A specialist intelligence: the case of a polyglot savant[*]

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1 Introduction

In previous work (Smith & Tsimpli, 1991; Smith, Tsimpli & Ouhalla, submitted; Tsimpli & Smith, 1991, 1992, in prep.; cf. also O'Connor & Hermelin, 1991), we have documented the apparently unique talent of a polyglot *savant*, Christopher. Despite some considerable disability, resulting in institutionalisation, Christopher can read, write and communicate in any of some 15 to 20 languages.

Christopher's linguistic talent is combined with somewhat impaired performance skills. He has poor hand-eye coordination, and hence has difficulty with every-day activities such as shaving, doing up buttons, cutting his finger nails, hanging cups on hooks, and similar fine-judgment tasks. He has some difficulty in finding his way around; he has poor arithmetic ability (he does not 'conserve number'); his problem-solving ability is weak, so he is unable to formulate a strategy for playing noughts and crosses, or identify abstract patterns; he is conversationally and socially awkward; etc.

The present paper is a preliminary attempt to provide a general account of the full range of Christopher's abilities and disabilities. In the earlier work referred to above we have exploited a number of different strands; specifically, Chomsky's Principles and Parameters theory of U(niversal) G(rammar) (Chomsky, 1986), Fodor's theories of the Modularity of Mind (Fodor, 1983) and the Language of Thought (Fodor, 1975), and Sperber & Wilson's theory of Relevance (Sperber & Wilson, 1986). We continue to presuppose this work together with Anderson's Cognitive Theory of Intelligence (Anderson, 1992).

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2 Psychological background[1]

We begin by recapitulating in (1a) to (1k) some of the "Intelligence" test results, on the basis of which Christopher (date of birth: 6 January, 1962) has been categorised as a *savant*, and which provide a subset of the phenomena to be accounted for. The basic generalisation is that he combines a relatively low performance IQ with an average or above average verbal IQ:

(1)	a.	**Raven's Matrices**	- 75 (76)
	b.	**WISC-R, UK**	- Performance 42 (67)/(52) - Verbal 89 (102)/(98)
	c.	**Draw a Man Test**	- 40 (63)

In all of (1a) to (1c) the first figure refers to tests carried out when Christopher was aged 14; figures in parentheses refer to later tests carried out by O'Connor and Hermelin (1991; p.c.).

(1) d. **Conservation of Number**

We administered a simple number conservation task which involved Christopher in judging whether two wires contained the same number of beads, when these were (a) aligned so that the beads on the two wires were identically positioned, and (b) arranged so that the beads on one wire were spread out to form a longer line than those on the other. Christopher was consistent in claiming that whichever line the beads were spread out on contained more items than the other. Children normally conserve number by the age of five (see Karmiloff-Smith, 1992a, for recent discussion) and it was striking that Christopher maintained his view in the face of contrary judgments on the same task by a number-conserving five-year-old child.[2]

[1]As always, we are grateful to Ati Hermelin and Neil O'Connor for their help and guidance with these tests.

[2]We are grateful to Alexia Antjaka for her cooperation in this task.

(1) e. **'Sally-Anne' (autism) Test**

In a simple version of this test (for details see section [4] below), it appeared that Christopher consistently failed to impute appropriate beliefs to others.

(1) f. **Gapadol Reading Comprehension Test**

On this test Christopher scored at the maximum level, indicating a reading comprehension age of 16 years 10 months

(1) g. **Peabody Picture Vocabulary Test**

O'Connor & Hermelin (1991) devised a multi-lingual version of this test on which Christopher scored as follows:

English	121
German	114
French	110
Spanish	89

(1) h. **Columbia Greystone Mental Maturity Scale**

Score 68; Mental age 9.2; IQ 56
(Administered at age 29.2)

Christopher scored 59 of the first 61 test items correctly; 5 of the next 19, and 3 or 4 of the last 20. This seems to indicate an accurate cut-off point and that he was probably performing at random in the last groups.

