1 Introducing Christopher

Every once in a while Nature gives us insight into the human condition by providing us with a unique case whose special properties illumine the species as a whole. Christopher is such an example. On first inspection his fate may not seem fortunate. Because he is unable to look after himself, he lives in sheltered accommodation; on a variety of standard tests of intelligence he scores poorly, with particular difficulty on non-verbal tests; his horizons seem to be limited to the performing of routine tasks of a non-demanding nature. His life looks sadly circumscribed. Until one turns to language.

Despite his disabilities, which mean that everyday tasks are burdensome chores, Christopher is a linguistic wonder: with varying degrees of fluency, he can read, write, speak, understand and translate more than twenty languages. Playing noughts and crosses is beyond him, but interpreting between German and Spanish is easy; he doesn't understand the kind of make-believe play that 3- or 4-year-old children indulge in – pretending that a banana is a telephone for instance – but he learns new languages, from Berber to Welsh, with enviable ease. His drawing ability indicates a severely low IQ of between 40 and 60 (a level hinting at ineducability), yet his English language ability indicates a superior IQ in excess of 120 (a level more than sufficient to enter University). Christopher is a savant, someone with an island of startling talent in a sea of inability.

1.1 Personal background

Christopher was born in England on 6 January 1962, the youngest – by about ten years – of five children: he has two brothers and two sisters. His mother was 45 years old at the time of his birth, and the pregnancy was not without complications. However, there is no clear link between these problems and his later physical and mental condition. He was diagnosed as brain-damaged at the age of six weeks, and he was late in walking and talking. In addition, he has a minor speech disfluency which masked his early talent and still makes it hard for those not used to him to understand what he says. Throughout his childhood his mother and father, now both deceased,[1] fought strenuously for

Table 1 *Christopher's performance on formal psychological tests (Morgan* et al.*, 2002a: 3)*

Raven's matrices [Administered at ages 14 and 32]	75	76
Wechsler Scale – WISC-R, UK [Administered at age 13.8]	42 (performance)	89 (verbal)
Wechsler Adult Intelligence Scale [Administered at age 27.2]	52 (performance)	98 (verbal)
Columbia Greystone Mental Maturity Scale [Administered at age 29.2]	56	
Goodenough *Draw a Man Test* [Administered at ages 14 and 32]	40	63

In a multi-lingual version of the Peabody Picture Vocabulary Test, administered at age 28, (O'Connor & Hermelin, 1991), Christopher scored: English 121; German 114; French 110; Spanish 89.

him to be accorded the special provision his talents and limitations required. His brothers and sisters have also systematically cared for him and provided an enriched and loving environment for him to live in. He regularly visits them in their homes and is taken on holidays both in the UK and abroad. Since 1988 he has lived in a Camphill Community home, where 'those with developmental disabilities can live, learn and work with others in an atmosphere of care and respect' (www.camphill.org.uk/) and where emphasis is laid on preserving the residents' human dignity and enhancing their quality of life.

1.2 Psychological profile

The most striking characteristic of Christopher's psycholinguistic profile is the asymmetry between his verbal and non-verbal abilities. As indicated in table 1 above (taken from Morgan *et al.*, 2002a: 3), there is a striking mismatch between these two halves of his performance.[2] The different figures show his performance on different occasions (the average is in each case 100).

An explicit indication of the interaction of his visual and artistic abilities is provided by his performance on the Rey-Osterrieth complex figure test of visual memory (fig. 1a). His copying of the figure was not without problem (his attempt is shown in fig. 1b), but his drawing of it from memory immediately afterwards (fig. 1c) was extremely poor.

A more intuitive idea of Christopher's artistic abilities can be derived from his picture in fig. 2 of two of the authors (reproduced from Smith & Tsimpli, 1995: 6).

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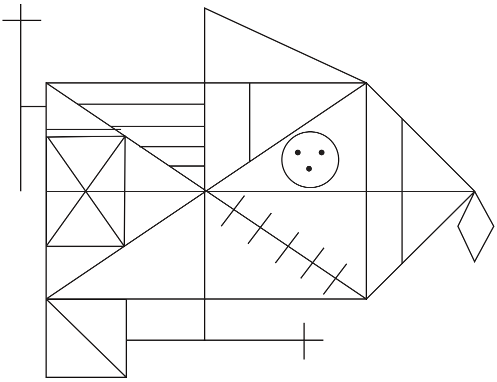

