short-term memory, cognitive flexibility, a range of vocabulary from which to access the responses, the linguistic search and retrieval skills to make use of this knowledge, and executive controls which allow for organization, decision-making, response inhibition, self-monitoring, and adherence to the rules of the task (Mitrushina et al. 2005; Ruff et al. 1997). Factors which have been shown to influence the individual's performance on a measure of verbal fluency include age, education, bilingualism, and disability (Kempler et al. 1998; Portocarrero et al. 2007).

Performance on verbal fluency measures generally increases during childhood, with relative stabilization during adolescence or early adulthood. This may in part relate to findings that word retrieval efficiency has been shown to increase with age (Cohen et al. 1999), with some studies showing that children reach adult levels of efficiency as early as age 10 (Regard et al. 1982) and others showing continued development into adolescence (Welsh et al. 1991). Within the adult population, mild declines in performance occur with age on measures of semantic fluency (Lezak et al. 2004). However, while some studies suggest a lack of age differences in performance among adults on phonemic fluency tasks (Axelrod and Henry 1992; Troyer et al. 1997), the meta-analysis by Rodríguez-Aranda and Martinussen (2006) indicates that these declines do occur, especially after age 40.

Ruff et al. (1997) presented multiple supports, including the impact of educational level on word fluency scores, for the contention that word knowledge is an essential component of verbal fluency, and that a larger pool of available words would lead to increased performance on word fluency. More recently, Luo et al. (2010) provided data supporting the direct impact of vocabulary on verbal fluency performance. The impacts of English vocabulary on performance on fluency tasks—particularly those based on English letters/phonemes—are especially relevant with people who are deaf or hard-of-hearing (D/HOH), as they typically have limited access to spoken language. Thus, they may not attain the same level of fluency expected of age- or education-matched hearing peers due to a more limited pool of available words.

It is important to analyze the effects of bilingualism on verbal fluency performance. While some debate exists about the definition of bilingualism, it is important to note that some D/HOH individuals use components of both English and ASL in their everyday lives. Communicating in more than one language, or language modality, may impact one's performance on verbal fluency tests. However, while bilingual children often have lower scores on vocabulary tests and other specialized language tests (Luo et al. 2010), this does not automatically lead to lower linguistic abilities in adulthood. Additionally, bilinguals are often slower at tasks requiring rapid lexical access, such as picture naming tasks, even if they are just as accurate as monolinguals (Costa 2005; Luo et al. 2010).

One theory proposes that there is a bilingual disadvantage for phonemic fluency tasks because such tasks consume more cognitive resources than category naming tasks, as words are typically stored semantically rather than lexically and cognitive associations and cognitive searches are typically based on categorical associations (Luo et al. 2010). Phonemic generation is not a common strategy in everyday word retrieval, making this type of task more dependent on executive control (Luo et al. 2010; Strauss et al. 2006). Further, interference from the person's "other" language (e.g., the language not targeted by the task) may slow the search, as the person may have to consider and reject phonemically appropriate responses from the "other" language. During categorical tasks, the person is searching by content, so there may be less lexical/phonological interference. Further, studies have found that fully bilingual people tend to have a reduced lexicon in each language compared to monolinguals, although there are no reductions in the overall corpus of vocabulary across languages (Bialystok et al. 2008; Oller and Eilers 2002).

Recent research has investigated individuals who are deaf and for whom ASL is a first language. Morford et al. (2011) found that deaf signers activated sign translations of the stimuli during a task involving reading English words, although the participants were not asked about ASL. Thus, the authors concluded that deaf readers activate ASL networks even on tasks that do not directly involve signs. While these types of activation may be occurring on the reading tasks, this raises the question of whether English demands will affect performance on tasks involving signed responses. The current study investigated linguistic fluency using three related tasks. First, in addition to the English-based phonemic fluency task using the standard F–A–S stimuli, a measure of fluency was developed based on the phonemes (or cheremes) of ASL related to handshapes. Second, semantic fluency was measured using categorical probes. In order to investigate the impact of priming in the two languages, the semantic tasks were administered twice, once after each of the two phonemic tasks. (Note that although technically the handshapes represent cheremes, since they are not sound based, the term phoneme will be used here as a generic term for the basic discernible units of both languages.)

