

On Language Deficits and Modality in Children With Down Syndrome: A Case Study of Twins Bilingual in BSL and English

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It has been suggested that there may be an age advantage for the acquisition of sign language relative to spoken language for two reasons: (1) language in the visual-motor modality may be easier to access, recall, and produce than language in the auditory-vocal modality and (2) the continuity in form between gesture and sign language may promote the transition from prelinguistic to linguistic communication. These suggestions have provided the impetus for many language intervention programs for children with intellectual impairments. This article reports on hearing identical twins with Down syndrome who have Deaf parents. The twins are bilingual, having been exposed since infancy to both English and British Sign Language. Analyses of tests and spontaneous data reveal a high degree of fluency in gesture but impairments in both languages, suggesting that the fundamental problems of children with Down syndrome are not modality-specific and that there are discontinuities between gesture and language.

British Sign Language (BSL) is one of the natural languages of Deaf people. Manual signs taken from these natural languages are used extensively with people who are not deaf, but who have difficulties with the reception or production of spoken language. These include a large proportion of the population of children and adults who have intellectual impairments (Kiernan,

This research was funded by a grant from the Down's Syndrome Association. We thank the Down's Syndrome Association, Professor Sue Buckley of the University of Portsmouth, The Sarah Duffen Centre in Portsmouth, Carolyn Edwards, Ruthie, Sally, their parents, teachers, and speech therapist. Correspondence should be sent to Bencie Woll, Sign Language and Deaf Studies, Department of Clinical Communications Studies, City University, London EC1V 0HB, England (e-mail: b.woll@city.ac.uk).

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Reid, & Jones, 1982). The rationale underlying the use of sign is that the visual-motor modality is easier to access, recall, and produce than the auditory-vocal modality. In particular, children with Down syndrome (DS) may make more progress with signing, because of the nature of their specific linguistic problems. The question is whether the modality is more accessible, or the linguistic system underlying it. If, as has been suggested, the primary problem for the child with DS concerns the perception and production of spoken language, maybe a visual-spatial language would be intrinsically easier to acquire.

It has been difficult to resolve this issue, because the conditions under which children with intellectual impairments acquire signs are generally very unfavorable; the input is limited and inconsistent and often restricted to teaching contexts. Frequently, signing is only offered as a "means of last resort" when speech fails (Grove & McDougall, 1991). Exceptions are the programs that introduce signs to babies or toddlers with DS (Abrahamsen, Lamb, Brown-Williams, & McCarthy, 1990), but even in these cases, children are not exposed to fluent input from a native user of sign language. Assessment of the potential for developing a visual-spatial linguistic system in this population is therefore problematic. Thus, a case of a child with DS exposed to fluent models of both signed and spoken language would enable us to explore this question.

The current study involves the unique case of hearing twins with DS who are bilingual in speech and sign

because their parents are Deaf native users of BSL. Although this research is still in its earliest stages, the results are highly relevant to two topical debates in the fields of psychology and linguistics: (1) the question of processing problems in DS—both within and between modalities, and (2) the question of the relative rate of acquisition and mastery of specific linguistic structures in signed and spoken language.

Language Difficulties in DS

The language difficulties associated with DS have been investigated for many years. Specific deficits exist in both comprehension and production of the computational, formal aspects of language—phonology and morpho-syntax—whereas lexical, semantic, and pragmatic aspects of language are less impaired. The reasons for this disassociation are now thought to lie at the level of information processing, but there is still some uncertainty about the precise nature of the difficulty. The various hypotheses advanced in explanation include: a specific linguistic deficit, a generalized sequential processing deficit, and an auditory-vocal processing deficit.

Specific linguistic deficit. There are consistent reports of difficulties in the acquisition and generalization of particular rules or parameters affecting complex sentence structure. Most individuals with DS seem to plateau at a very early level of simple sentences (Chapman 1995; Fowler, Gelman, & Gleitman, 1994; Fowler, 1995). However, recent evidence that exceptional individuals can produce and comprehend complex sentences (Rondal, 1994; Vallar & Papagno, 1993) suggests that a linguistic deficit is not inevitably associated with the syndrome.