Figure 1a Rey-Osterrieth complex figure test of visual memory

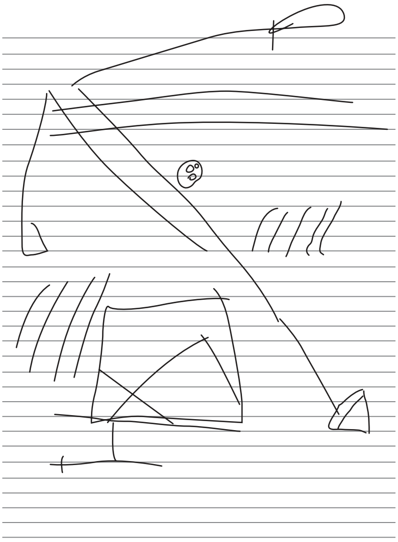

Figure 1b Christopher's copy of the Rey-Osterrieth complex figure test

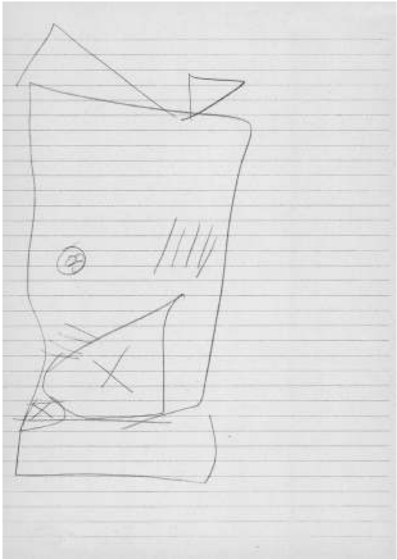

Figure 1c Christopher's drawing from memory of the Rey-Osterrieth complex figure test

Christopher's predilection for the verbal has previously manifested itself in his obsessive acquisition of a large number of spoken languages, but is borne out by two further tests. The first of these is a variant of the Gollin figures test (Smith & Tsimpli, 1995: 8–12) on which he was strikingly better at identifying words (in either Greek or English) than objects. The second is Warrington's (1984) test comparing ability to recognise faces and words. Christopher scored

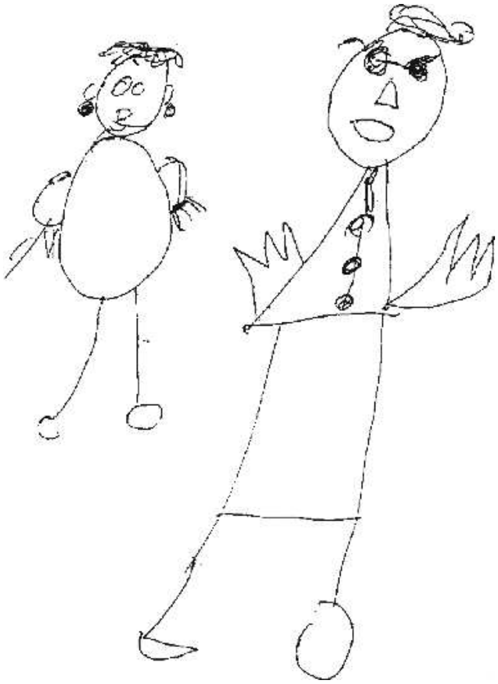

Figure 2 Christopher's drawing of Ianthi and Neil

within normal limits on words, but performed too badly to score at all on faces (section 1.4 below). One of the major aims of the present book is to see if this verbal talent generalises to a signed language, but first we need to present a little more background material.

1.3 Medical background

Christopher's medical background is not as clear as one might wish. As mentioned above, he was born when his mother was 45 years old. Early in pregnancy she had contracted German measles, and towards the end of pregnancy she had a bad fall. Moreover, the delivery was long and difficult and the nurses sent for oxygen, presumably because of foetal distress, though this is not made clear in the records. Apart from the early suggestion that he was brain-damaged at birth, later institutional records suggest hydrocephaly (an abnormal build-up of cerebrospinal fluid in the brain), and an EEG carried out at age 13 revealed some oddities. A year later 'his intra-cranial pressure showed no abnormality but in 1982, at age 20, he was diagnosed as "possibly having hydrocephalic brain damage and severe neurological impairment of his motor coordination, amounting to apraxia" ' (O'Connor & Hermelin, 1991: 675). In 1993 he had an MRI scan which revealed 'moderate cerebral atrophy . . . and the cerebellar vermis [was] hypoplastic' (O'Connor *et al.*, 1994: 105). Such a configuration is not atypical of high-functioning autists, but there is no obvious connection between cerebellar hypoplasia and Christopher's unique combination of talents and disabilities. Indeed, while pathologies of various kinds can often be traced to particular patterns of neuro-anatomical abnormality, talents are generally unamenable to such explanation. Moreover, it seems unlikely that the range of characteristics found in the autistic spectrum is reducible to any single aetiology (see e.g. Happé & Vital, 2009). We return to the issue in ch. 5 where we compare Christopher with a number of other unusual cases.