The Linguistic Fluency Tasks

Phonemic Fluency: F–A–S and 5–1–U

The previously discussed COWA, or F–A–S, was used to measure English letter, or phonemic, fluency. The F–A–S task was selected due to its wide use, both clinically and in research. It is the most commonly used form of phonemic fluency (Barry et al. 2008), and is the form of the task used in the Delis–Kaplan Executive Function System (D-KEFS; Delis et al. 2001), a respected battery of executive functioning.

The 5–1–U was developed in-house to measure sign-based phonemic fluency. While the task administration may vary slightly, Strauss et al. (2006) report that on the F–A–S task, the hearing individual is given the spoken prompt of the letter and asked to produce as many words as possible which start with that letter within a 1-min time frame. Prior to being given the first prompt, the participant is provided with a model of an unrelated letter (e.g., "For example, if I were to say "G", you could respond with gum, go, gas, etc.") and is told that neither proper nouns (e.g., names of people and places, "you shouldn't say Greg or Georgia") nor multiple forms of the same word but with a different ending (e.g., run, running, runs) are allowed. These are standard rules for phonemic fluency tasks. After the first letter task is completed, the subsequent two letters are presented, one at a time. For the oral administration, the examiner typically writes down the participant's responses in the order they are given. This has the added advantage of allowing further analyses of constructs such as clustering (e.g., producing multiple words from a semantic group or subgroup) and switching (changing to a different word type).

For the current F–A–S task, the instructions were signed to the participant, who responded via sign. In addition to the examiner's writing down the responses, the participants' responses were videotaped, so that unclear or missed responses could be reviewed to ensure accurate scoring. While individual signs can represent multiple English words, credit for each sign was given if a standard or commonly used English interpretation of the sign began with the relevant letter.

As mentioned above, the 5–1–U is a sign-based task internally developed by Morere and members of the VL2 team specifically for this study. Based on a linguistic analysis, ASL has three main phonological criteria (Battison 1978; Stokoe 1960): handshape, location of the sign, and movement of the hands. While for spoken languages, the influence of phonologically, morphologically, or semantically related words stimulate a priming effect on target words (Hamburger and Slowiaczek 1996); ASL priming occurs based on the sign language phonemic domains of handshape, location, and movement (Corina and Emmorey 1993). As handshapes appear to be the parameter which exhibit categorical perception (Emmorey et al. 2003), the 5–1–U task focuses on the parameter of handshapes. This task requires the participant to generate signs that use specific handshapes. It was designed to recruit sign-based strategies comparable to those used on the letter-based task. The handshapes 5, 1, and U were selected and sequenced in an attempt to reflect the relative frequency of their occurrence in the ASL lexicon similar to the forms of commonly used phonemic frequency tasks. While few data are available related to the frequency of handshapes used in signs in ASL, the data from Morford and Macfarlane (2003) suggest that the 1 and 5 handshapes are used by the dominant, the nondominant, or both hands in the signs having the highest frequency, while the U represents a less frequent but not rare usage, presenting a somewhat more challenging task. These frequencies are supported by a more recent study (Chong et al. 2009). While the selection of the letters F, A, and S is less well defined—indeed Mitrushina et al. (2005) state that they were chosen at random—and all three letters are considered relatively easy, the other two most commonly used letter sets (CFL and PRW) were developed so that one letter had a very high frequency and the other two letters were selected for decreasing frequency in English words (Ruff et al. 1996). Although the latter tasks might be considered more difficult than the FAS, a meta-analytic study comparing the FAS and CFL forms found that while such a difference did occur, the effect size was small, suggesting that while norms for the two tasks should not be used interchangeably, performance by normal individuals was similar (Barry et al. 2008).