(1) i. **Pyramids and Palm Trees**[3]

In this test (see Howard & Patterson) the subject is presented with a picture which cues one of two subsequent pictures. For instance, given 'glasses', he has to choose either 'eye' (correct) or 'ear' (incorrect). Christopher scored 48 out of 52 correct, whereas normal controls have a mean score of .99 and "all make 3 errors or less".

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[3]We are grateful to Maria Black for making this test available to us.

(1) j. Embedded Figures Test

In this test (see Witkin, 1969) Christopher's responses seemed to be random, and it was reasonably clear that he had no idea what was going on. He scored one out of 12, and even this was of dubious validity, as his tracing of the figures was too clumsy to be convincing.

(1) k. Gollin Figures

In this test the subject has to identify either objects or words from partial representations of them, the aim being to effect the identification with the minimal amount of information. (Each item was cued in three stages: a minimal partial outline, a fuller but still incomplete representation, and a complete representation.) Impressionistically, Christopher did markedly better on words than on objects, identifying objects on average at exposure 2.4 and words on average at exposure 1.7, prompting us to explore this aspect of his abilities further.

3 Word and object recognition

Building on the interesting discrepancy in the Gollin test between Christopher's identification of words and objects, we devised a further experiment to see if his superior performance on words was consistent.[4] We presented him with successive approximations to three different kinds of representation: words of English, (symbols of) objects, and words of Greek. The stimuli were presented in the form of computer print-out in approximately twenty successive stages. The first stage contained minimal information (roughly 6%), so that the item represented was essentially unrecognisable. Succeeding stimuli increased the amount of information monotonically until at the final stage the representation was complete. Three stages of each of the three kinds of stimuli can be seen in Figures 1 - 3 below. Figure 1 shows the earliest representation on which either Christopher or one of the controls correctly identified the items concerned; figure 2 shows the average stage at which Christopher and the controls correctly identified the representation; and figure 3 shows the latest stage at which Christopher or any of the controls correctly identified the relevant item.[5]

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[4]We are grateful to Justin Cormack for writing the program for this experiment.

[5]We are grateful to Ivan Smith for detailed help and advice in the administration and interpretation of this test.

We began by giving the subjects nine practice items, all of them English words, which we have not included in the statistical analysis of the results. The use in the practice session of English words to the exclusion of objects or Greek words may have had a facilitating effect on the subjects' performance with this category, but the pattern of results makes this unlikely. The practice items with the results obtained are given in Appendix 1, Table A.

It is notable that Christopher's performance on this test material was essentially indistinguishable from that of the controls. The test proper consisted of the 25 items in (2) below presented in the order given in Table B (Appendix 1). Christopher was told that the stimuli could be either words or objects, and if words, in either English or Greek. In (2), CAPITALS indicate an object, lower case roman indicates an English word, and italics indicates a Greek word. That is, there were ten 'objects', 8 English words, one numeral, and six Greek words. The results are given in Appendix 1, Table B.

(2)	TELEPHONE	weary	squid	*telos*	FLOWER
	chris	STAR	grocer	*lathos*	DIAMOND
	SCISSORS	sieve	*karavi*	CLUB	uncle
	HAND	*pleno*	1962	*selida*	AEROPLANE
	absurd	wrench	ARROW	HEART	*fagito*

It is clear from the detailed results in the Appendix that the test was not optimal, not only in that some items were inherently easier than others: compare the control average for 'uncle' as opposed to 'weary', or for 'HAND' as opposed to 'CLUB', but in that some items fail to differentiate the various subjects. Nonetheless, the results, as presented in Table 1, are sufficiently clear-cut for us to be confident that they reveal on the one hand a consistent difference between Christopher's verbal and pictorial ability, and on the other hand the absence of such a difference in the parallel abilities of normals.

Figure 1: The earliest stage at which the word/object was identified.