1.3.1 Autism and perspective

In order to interact appropriately with other people, it is essential that you be able to adopt their point of view: saying 'Look at the picture' to someone whose line of sight is obstructed is an invitation to frustration. But this merely physical point of view is only a very small part of being able to appreciate someone else's point of view in the (more usual) metaphorical sense. If your partner agrees to fetch your keys from the kitchen, and you know that they are in the bedroom, you had better clarify the situation. Here the problem revolves around different assumptions about how the world is, and it is a commonplace that such disagreements are pervasive. But how do you interact with someone whose perception of reality differs from yours? The simple answer is that you entertain the relevant proposition and attribute it to them as a second-order representation or 'metarepresentation': 'I know that the keys are in the bedroom but Ann thinks the keys are in the kitchen.' What you do is then a separate matter: you can tell her, leave her to find out for herself, or whatever. This simple answer relies on your having a theory of (other) minds. But if you can't adopt someone else's point of view in this way, you have problems. There are two categories of people in this position: children up to the age of 3 or so,[3] and people with autism. The classic way of showing this is by tests in which the subject has to impute a 'false belief' to some individual.[4] This can be most simply illustrated by the 'Sally-Anne' and 'Smarties' tasks.

In one version of the Sally-Anne test, the subject and another observer watch while the experimenter hides a toy. The observer is then sent out of the room and, in full view of the subject, the toy is moved from its first position and hidden in a new position. After ensuring that the subject was aware of where the toy was first hidden and of when the observer was last present, he or she is then asked where the observer will look for the toy on returning to the room. From about the age of 4, normal people indicate the first hiding place. Children under the age of 4, and autistic subjects, usually indicate the second hiding place, *where the toy actually is*. In the Smarties test, subjects are shown a Smarties container (a well-known chocolate candy) and asked what they think is in it. When they reply ‘Smarties’, they are shown that it really contains a pencil, and are then asked what their friends across the room will think is in it when they are asked. Again, very young children and autists typically reply ‘a pencil’; older children, of course, reply correctly ‘Smarties’. That is, young children, and autists, are unable to entertain the idea that someone else could have a representation of the world which deviates from reality, they cannot understand ‘false belief’.

Christopher has never been formally diagnosed as autistic, but it is clear that he has a number of the characteristics of autism. Apart from his obsession with languages, a domain of interest which is markedly unusual, perhaps unique, for savants, he is extremely laconic in his interactions with other people, he is emotionally opaque – so that it is extremely difficult to gauge his feelings, and he is socially unforthcoming, typically failing to make eye contact and barely indulging in the normal rituals associated with meetings and leave-takings. More importantly, on formal tests of the ability to impute false belief to others, he shows a mixed profile, failing various forms of the ‘Sally-Anne’ test, but passing variants of the ‘Smarties’ test. In Tsimpli & Smith (1998) we pursued this issue in some detail and we return to it in section 1.4.4.1 below.

In addition to having problems with false belief, many, perhaps most, autistic children have impairments in the imitation of movements amounting to apraxia (see e.g. Baranek *et al.*, 2005). As a result, there are domains in which they are not good learners. As the acquisition of a sign language necessarily involves such imitation we would anticipate that autists should find the task more difficult than the general population.

1.3.2 Apraxia and the visuo-spatial

Some of the differences in Christopher’s achievements on ‘verbal’ and ‘performance’ tests are a partial function of his mild autism, with his poor performance scores being exacerbated by a visuo-spatial deficit and apraxia. How far such impairments are independent is an interesting, if vexed, issue: Maguire (2008) notes that spatial navigation, the imagination of fictional states of affairs, and the prediction of future events (all of which cause Christopher problems) all involve the same neural substrate. Christopher is myopic and probably astigmatic; he has difficulty finding his way around and is quite severely apraxic. On an adaptation of the Boston Diagnostic Aphasia Examination (Goodglass & Kaplan, 1972, described in Poizner *et al.*, 1987), where the subject has to follow instructions such as ‘show me how you chew something’, ‘wave goodbye’, ‘write your name’, etc., Christopher scored twelve out of thirteen correct.