Although the current frequency data for ASL do not allow for precision, the general approach to item selection and sequencing used to develop the CFL and PRW was taken with the 5–1–U, with both the 5 and 1 handshapes having a reportedly high frequency in ASL, and the U being somewhat more moderate usage. As is suggested by the comparison of the FAS and CFL, even within a language direct comparison between independently developed forms of superficially identical tasks should be done with caution. As will be discussed below, even greater caution is advised when comparing tasks using not only different languages, but also different modalities

For the 5–1–U task, analogous to the F–A–S, participants were asked to come up with as many signs as possible that use the ASL manual alphabet/number handshapes representing the closed hand version of the number 5 (also referred to as an open B), the number 1, and the letter U. An English translation of the instructions follows: "I will show an ASL handshape. Then I want you to give me as many words (signs) that use that handshape as quickly as you can. For instance, if I use the handshape "K," you might give me "pink, plant, king…" I do not want you to use words that are proper nouns such as "Philadelphia" or namesigns like "Krystle." Any questions?" After a pause, the examiner would sign, "Begin when I show the handshape. You will have one minute for each handshape. The first handshape is 5. Go ahead."

Scoring also paralleled the standard phonemic fluency tasks, with proper names and repetition of the same sign with elaboration (e.g., grandfather and then great-grandfather only given one point, with the elaborative sign scored zero). One point was given for any sign which used a handshape which resembled the relevant handshape (e.g., 5, 1, or U). Additionally, if the concept presented was clearly differentiated, a score of one was given even when the sign was the same (analogous to giving points for homophones such as “see” and “sea” if the meaning is clarified).

As noted above, while this task was designed to emulate commonly used English phonemic fluency tasks, there are a number of issues which make direct comparison of the 5–1–U to the English-based tasks problematic. For one thing, as previously discussed, these tasks are affected by the range of the individual’s vocabulary. While ASL is a rich language with the ability to offer detailed and complex information, since the signs are conceptual in nature, the overall number of signs in ASL is generally considered to be smaller than the number of words in English. Thus, even moderate impacts of vocabulary could limit the number of signs produced. Additionally, while handshapes represent one aspect of the basic units of ASL, they are only one component of the formational structure of signs, sharing this distinction with location, movement, and palm orientation. Thus, they are not directly analogous to speech-based phonemes. Even so, this task provides a potential tool for use in this population, both for the study of processing of ASL and for clinical use, although additional research would be required on broader populations prior to clinical application of this task.

Semantic Fluency: Animals and Foods

As previously discussed, the second general type of fluency task involves semantic fluency, for which the participant is asked to provide words belonging to a specific semantic category. Category fluency is generally considered to be a less difficult task than letter fluency (Lezak et al. 2004). While phonemic and semantic fluency tasks appear to tap somewhat different, although overlapping cognitive processes (Grogan et al. 2009), they are superficially fairly similar. While on the phonemic tasks, the participant is asked to produce as many words (signs) as possible within 1 min which begin with a certain letter or handshape, for the semantic tasks, they are asked to produce as many words as possible from within a specified category.

The most commonly used categorical task is to ask the participant to report the names of as many types of animal as they are able within the 1-min time constraint (Mitrushina et al. 2005; Strauss et al. 2006). This was selected for the first category used for the Psychometric Toolkit. The second measure was foods. This category is one which is used in various forms (e.g., foods; things you eat and drink; fruits and/or vegetables; things you find in a supermarket) in multiple studies and within various instruments, and represents a clear category of common items with which most people are familiar. It avoids the issues associated with using boys or girls names (e.g., unique namesigns and dependence on fingerspelling) and provides a wider range of potential responses than categories such as furniture and clothing.

As noted above, each categorical task was presented twice, once following the F–A–S task, and once after the 5–1–U task. The two trials were administered during separate testing sessions with an average of approximately 1 week between sessions. While both the order of the sessions (for example, half were administered 5–1–U on the first session and half F–A–S on the first session) and sequence of presentation of the Toolkit tasks were counterbalanced for the linguistic fluency tasks, the semantic task was always administered immediately following the phonemic fluency task, with foods administered followed by the animal category. As with the phonemic tasks, the instructions were signed to the participant and all responses were signed by the participants.