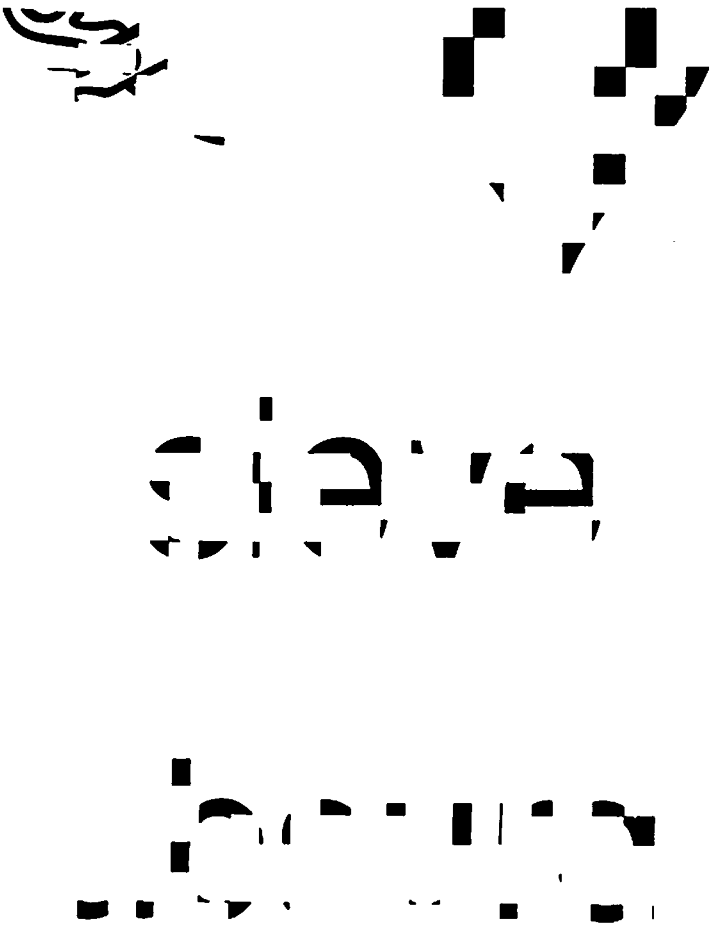

Figure 2: The average stage at which the word/object was identified.

Figure 3: The latest stage at which the word/object was identified.

Table 1: Word/picture recognition

	Christopher	Control (average)	
English:	6.4	8.25	(n=16; range 5.4-10.2)
Greek:	7.8	6.3	(n=3; range 4.8-7.2)
Objects:	13.9	6.1	(n=16; range 4.4-8.5)

The averages in Table 1 are merely suggestive, so we thought it necessary to calculate the subjects' rank for each of the test items (excluding the Greek examples for which there were too few subjects). Detailed results are given in the Appendix, Table C, with the average ranks given in Tables 2a and 2b:

Table 2a: Average rank for words

Chris	C1	C2	C3	C4	C5	C6	C7	C8
4.69	11.94	9.19	10.06	10.25	6.81	8.37	8.69	11.94

C9	C10	C11	C12	C13	C14	C15	C16
8.19	9.44	11.50	10.25	11.62	7.81	4.12	8.12

Table 2b: Average rank for objects

Chris	C1	C2	C3	C4	C5	C6	C7	C8
14.55	10.30	8.10	8.45	10.70	7.95	7.80	8.05	13.05

C9	C10	C11	C12	C13	C14	C15	C16
7.55	7.55	7.35	13.05	6.75	4.70	7.45	9.65

The correlation between the score on words and the score on pictures is highly significant, whether Christopher is included in the calculations or not. Spearman's rank correlation is 0.78 (including Christopher) and 0.87 (for the controls only): $p < 0.005$.

If we then calculate the difference between the average rank for words and the average rank for objects, we get the display in Table 2c, with Christopher dramatically different from all the controls. (The figures show the average for the recognition of objects subtracted from that for words).

Table 2c: Difference between the average ranks for word and object recognition

Chris	C1	C2	C3	C4	C5	C6	C7	C8
-9.86	1.64	1.09	1.59	-0.45	-1.14	0.57	0.64	-1.11

	C9	C10	C11	C12	C13	C14	C15	C16
	0.64	1.89	4.15	-2.80	4.87	3.11	-3.33	-1.53

It is striking that Christopher was (by far) the worst on object recognition, but second best on word recognition. This is particularly noteworthy given that the controls included several undergraduate and postgraduate linguistics students, who can be assumed to have considerable familiarity with the written word.