His one incorrect response was his reaction to ‘move your eyes up’, where he instead tilted his whole head back. However, on the Kimura movement copy test of non-representational gesture (Kimura, 1982), he scored extremely poorly, getting seven points (29%) with his right hand and none with his left hand. In this test, the subject has to imitate meaningless sequences of gestures involving only one hand and arm. For example, the first sequence begins with the arm positioned across the body with the hand in front of the opposite shoulder and the fingers spread apart. From this position the arm moves steadily across the front of the body to an outstretched position on the opposite side to the beginning of the movement. As the arm moves across, the fingers move from the spread position to touching each other. Two points are scored if the movement is copied correctly on the first trial; one point if it is copied correctly on the second trial, and no points if it is incorrect on both trials. A score below 90 per cent is considered apraxic. Comparable results were obtained in tests of motor coordination and praxis.[5] On tests of grip force Christopher performed normally, except that when the load force was increased unpredictably there was a delay in his latency increase. The tests involved holding an object such as a pen stable in a ‘precision grip’ between the thumb and the opposing index and middle fingers. It is plausible that this might be a reflection of cerebellar dysfunction, a conclusion compatible with the MRI results obtained some years previously (O’Connor *et al.*, 1994). On tests of praxis Christopher was able to recognise conventional movements (such as using a comb or scissors, or waving good-bye) at a normal level. In contrast, his ability to ‘show how he would carry out a movement’, such as using a comb or a teapot, (but without touching them) was impaired. With the actual use of the objects his performance was enhanced but there were still signs of object misuse. In the imitation of movements (such as blowing, shaving or smiling) his performance was very impaired. He was unable to reproduce the fine details of movement and there was considerable distortion, especially when the movements were complex, involving timing, sequencing and spatial organisation of the limbs. In addition, there was a marked lack of buccofacial expression. The results were even worse when it came to the copying of meaningless movements (touching his right hand to his neck, describing a circle with his foot, holding his hands parallel to the front while putting his right leg a step back). Altogether he scored nineteen out of a possible fifty-four, where this maximal higher score would normally be achieved by an adult of his age.

Christopher is a strikingly good learner when it comes to spoken languages, but his visuo-spatial deficit could affect his perception of sign, leading to incomplete or incorrect representation of signs; his autism could seriously limit his ability to imitate limb movements; and his severe apraxia would be expected to cause considerable problems in his production of a signed language. The auguries for the learning of BSL do not look very good.

1.4 Theoretical background

In order to make sense of Christopher's skewed abilities, we need to make a number of theoretical assumptions: about the nature of the language faculty; about the structure of the mind more generally, especially with regard to memory and general intelligence; about the 'theory of mind' which is standardly taken to underlie the problems shown by autistic subjects; about pragmatics; and about first and second language acquisition. We discuss each briefly in turn. More details are provided in some of the earlier work cited, especially Smith & Tsimpli (1995), and the references given there. In a nutshell, we adopt a broadly modular view of cognition and a Chomskyan approach to the language faculty. The details are sketched out immediately, beginning with memory. We have attempted to confront at least some of the technicalities of the relevant literature, so those prepared to take our conclusions on trust are invited to skim.

1.4.1 Memory

It is clear from his remarkable vocabulary in a large number of languages that Christopher must have an excellent long-term memory. He presumably also has a good phonological working memory as there is a correlation between this and native or foreign language vocabulary learning (Papagno *et al.*, 1991; Ellis & Beaton, 1995; Masoura & Gathercole, 1999). Moreover, on formal tests of auditory recognition, visual recognition and temporal order,[6] he performed extremely well. The temporal order task involved us in presenting Christopher with a series of five pictures, each with an auditory label. Two of the five pictures were then shown or named and Christopher had to indicate which of the two he had seen or heard most recently. He made only one error across ten trials.

The test of auditory recognition followed the test of temporal order. He was asked to indicate whether or not he had recently heard each of twenty words, where ten of the words had been used in the previous experiment and ten had not. Christopher made his judgement by pointing to a YES-NO response sheet. He made no errors. The test of visual recognition was similar, but this time Christopher was shown twenty pictures, ten of which had been used in the temporal order task and ten of which had not. He made only one error on this task, failing to recognise the picture of a horse. Even this may not really be a mistake: the picture of the horse had previously been labelled by the experimenter as a 'mustang'. If Christopher was naming each of the pictures during the task and then matching his self-generated auditory label with the auditory labels given by the experimenter and held in memory, then the mismatch between 'horse' and 'mustang' might account for his error. Whether this explanation is correct or not, one error in twenty is very good.