Results for Measures of Linguistic Fluency

Descriptive Statistics

Metanorms based on 32 studies of the F–A–S task by hearing participants indicate a mean of 43.51 and standard deviation of 9.44 for individuals below age 40 (Loonstra et al. 2001). The participants in the current study demonstrated a comparable standard deviation; however, their mean performance was more than one standard deviation below the performance of typical English-speaking young adults (Table 8.1). It should be noted that these participants were performing a task best approached using an English alphabetical search, but were required to respond using signs. Thus, the impact of both English proficiency and translation demands need to be taken into consideration. Furthermore, despite their status as college students, it is likely that their English vocabulary is lower than expectations for same age peers. With this in mind, while the two measures can only be compared in very general terms, it is notable that the performance on the sign-based task was approximately half of a standard deviation greater than that on the English-based task, although the ranges were still comparable. This suggests that the participants may have been better able to access a sign-based search than one based on English letters/phonemes. It is possible that the sign-based task was less resource-intensive, as it required only the retrieval and production of the signs, while responses on F–A–S required the student to search for the English word and then associate it with the relevant sign in order to respond. One possible future area of research would be to investigate the relative performance on this type of task when the responses were written or typed rather than signed for the speech-based task. While this may limit use of sign-based processing on the English fluency task, based on the work of Morford et al. (2011), it is possible that activation of signs will occur regardless of the modality of the task.

A meta-analysis of 11 studies of animal naming indicated that individuals between the ages of 25 and 29 are predicted to generate 24.28 words with a standard deviation of 4.65 (Mitrushina et al. 2005). The animal naming outcomes for the current group were consistent, with a mean which rounds to 21 and standard deviation of about 5. Indeed, this was true for both the animal and food tasks regardless of whether they were primed using the ASL- or English-based phonemic fluency task. The current

Table 8.1 F–A–S and 5–1–U—descriptive statistics

Language	Test/subtest	Range	*N*	Mean (SD)
English	F–A–S	13–58	49	30.08 (10.84)
	Animals	10–38	49	21.16 (5.03)
	Foods	9–35	49	20.69 (5.04)
ASL	5–1–U	15–57	48	35.00 (9.94)
	Animals	13–40	46	20.57 (4.75)
	Foods	13–36	46	21.20 (5.31)

data reflect outcomes that are below, but within one standard deviation of, the outcomes on the animal fluency task for hearing English speakers in previous studies. This is not surprising, as many signs represent broad categories of animals. For example, a hearing person might report salmon, trout, carp, and flounder. The sign for all of these is "fish" and in order to indicate the individual species of fish, the participant would have to fingerspell the English word. This would both slow down the response due to the time demands of fingerspelling and it would require activation of the English. This difference in the range of animal names directly available in ASL and English could account for some of the differences in the above scores. Even so, the mean performance of this group was within expectations on this task.

While metanorms were not available for the food category, and this category is often reported combined with other categories in a single score, a number of the studies presented by Mitrushina included categories such as items found in the supermarket, fruits, or vegetables in conjunction with animal naming. It appears that the broader category of items found in a supermarket generally produces a slightly larger set of responses than animal naming, while the more restrictive categories of either fruits or vegetables produce slightly fewer items than the animal category. Thus, the consistency between the relatively broad, but somewhat constrained categories of animals and foods appears to be appropriate. This is consistent with the results of Halperin et al. (1989), who found that children between the ages of 6 and 12 increased the number of words retrieved for the categories of animals and foods, but that the numbers for the two categories were within one item of each other for each 1-year age group. This again suggests that these are comparable semantic retrieval categories.

Overall, the descriptive data for these measures suggest that the deaf students in this study found the English-based phonemic fluency task more difficult than their hearing peers. They also found it to be more challenging than an analogous sign-based task as well as the semantic fluency tasks. There are multiple potential explanations for the difficulty observed with the F–A–S task relative to the other two types of tasks.