Sequential processing deficit. Some researchers argue that people with DS have particular problems with sequential processing (Hodapp, Leekman, Dykens, & Sparrow, 1992; Molina & Perez, 1993; Rosin, Swift, Bless, & Verter, 1988). Other findings suggest that the difficulties lie with the retrieval and storage of information, rather than with linear sequencing (Kay-Rainingbird & Chapman, 1994; Pueschel, Gallagher, Zartler, & Pezzullo, 1987; Varnhagen & Varnhagen, 1987).

Auditory-vocal processing deficit. Individuals with DS typically show a pattern of higher abilities in the visual-spatial/visual-motor modality than in the auditory-vocal modality (Chapman, 1995; Fowler, et al., 1994). The focus of the problem appears to be in the area of short-term auditory recall and the function of the phonological loop mechanism thought to support sub-vocal rehearsal (Bower & Hayes, 1994; Kay-Rainingbird & Chapman, 1994; Marcell & Weekes, 1992; Varnhagen, Das, & Varnhagen, 1987). Currently, there seems to be broad agreement that the third explanation is the most plausible—that is, a specific deficit involving the perception, planning, and production of speech. Other variables, such as the quality of linguistic input and the organic structural impairments characteristic of the syndrome, are now thought to be contributory, but not primary causes of language delays and difficulties (Chapman, 1995). If the foregoing arguments are correct, the outlook for children with DS who have the opportunity to acquire a visual-spatial language is highly optimistic. If the problems affecting linguistic development specifically affect the perception and production of speech, and visual and motor modalities are relatively unimpaired, no serious problems would be anticipated in the acquisition of sign language. If, however, the problems relate to linguistic, as opposed to more general cognitive abilities, then delays and difficulties should be seen in language, regardless of modality. In a child with DS who has been exposed simultaneously to spoken and signed language from birth, it should be possible to isolate these effects.

The Twins and Their Family

The twins were born in May 1985. Both parents are deaf and members of the Deaf community. The mother was deafened at the age of seven from meningitis, and the father's deafness is of unknown etiology. Both parents are the only deaf members of their respective families and attended residential schools for the deaf. The mother was 37 at the time of the twins' birth, and there is one older brother, who is hearing and has no learning disabilities.

The twins are monozygotic (identical) and have been diagnosed as having Mosaic DS. Their hearing and sight is within the normal range, although both

have had transitory conductive losses, and both have glasses. Sally is predominantly left-handed, but with some cross-over; Ruthie is right-handed. The twins are being educated in a mainstream setting, attached to a unit for children with special needs in their local primary school. They have no contact with deaf children at school, although they have occasional contact with signing children of deaf parents at the local Deaf club.

The existence of the twins came to our attention only in 1993, when they were eight, and the research project began in 1994, with data collection beginning in 1995 just after their tenth birthday and planned to continue, should funding permit. Data of spontaneous interaction with different conversational partners and test data have been obtained in both their school and at home. Recordings at home and sign language tests are undertaken by a Deaf researcher, while school recordings and English tests are undertaken by a hearing researcher. The Deaf researcher is a fifth-generation native signer. She uses BSL with no voice, but with appropriate BSL mouth patterns, and communicated in this way during data collection. The hearing researcher is a native speaker of English, who used no signs or iconic gestures during data collection.

Background

The twins are "functionally bilingual." In the presence of their parents and other deaf people they mostly use BSL without voice, although in such contexts they occasionally address English-only utterances to each other (these appear to function as private asides). They also produce occasional single-word English-only utterances and utterances produced with simultaneous sign and voice addressed to their parents. In the presence of hearing children and adults and when playing together, they use English. We have very occasionally observed signs accompanying English in school and frequent use of gestures accompanying English. They have not been observed to use BSL with each other when there are no deaf adults present. In this sense, English appears to be their dominant language. Both parents appear to use more voice when signing than the twins do. Most BSL utterances are accompanied by silent mouthing; however, the order of the mouthed words corresponds to the sign order and not to English.

Table 1 Test Results (English) with mental age equivalents

Test	Sally	Ruthie
SON (nonverbal IQ)	5;8	5;3
BPVS (receptive vocabulary)	3;7	3;1
TROG (receptive grammar)	4;0	<4;0
EAT (articulation)	5;6	4;0
ITPA auditory memory	3;0	2;5
visual memory	4;4	3;7
manual expression	4;10	5;6

They occasionally mouth words that are not signed, but these are not voiced. For example, in response to a request to describe a picture of a teddy bear on a box, they produced the following:

<i>SALLY</i>	BOX	SIT	TEDDY
sign			
mouth	<i>box</i>	<i>sit</i>	<i>teddy</i>
<i>RUTHIE</i>	BOX		TEDDY
sign			
mouth	<i>box</i>		<i>teddy</i>

English and Non-verbal Test Data.