It is also worth noting that the only putatively English 'word' that took more than eight stages for Christopher to recognise was '1962' (his birth year). In fact he recognised it as a number at stage five yet still tried to sound out putative letters. (For these reasons we have excluded '1962' from the calculations). The difficulty occasioned by this example is in contrast with the expected ease with which he recognised his own name 'chris'. We do not think this advantage distorts the results in any way (especially as one of the controls, also named 'Chris', seemed to receive no benefit). Even when he had correctly recognised that some stimulus represented an object rather than a word, Christopher frequently tried to sound out the phonetic value of putative letters that might be formed by the sub-parts of the object. On the other hand he never guessed at names of objects after recognising something as a word. He often asked for clues (which were never given) such as 'what do you use it for?', when attempting to identify objects. At stage four of the aeroplane he asked "Do you use it in the home or in an aeroplane?", yet he was still unable to identify the representation as an aeroplane for another four stages.

4 'Sally-Anne'

Although O'Connor & Hermelin quote Christopher's medical record as referring to 'slightly autistic and obsessional behaviour' (1991:675), they also note the 'lack of any social hesitancy ... along with his willingness to initiate social contacts' (ibid).

Accordingly it was with some surprise that we discovered that Christopher performed on a version of the 'Sally-Anne' test in the same way as autistic children. (See Frith, 1989; Perner, 1991; Baron-Cohen *et al*, 1985; Leslie, 1987;

Leslie & Frith, 1987). We tested him as follows. We 'hid' a child's toy in full view of Christopher and a five-year-old child[6], ensured that both knew where it was, and then sent the child out of the room. In her absence, but still with Christopher watching, we moved the toy to a new hiding place. At this stage we asked Christopher where Alexia would look for it, and he indicated the new hiding-place. On subsequent trials we also checked that Christopher could remember where the item had originally been hidden, and that he was aware that the child had not been present when the object was moved. The results were the same and his behaviour was consistent on a repetition of the task with a different object and different hiding-places. When asked how the child could know where the object now was, Christopher responded either "I dunno" or "Because you put it there".

Perhaps surprisingly in view of these results, Christopher performed entirely appropriately on the 'Smarties' test (see Perner *et al* (1987), Karmiloff-Smith (1992a). In this test a child is shown a Smarties container and asked what it contains. Typically, he or she responds "Smarties", and is then shown that the container actually contains something different (in Christopher's case some plastic balls). The subject is next asked what a friend, who has not seen inside the container, will respond when asked what is in it. Three-year-old children and autistic subjects typically respond that the friend will say there are balls (or whatever) in the container, older children -and Christopher - answer correctly that the friend will assume there are Smarties in it. If such differential results are dependent on maturational considerations, it may be that we have, in this one small area at least, an indication of the developmental stage which Christopher has reached.

We discuss some of the implications of these results below. Suffice it here to say that we believe the 'Sally-Anne' results are interestingly consistent, in ways to be made explicit in section 6.1, with Christopher's insensitivity to jokes, irony, and a range of 'interpretive' uses (in the sense of Sperber & Wilson, 1986).

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[6]We are once again grateful to Alexia Antjaka for her help with this test.

Figure 4: Anderson's model (Anderson, 1992:97).