Correlational Relationships

Table 8.2 presents the significant correlations between the F–A–S and the other toolkit measures. Considering the need for English word knowledge and the ability to use English letter-based search strategies, it is not surprising that this task correlated moderately with all of the reading and writing tasks. This does not solely represent

Table 8.2 F–A–S—significant correlations

Test	*r*	*N*
WJ-III Reading Fluency	0.53**	46
WJ-III Writing Fluency	0.38**	46
WJ-III Academic Knowledge	0.41**	46
WJ-III Passage Comprehension	0.44**	47
PIAT Reading	0.36*	47
F–A–S Animals	0.46**	49
F–A–S Food	0.50**	49
5–1–U	0.43**	47
5–1–U Animals	0.47**	46
5–1–U Food	0.55**	46
ASL-SRT	0.47**	33
Fingerspelling Test Total Correct	0.50**	49
Fingerspelling Test Real Words Correct	0.50**	49
Fingerspelling Test Fake Word Correct	0.45**	49
TOSWRF	0.29*	46
TSA Percent Correct	0.44*	23
TSA Relativization Percent Correct	0.50*	23
Print Letter Forward Span	0.58**	36
ASL Letter Forward Span	0.39**	49
ASL Letter Backward Span	0.41**	49
ASL Digit Backward Span	0.37**	49

**Significance at $p<0.01$, *significance at $p<0.05$

the impacts of academic fluency, which would be assumed to be related to linguistic fluency, as the correlations with the untimed reading and academic knowledge tasks were similar to those on the two fluency tasks. Not unexpectedly, F–A–S correlated at moderate levels with the other linguistic fluency tasks, including the sign-based 5–1–U, suggesting that despite their differences, these measures do tap an underlying linguistic fluency process. Similarly, the ability to receive fingerspelling, whether real- or pseudo-words were used, is consistent with facility with English words and the ability to use an alphabetic search: individuals who are better able to read fingerspelling would be expected to have broader access to English words.

Moderate to strong correlations were also observed with the letter-based linguistic short-term/working memory tasks as well as one digit-based working memory task. This is consistent with the observation by Mitrushina et al. (2005) that a range of studies in hearing populations have revealed relationships between verbal fluency and digit span tasks. The moderate correlations between F–A–S and both of the scores on the Test of Syntactic Ability (TSA) support the contention that while the TSA does not target word knowledge, greater word knowledge would be expected to be associated with knowledge of English syntax. Perhaps the most interesting relationship was the moderate correlation with the ASL-SRT, a measure of receptive ASL skills. It is possible that this reflects an underlying effect of general language skill; however, overall it appears that the F–A–S measure tracks most closely with tasks reflecting English skills.

Table 8.3 5–1–U—significant correlations

Test	*r*	*N*
WJ-III Writing Fluency	0.29*	47
F–A–S	0.43**	47
5–1–U Animals	0.40**	46
5–1–U Food	0.41**	46
M-SVLT Cued Recall	0.32*	46
Fingerspelling Test Total Correct	0.39**	47
Fingerspelling Test Real Words	0.38**	47
Fingerspelling Test Fake Words	0.39**	47
Print Letter Forward Span	0.40**	36
Corsi Blocks Manual Backward Span	0.43**	47

**Significance at $p<0.01$, *significance at $p<0.05$

As can be seen in Table 8.3, a smaller set of measures produced significant correlations with the sign-based 5–1–U measure, which involved both measures which correlated with F–A–S and measures which did not produce significant correlations with the English-based task. As previously noted, a moderate correlation was observed between the 5–1–U and F–A–S measures, suggesting both shared and disparate processes in these two superficially similar tasks. Interestingly, while the F–A–S task correlated significantly with both the English- and ASL-primed semantic fluency tasks, 5–1–U correlated significantly only with the self-primed categorical tasks. This suggests that while, as noted above, the results for the differentially primed semantic fluency tasks appear to be consistent, there may be differences in the underlying search and retrieval processes involved in achieving those scores. As with the F–A–S, the 5–1–U task correlated moderately, and somewhat more highly, with the fingerspelling reception tasks. These moderate to high correlations indicate a relatively strong relationship between receptive signing and the ability to use handshape-based information to perform the linguistic search and retrieval process involved in the 5–1–U.