The twins were tested (Table 1) using a battery of instruments designed to measure the following: non-verbal intelligence—The Snijders-Oomen Test of Non-verbal Intelligence (SON) (Snijders & Snijders-Oomen, 1976); receptive vocabulary and grammatical structure—The British Picture Vocabulary Scale (BPVS) (Dunn, Whetton, & Pintillie, 1982) and the Test of Reception of Grammar (TROG) (Bishop, 1989); articulation of single words—Edinburgh Articulation Test (EAT) (Anthony, Bogle, Ingram, & McIsaac, 1971); auditory memory, visual memory, and gestural expression—Illinois Test of Psycholinguistic Abilities (ITPA) (Kirk, McCarthy, & Kirk, 1982). These tests were administered by the hearing researcher, using spoken language.

Assessments of the twins' verbal and nonverbal ability show that nonverbal cognitive skills are in advance of their verbal skills (see Table 1). Sally's scores are consistently higher than Ruthie's, except for manual gesture. On comprehension measures of vocabulary (BPVS) and grammar (TROG), they are functioning between the level of three and four years. Using the

Table 2 Examples of BSL utterances

	Sally			Ruthie	
"cup on table"					
sign	TABLE	ON	CUP		ON
mouth	<i>table</i>	<i>on</i>	<i>cup</i>		<i>table</i>
other notes		left hand	righthand		
"ball under table"					
sign	UNDER	TABLE	UNDER	BALL	UNDER
mouth	<i>under</i>	<i>table</i>	<i>under</i>	<i>ball</i>	<i>table</i>
other notes		location of under	location of table		

Mean Length Utterance (MLU) stages of development originally proposed by Brown (1972), analysis of their spontaneous speech suggests that Sally is functioning at approximately MLU Stage III, and Ruthie at Stage II. Both show evidence of developing morphology and simple syntax in a range of English structures, including negation, plurals, locative constructions, and interrogatives. Their use of word order follows English, although their sentences are often telegraphic. These examples show utterances containing locative expressions: *Sally*: hay on it; going-back a class; R. sat down on a bench; I sit there; on there; she[’s] sat down on the road; I got baby on the train; and *Ruthie*: on a train; we sit in it; up sky; in the bathroom; what’s in here?; put in that one; on the table; that goes in there; her going in a bathroom. And these examples show plural expressions: *Sally*: got sandwiches; I got blue bands (i.e., on hair); they play the games; sunglasses; and *Ruthie*: sandwiches; there’s flowers; slippers; magics (overgeneralized plural = “magic things”).

Articulation scores (EAT) for words in isolation are high relative to other measures, but continuous speech is less intelligible than these scores would predict. Overall, the pattern of scores suggests that, as might be expected, visual and motor skills are relative strengths for both girls.

BSL Data

The discussion here is based on preliminary analyses of pilot test data. The test is part of a larger test currently being developed for assessing BSL acquisition that is not yet finalized or standardized.

The test was administered in the twins’ home by a Deaf researcher who is a native signer. Each child was

tested separately. Both receptive and expressive skills were tested. The test included the following sections that will be discussed in this article: spatial relations, physical attributes (size and shape), distribution and number (plurals), noun/verb derivational morphology.

Sally has a longer MLU and more developed BSL than Ruthie. This can be seen in comparing their responses to the same test items. Many of Ruthie’s two-item utterances consist of a lexical sign + mouthed word articulated sequentially or a lexical sign + point, whereas Sally’s two-sign utterances are all lexical sign + lexical sign. Even the most preliminary analyses of their BSL reveal that no advantage for BSL over English is present (see Table 2).

Spatial relationships. Static spatial relationships in BSL are expressed by locating signs in spatial relationship to each other, for example, TABLE BALL (ball on table) or TABLE CUP UNDER (cup under table); these can also be viewed as part of the verb agreement system, with the verb (UNDER) agreeing in location with its noun argument(s). Sign language acquisition research suggests that agreement with real-world locations is acquired by 3;0 to 3;6.