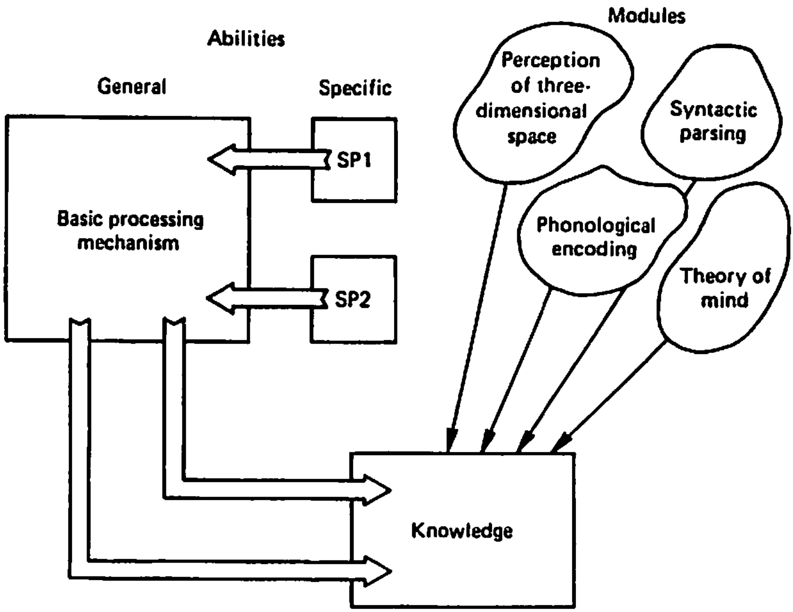
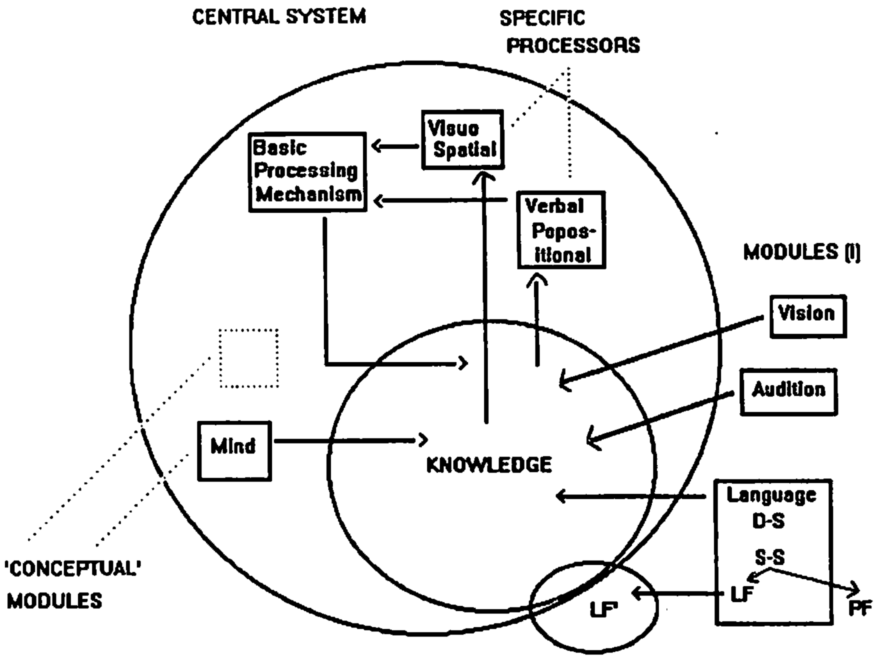


Figure 4': Anderson's model revised.



5 Anderson's model of intelligence

To put this pattern of abilities into a wider perspective, we propose to exploit a modification of Anderson's (1992) Cognitive Theory of intelligence. Apart from its inherent attractiveness, this model is particularly appropriate as Anderson is unusual in devoting considerable attention to *savants*, whose abilities "may be underlain by cognitive mechanisms that have been spared from ... generalized brain damage" (171), and he even includes a brief reference to Christopher (p.170).

We present a schematic representation of Anderson's model in Figure 4 above, and our modified version of it in Figure 4'.