Despite the shared relationships between the two phonemic fluency tasks, the relationships seen between the speech-based task and the tasks reflecting English skills were notably absent in the 5–1–U correlations. While there was a relatively weak association with the Writing Fluency task, this could reflect underlying linguistic fluency and/or motor speed and dexterity which are involved in both writing and signing, rather than English skills. Perhaps the most surprising absence was the significant association with the ASL-SRT. While there was a moderate correlation which approached significance ($r=0.336$, $p=0.06$), a stronger relationship would have been expected between the measure of receptive ASL skills and the sign-based task than with the speech-based task. This is an area which deserves further investigation.

In addition to the limited shared relationships, 5–1–U produced some correlational relationships not evident with the speech-based fluency task. While both tasks correlated moderately with the forward print letter span task, only 5–1–U correlated significantly with any of the visuospatial working memory tasks. While it correlated significantly only with the manually administered reverse span task, this does support the involvement of visual working memory in the sign-based fluency task. This may represent similar relationship to that of the various linguistic short-term/working memory tasks in the processing of the F–A–S. Rende et al. (2002) found that hearing college students used a combination of visual and verbal (phonological) working memory on verbal fluency tasks, with greater involvement of verbal working memory for letter fluency and greater visuospatial working memory involvement for categorical fluency. It may be that the association seen with the visual working memory task suggests a shift towards the more visual working memory focus for the sign-based phonemic fluency task. It is also possible that the priming with the 5–1–U task encouraged an even greater use of this strategy with the categorical fluency tasks in this battery, resulting in the significant associations reported above. Another unique relationship seen with the 5–1–U was the low moderate correlation with the cued recall trial of the sign-based memory and learning task. This may reflect underlying sign-based memory and retrieval skills for both tasks, although the lack of significant correlations with the other SVLT scores suggests that this may represent a more specific relationship which is not clear.

Overall, while there are clearly some shared processes between the 5–1–U and its English phonemic fluency equivalent, the ASL-based task appears to involve a somewhat different set of processes, focusing more on the visuospatial and manual aspects of cognitive processing and having little, if any, involvement of speech-based phonology and language. This suggests that the shared processing may reflect the underlying linguistic organization and search processes which are then applied in quite different manners for the two related tasks, which differ in their sensory foundations as well as the language of the underlying task.

While the differential associations with the F–A–S and 5–1–U tasks suggest some degree of discrepancy in the underlying processes, in general the ASL- and English-primed semantic fluency tasks appeared to be quite similar. Thus, the two animal and food tasks will be discussed jointly. As can be observed in Tables 8.4 and 8.5, the relationships between the two animal fluency tasks and the other measures are quite similar. Both tasks produced moderate to strong correlations with a range of academic measures reflecting reading and writing skills. Not unexpectedly, the English-primed task produced somewhat higher correlations with these tasks and correlated with a slightly broader range of English reading and achievement measures. This pattern of slightly stronger correlations was also seen with the receptive fingerspelling measures, suggesting that the English basis of this task had a significant impact on these associations despite the manual spelling of the stimuli.

Both animal fluency tasks also correlated at strong to moderate levels with all of the other linguistic fluency tasks, with the stronger associations being with the other semantic fluency tasks, suggesting that these tasks do reflect a relatively cohesive process separate from the phonemic fluency tasks. Both animal fluency measures also correlated at moderate levels with a range of linguistic short-term/working memory tasks; however, once again the English-primed measure correlated with a broader range of these tasks. Furthermore, consistent with the results of the F–A–S and 5–1–U, while the ASL-primed task produced a moderate correlation with a visuospatial

Table 8.4 F–A–S Animals—significant correlations

Test	*r*	*N*
WJ-III Reading Fluency	0.55**	46
WJ-III Writing Fluency	0.54**	46
WJ-III Academic Knowledge	0.44**	46
WJ-III Passage Comprehension	0.51**	47
PIAT Reading	0.48**	47
F–A–S	0.46**	49
F–A–S Food	0.65**	49
5–1–U Animals	0.61**	46
5–1–U Food	0.45**	46
ASL-SRT	0.40*	33
Fingerspelling Test Total Correct	0.62**	49
Fingerspelling Test Real Words	0.59**	49
Fingerspelling Test Fake Words	0.64**	49
Print Letter Forward Span	0.38*	36
Print Digit Backward Span	0.31*	49
ASL Letter Backward Span	0.41**	49
ASL Digit Backward Span	0.37**	49