In the expressive section, the twins were asked either to describe one of four similar pictures (for example, a table with a knife underneath, a table with a cup underneath, a chair with a cup underneath, and a table with a cup on top) or to describe one character in a complex picture (for example, a cupboard with one cat on top, one cat inside, and one cat at the side of the cupboard). Neither Sally nor Ruthie has full mastery of the adult system; some of Sally’s and many of Ruthie’s responses omit the spatial relationship completely; in others, they use separate lexical signs such as IN-

Table 3 Examples of the twins' static locative utterances (BSL test data)

	Sally	Ruthie
"cat in cupboard"		
sign	IN CUPBOARD	CUPBOARD CAT
mouth	<i>in cupboard</i>	<i>cupboard</i>
"girl on box"		
sign	SIT BOX ON	ON BOX
mouth	<i>sit box on</i>	<i>on box</i>

Table 4 Marking of spatial relationships through sign location

	Sally	Ruthie
"cup on table"		
sign	TABLE ON CUP	ON
mouth	<i>table on cup</i>	<i>table</i>
other notes		left hand right hand
"man in front of wall"		
sign	BOY STAND WALL IN-FRONT	STAND
mouth	<i>boy stand wall</i>	<i>stand man</i>
other notes		right hand, location of wall

FRONT and ON, rather than representing the spatial relationships directly (see Tables 3 and 4). Sally does mark some spatial relationships through the location of signs, whereas Ruthie produced no examples of this.

Physical attributes (size and shape). In BSL, many attributes of size and shape are expressed by modifications to the size and shape of the base sign (for example, BIG-TABLE, SMALL-BALL). Other attributes of size and shape require a separate lexical sign (BIG TEACUP, SMALL TEACUP). In this section of the test, the twins were asked to select (receptive task) or describe (productive task) one of four similar pictures (e.g., BIG TABLE, LITTLE TABLE, BIG BOX, LITTLE BOX). Sally selects the appropriate form of modification in each case (see Table 5). Ruthie has two structures: She has some lexical signs such as WIDE, and she modifies size and shape (sometimes correctly and sometimes incorrectly).

Distribution and number (plurals). In BSL, nouns that are not body-anchored inflect to indicate number and distribution (for example, CHILD:CHILDREN; FORK:

FORKS-IN-A-ROW). The twins were asked to describe one of a set of three or four pictures (e.g., a shoe, pairs of shoes in a row, cars in a row). Both Sally and Ruthie performed extremely poorly on this task, although Sally did produce one attempt to indicate distribution. She also attempted to contrast "many people standing at a bus stop" with "one person standing" by using the signs WALKING and STAND, respectively (3 & 4). Ruthie was unable to produce any correct plural forms (see Table 6).

Noun-verb distinctions (derivational morphology). As in American Sign Language (ASL), in BSL nouns for concrete objects and verbs for the associated actions performed with these objects frequently share the same stem, but are distinguished by derivational morphemes with contrasting movement and manner of articulation (CAR versus DRIVE). Although there has been no research on age of acquisition for noun-verb distinctions in BSL, ASL research (Launer, 1982) suggests that by 3;0-4;0, 71% of productions show partial or full adult morphology. In this section of the test, the twins were asked to select or describe one item from a set of three pictures. One was of the noun (e.g., SCISSORS), one

Table 5 Examples of the twins' physical attribute (size and shape) utterances (BSL test data)

	Sally		Ruthie
"big house"			
sign	WIDE		WIDE
mouth			
"short woman"			
sign	SHORT		SHORT
mouth	<i>short</i>	<i>woman</i>	<i>small</i>
"small ball"			
sign	SMALL	BALL	NA
mouth	<i>small</i>	<i>ball</i>	
"small cup"			
sign	CUP	SMALL	SMALL-CIRCLE
mouth	<i>cup</i>	<i>small</i>	<i>small</i>
"big cup"			
sign	BIG	CUP	BIG-CIRCLE
mouth	<i>big</i>	<i>cup</i>	<i>big</i>
"small table"			
sign	SMALL	SMALL-TABLE	NA
mouth	<i>tiny</i>		
"small box"			
sign	SMALL-BOX		SMALL-BOX
mouth			<i>little box</i>

was of the associated action (CUT PAPER), and one was a visually similar sign in BSL (e.g., WALK). Ruthie and Sally both show near complete mastery of this system, with 5/6 correct items on the receptive task and 4/6 correct on the productive task (see Table 7).