So Christopher clearly has an impressively good memory, but, as with everything else about him, this initial characterisation turns out to be too simplistic. We wish to draw attention to two unusual and somewhat contradictory characteristics of his memory, as both have implications for the investigation of his linguistic and other abilities. The first is a 'delay' effect; the second is a 'speed' effect. The latter is simpler, so we discuss that first. On standard tests of digit span, Christopher tends to perform poorly if the stimulus rate is kept at the usual speed (roughly one item per second). If the stimulus rate is increased, his performance improves dramatically; indeed, to within normal limits. Specifically, on forward recall with the items being read out at a rate of approximately one item per second, Christopher showed a digit span of 4.5; but when the speed was increased to approximately five items per second, his span increased to 8 digits. Presumably he is using a (somewhat impoverished) response buffer to store the information temporarily and the signal fades too rapidly for him to keep track of all the stimuli at the usual rate. This would follow from the kind of account provided by Alan Baddeley, where information from the phonological loop tends to 'fade and become unretrievable after about one-and-a-half to two seconds' (Baddeley, 1997: 52).[7]

More interestingly, on forward recall he sometimes got the order of the digits wrong but recalled them in their correct ascending order. For example, following the presentation of the items in (1a) he recalled them in the order in (1b):

(1)	a	6 8 1 9 7 2	7 4 3 2 8 1
	b	1 2 6 7 8 9	1 2 3 4 7 8

This shows that he has remembered the items and sorted them into a coherent sequence, suggesting that a contributory factor in his behaviour is the semantic content of the stimuli. In tests of digit span there is, deliberately, no linking thread connecting the items to be repeated, whereas in the case of a text or discourse there is a semantic connection that can be retained subconsciously and exploited off-line. Christopher's performance on the digit span task would then appear to be an effect of redintegration[8] 'by which, before output, incomplete phonological traces held in STM [short-term memory] are reconstructed . . . by using knowledge relating to the phonological, lexico-semantic and conceptual properties of specific items' (Jacquemot & Scott, 2006: 482), and clearly shows the tight association but potential dissociability of phonological and semantic memory.

Given Christopher's talent for the verbal, we expected that his performance on a parallel 'letter span' task would show comparable effects of enhancement and redintegration. Accordingly we tested him on sequences of letters at two different speeds in three different conditions. The first series consisted solely of consonants with no obvious relation to a word of English; the second series consisted of consonants arranged so that they could be easily associated with a word of English; the third series consisted of consonants and vowels which moreover formed an anagram[9] of a common English word. Each of the three is illustrated in (2):

(2)	a	F M H Z G C	
	b	R P B L C N	(cf. ‘republican’)
	c	N E H S O T	(cf. ‘honest’)

His performance improved steadily on the three groups. At the slow rate of one item per second his span was 4 for simple consonants as in (2a), 6 for ‘associated’ consonants as in (2b), and 7 for ‘anagrams’ as in (2c). At the faster rate of four or five items per second the corresponding figures improved to 6, 7 and 8 respectively. His mistakes in all conditions consisted typically of transposing letters otherwise correctly remembered: e.g. repeating ‘N C W D P Y Q’ as ‘N C P W D Y Q’. He gave no indication of reorganising the letters (into, say, alphabetical order) in the way he had regularised digits into ascending order, and the only explicit indication of the facilitatory effect of the use of ‘anagrams’ was his spontaneous reaction ‘Bank’ after he had correctly repeated ‘K B A N’.

The picture becomes murkier when we consider the results of a reading span test[10] on which Christopher performed surprisingly badly. The test (adapted from Williams & Möbius, 1997) requires the subject to read aloud sentences that are presented on a computer screen one at a time. As soon as the subject has finished reading one sentence a new one is revealed. The stimuli are grouped into sets of two to six sentences. At the end of a set (e.g. after having read two or three sentences) the subject is asked to recall the final word of each sentence in the set in the correct order. Immediately after the recall, the subject is presented with a yes–no comprehension question on one of the sentences in the set. Christopher’s score was below normal for a native speaker of English and below average even for Chinese speakers of English as a second language. He completed only one trial successfully at level 2, and recalled the words correctly in a second trial but failed to answer the comprehension question. The discrepancy between this and the preceding tests may be a result either of his wavering attention or of the delayed integration of meaning from the sentence’s component parts (see sections 1.4.4.3 and 1.5 below). The results are also comparable with his extremely poor performance on tests of digit span to signed input and of letter span to finger-spelt input (see ch. 2, p. 46 below).

The second (delay) effect is less easily explicable and is in apparent conflict with any model restricted to a phonological loop. On a number of occasions we have observed that Christopher does better on a task after a considerable lapse of time than on immediate repetition. The simplest example is provided