**Significance at $p < 0.01$, *significance at $p < 0.05$

Table 8.5 5–1–U Animals—significant correlations

Test	*r*	*N*
WJ-III Reading Fluency	0.52**	45
WJ-III Writing Fluency	0.32*	45
PIAT-Reading	0.31*	46
TOL Time Violations	0.32*	45
F–A–S	0.47**	46
F–A–S Animals	0.61**	46
F–A–S Food	0.63**	46
5–1–U	0.40**	46
5–1–U Food	0.66**	46
M-SVLT Cued Recall	0.33*	45
M-SVLT Recognition Number Correct	0.30*	44
ASL-SRT	0.48**	31
Fingerspelling Test Total Correct	0.53**	46
Fingerspelling Test Real Words	0.50**	46
Fingerspelling Test Fake Words	0.52**	46
TOSWRF	0.36*	45
Print Letter Forward Span	0.34*	45
Corsi Blocks Manual Backward Span	0.31*	46
ASL Letter Backward Span	0.39**	46

**Significance at $p < 0.01$, *significance at $p < 0.05$

working memory task, this was not the case with the F–A–S-primed task. This suggests that while Rende et al. (2002) found a greater focus on visual processing in semantic fluency tasks in the hearing students in their sample, it appears that priming with a speech-based task may elicit more linguistic analysis even on semantic fluency tasks in this population.

Perhaps one of the more interesting shared relationships for this task was the moderate correlations seen for both animal fluency measures with the receptive ASL measure. Just as the associations with the measures of English skills correlated more strongly with the F–A–S-primed trial, the 5–1–U-primed trial appeared to have a somewhat stronger relationship with the receptive ASL measure. These relationships support the importance of underlying language skills, regardless of the language, on this type of task. At the same time, the slight difference in balance of the relationships does suggest that there was some effect of priming on the manner in which the tasks were performed. Consistent with that contention, the final relationship observed for the animal fluency tasks was that of the ASL-primed task with two scores on the sign-based learning and memory task. While relatively low, these correlations again support the impacts of ASL priming on the participants' approach to this task.

While the correlations with the food-based tasks were similar to those for the animal category, this category appeared to tap a broader range of underlying processes (Tables 8.6 and 8.7). The correlations with the measures reflecting English literacy and academic knowledge were consistent across the two trials of this task, perhaps suggesting a greater influence of reading on knowledge of a variety of foods compared to animals. Furthermore, in addition to the intercorrelations with the other linguistic fluency tasks and the relationships with the fingerspelling, working memory, and receptive ASL measures, the two food fluency measures both produced significant correlations with other measures of executive functioning. Both correlated moderately with at least one score on the Wisconsin Card Sorting Test (WCST) as well as with the Towers of Hanoi.

The correlations between the fluency tasks and the WCST are consistent with the lesion study by Davidson et al. (2008), which found that these two tasks were both affected by lesions to the same frontal lobe structures, although a meta-analysis of lesion studies by Henry and Crawford (2004) suggested that the relationship between the WCST and phonemic fluency should be greater than that for semantic fluency despite conflicting data from some previous research. The fact that the two food fluency tasks both produced moderate, but significant, correlations with the WCST as well as other executive functioning measures suggests that perhaps there is a greater involvement of the executive control system for this type of semantic fluency task than is typical for this task as well as compared to the current animal fluency task. It is possible that this is related to the stronger relationships with the academic and English literacy measures seen with the food compared to the animal fluency task. Additional analysis of the current data might investigate the possibility that higher levels of fingerspelled responses, which might recruit more English-oriented strategies, were produced for this category than for the animal category. Clearly, while these tasks involve many shared cognitive processes and skills, they also tap unique aspects of cognitive functioning.