Discussion

We have described four areas of morpho-syntax in BSL for these two children: static spatial relations, physical attributes, number and distribution, and noun/verb derivational morphology. Each one of these requires mastery of different elements as indicated in Table 8.

As can be seen from the table, the morpho-syntax of spatial relationship and number/distribution both require marking of location, whereas physical attributes and noun/verb distinctions do not. Physical attributes and spatial relationships can also be (partly) signaled by use of lexical items. Sally, who is cognitively more able than her twin, has mastered those sys-

tems that do not require marking of location and has partly mastered spatial relationships, largely through the use of lexical signs. Ruthie has mastered noun/verb distinctions, which require no marking of location, and has partially mastered physical attributes, through the use of lexical signs and manner of articulation. Neither twin has mastered number/distribution, which requires spatial location and for which neither lexical items nor manner of articulation is available.

The different sets of problems and strengths in the development of the spoken English of the twins and the development of their BSL may arise from differences in how the languages realize particular formal structures. Their English plurals are generally well-developed (although with some overgeneralizations) by the twins, whereas structures with comparable functions (distribution/number) but very different structures in BSL are not. Among possible explanations are (1) difficulties with processing those structures requiring simultaneous marking of morphology (hence the preference for lexical marking), (2) difficulties with

Table 6 Examples of the twins' distribution and number utterances (BSL test data)

	Sally	Ruthie
"alphabet bricks"		
sign	BRICK	STACK
mouth	<i>bricks</i>	
"people standing in a line"		
sign	WALK [cont.]	NA
mouth	<i>walking</i>	
"1 person"		
sign	STAND	NA
mouth	<i>stand</i>	
"pairs of shoes in a row"		
sign		
mouth		<i>shoe</i>

Table 7 Examples of the twins' derivational inflection utterances (nouns/verbs) (BSL test data)

	Sally		Ruthie	
"drink"				
sign	DRINK		DRINK	BLACK C
mouth	<i>drink</i>		<i>drink</i>	<i>blackcurrant</i>
movement	enlarged, slow		slow	
"cut"				
sign	CUT	PAPER	CUT	PAPER
mouth	<i>cut</i>	<i>paper</i>	<i>cut</i>	<i>paper</i>
movement	single		single	
"pencil"				
sign	PENCIL			PENCIL
mouth	<i>pencil</i>			<i>pencil</i>
movement	restricted, repeated			restricted, repeated
"bicycle"				
sign	BICYCLE		RED	BICYCLE
mouth	<i>bicycle</i>			
movement	restricted, repeated			restricted, repeated

Table 8 BSL morpho-syntax mastery of system, manner of articulation, marking of location(s), and available lexical item(s)

System	Manner of articulation	Marking of location(s)	Available lexical item(s)	Sally's mastery of system	Ruthie's mastery of system
Spatial relationships	no	yes	yes	partial	no
Physical attributes	yes	no	yes	yes	partial
Number/distribution	no	yes	no	no	no
Noun/verb distinction	yes	no	no	yes	yes

handling three-dimensional representations of space (recent studies of children with DS have reported impaired spatial representational abilities). Although children with DS use gestures freely, these may not exhibit the sorts of spatial representations required by a sign language.

Although it is impossible at this stage to give definite explanations for the language impairments of children with DS, recent studies of children with DS suggest that although their visual-spatial skills are generally more advanced than their auditory-vocal skills, there may be impairments in the area of spatial representation (Uecker, Mangan, Obrzut, & Nadel, 1993; Vallar & Papagno, 1993). This has implications for the design of intervention programs that use manual sign with nondeaf populations, since it may be necessary to evaluate the separate contributions of the modality, the lexicon, and the grammar to the child's developing communication (see Grove, Dockrell, & Woll, 1996).

In conclusion, this study has shown that children with DS apparently find the linguistic system of a sign language no easier to master than that of a spoken language. Indeed, in many respects, although their earliest exposure was to BSL, they show a preference for English. This finding challenges the predictions that derive from the research literature, and from current intervention practice with this group of children. Regarding the relationship between modalities and language, the findings reinforce the arguments for discontinuity between gesture and language. They also demonstrate that ease of access to production and perception of a language pose a different issue from acquisition. Further studies of the twins' gestures, nonverbal spatial cognitive abilities, English, and BSL will help illuminate the cognitive and linguistic capacities of

children with DS and the relationship of language and modality.

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