Table 8.6 F–A–S Food—significant correlations

Test	*r*	*N*
WJ-III Reading Fluency	0.55**	46
WJ-III Writing Fluency	0.52**	46
WJ-III Academic Knowledge	0.34**	46
WJ-III Passage Comprehension	0.48**	47
PIAT Reading	0.55**	47
WCST Total Correct	0.35*	35
WCST Categories Completed	0.42*	35
Towers of Hanoi	0.45**	43
F–A–S	0.50**	49
F–A–S Animals	0.65**	49
5–1–U	0.37*	47
5–1–U Animals	0.63**	46
5–1–U Food	0.64**	46
ASL-SRT	0.53**	33
Fingerspelling Test Total Correct	0.59**	49
Fingerspelling Test Real Words	0.57**	49
Fingerspelling Test Fake Word	0.57**	49
TOSWRF	0.39**	46
Print Letter Forward Span	0.39*	36
Print Digit Backward Span	0.31*	45
ASL Letter Forward Span	0.35**	49
ASL Letter Backward Span	0.39**	49
ASL Digit Backward Span	0.34**	49

**Significance at $p<0.01$, *significance at $p<0.05$

Summary of Linguistic Fluency

The measures of linguistic fluency correlated with a wide range of measures, with a primary focus on language (both English and ASL) and literacy related tasks. While the sign-based phonemic task correlated with a narrower range of measures than the English-based phonemic task and the semantic fluency tasks, it did correlate significantly with both the English word-based fingerspelling task and the writing measure, suggesting an underlying linguistic mechanism which can be accessed using either speech- or sign-based strategies. One of the more interesting outcomes was the apparent subtle impact of priming with either the speech- or sign-based phonemic tasks on the strategies used for the semantic fluency tasks. The outcomes were comparable for the two tasks, as reflected in the near identical means and standard deviations for the two administrations of both the food and animal fluency tasks. However, the correlations suggest somewhat more English-oriented associations with the tasks administered following the English-based F–A–S task, and more sign-oriented and visual associations with the semantic tasks administered immediately following the sign-based 5–1–U task. The equivalent outcomes suggest that the search strategies employed are equally effective for semantic searches. This is a fascinating outcome and is worthy of future investigation.

Table 8.7 5–1–U Food—significant correlations

Test	*r*	*N*
WJ-III Reading Fluency	0.64**	45
WJ-III Writing Fluency	0.51**	45
WJ-III Passage Comprehension	0.48**	44
PIAT Reading	0.50**	46
WCST Total Correct	0.37*	35
Towers of Hanoi	0.37*	42
F–A–S	0.55**	46
F–A–S Animals	0.45**	46
F–A–S Food	0.64**	46
5–1–U	0.41**	46
5–1–U Animals	0.66**	46
M-SVLT List B Recall	0.31*	46
M-SVLT Cued Recall	0.46**	45
M-SVLT Delayed List A Free Recall	0.41**	45
M-SVLT Recognition Number Correct	0.47**	44
ASL-SRT	0.55**	31
Fingerspelling Test Total Correct	0.55**	46
Fingerspelling Test Real Words	0.56**	46
Fingerspelling Test Fake Words	0.50**	46
TOSWRF	0.43**	45
Print Letter Forward Span	0.36*	35
Corsi Blocks Manual Backward Span	0.41**	46
ASL Letter Forward Span	0.33*	46
ASL Letter Backward Span	0.39**	46

**Significance at $p<0.01$, *significance at $p<0.05$

In addition to the language and literacy connection, the linguistic fluency tasks also produced consistent relationships with measures of short-term/working memory, especially the linguistic forms of these tasks. This is not surprising as the linguistic fluency tasks employ working memory during the search and retrieval process. Additionally, most of the tasks yielded significant correlations with one or more measures of executive functioning. This is consistent with the traditional use of verbal fluency tasks as measures of executive functioning and suggests that this relationship holds for this population.

While further work needs to be done, it appears that (1) signing deaf individuals will likely produce fewer words than their English-speaking hearing peers on measures of English phonemic fluency, (2) the sign-based phonemic fluency task shows promise as a more appropriate measure of overall phonemic fluency in signing deaf individuals, and (3) although the underlying strategies being used may vary, outcomes of semantic fluency tasks appear to be consistent regardless of whether they follow sign- or speech-based measures. While these data do not provide norms for clinical interpretation, they do provide guidance for clinicians who are aware of the issues related to working with deaf individuals and could be used as supportive data in careful clinical practice as well as research.

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