Anderson's model is explicitly designed to be compatible with the Fodorian distinction between modular input systems and putatively non-modular central systems (but see the discussion of 'central modules' in section 6.1 below). Accordingly, the knowledge store or encyclopaedic memory which is at the heart of the model is built up on the basis of input from (Fodorian) modules and from the Basic Processing Mechanism (BPM). Modules are essentially identical across the species, and hence contribute minimally to individual differences in intelligence. On the other hand the BPM, which implements thinking, is held to be "responsible for the phenomenon of psychometric *g*, because it varies in its speed among individuals in the population" (Anderson, p.58). That is, he postulates a knowledge-free processing parameter which, precisely because of its role in 'implementing thinking', correlates with and indeed underlies knowledge-rich performance. Anderson further claims that his BPM is 'central' in Fodor's sense (p.66), and in the absence of any discussion of an 'executive' *homunculus* or meta-component (cf. Sternberg (1988) and Shallice (1988) for relevant discussion), it is tempting to associate such an executive with it.[7] Because modules are, by hypothesis, informationally encapsulated, their outputs need to be mediated by considerations of relevance before they can constitute appropriate input to the knowledge base, that is, we need some form of **evaluation mechanism.**

The third main component of the model consists of 'Specific Processors', of which Anderson postulates at a minimum two. While these both (all) have Turing

[7]Sternberg (1988:269) breaks down these control processes into eight sub-types, ranging from the recognition that a problem exists, via the choice of a strategy or strategies to solve it, to the monitoring of the activities engaged in during the solution. We ignore these complexities here. A fuller model of cognition would also need to include components dedicated to *decision-making*, to the *emotions*, to *creativity* (cf. Guilford), and to *volition* (including *motivation*). This last is presumably orthogonal to intelligence, but is of direct relevance to any account of Christopher's obsessional interest in language, and may merge with whatever mechanism caters for *attention*. Shallice (1988) postulates a "Supervisory Attentional System" which is responsible for the programming, regulation and monitoring of various activities.

machine power (see Anderson, 1992:96), they differ in terms of the operations they carry out and/or in terms of the representations they range over. Thus, they are analogous to computer languages where, for instance, the declarative PROLOG is good for semantics, C is ideal for number crunching, and COBOL is best suited for business purposes, even though all of them can do anything either of the others can.

The two Specific Processors that Anderson proposes are the traditional 'visuo-spatial' and 'verbal-propositional' ones. The 'verbal' SP is preeminently devoted to *successive* processing, which "takes place in a temporal sequence" (Anderson, 1992:83), and is held to underlie proficiency in serial recall, digit span, etc. The 'visual' SP is preeminently devoted to *simultaneous* processing, which "involves the synthesis of elements into groups and entails holistic, spatial representations" (ibid.), and is taken to underlie proficiency in memory for designs, tests of visualisation, and perhaps tests such as Raven's Matrices. As the operation of the SPs is mediated by the BPM (see figure 4), their efficacy is dependent on the latter's inherent speed. That is, whatever the efficiency of the SPs, this may be obscured if the BPM is unable to cope adequately with the representations it receives from them. It follows that significant differences in the operating power of the SPs will only be manifest in the presence of a relatively unimpaired BPM.

In addition to the foregoing, Anderson's model is completed by a set of further (non-Fodorian) 'modules Mark II' responsible for 'fetch-and-carry' operations and for over-learnt routines.[8] The former of these are not really 'modular' in any usual sense of the term but allow, for instance, for information to be retrieved from memory. The latter, over-learnt, processes may be closer to (encapsulated) modularity. They are putatively involved in any of a range of activities from tying one's shoelaces to calendrical calculation, though as Anderson is somewhat reticent about the place of skills in his model, it is hard to be more specific.

6 Discussion

6.1 The mind module

With this much machinery in place, we can begin to account for certain aspects of Christopher's (and others') abilities. Figures (4) and (4') above differ in a number of respects, in particular with respect to the position of the 'Theory of Mind'. We

[8]Anderson also proposes (1992:194) a third class of modules, but these are left too inexplicit to be usefully exploited here.

would like to begin by suggesting that Anderson's characterisation of the theory of mind as a Fodorian module is inappropriate. While a theory of mind is, by hypothesis, domain-specific, and while it also has certain other 'modular' attributes (e.g. its operation is fast, mandatory, subject to idiosyncratic pathology - as in autism, and so on), there are at least two considerations which lead us to consider that it belongs to the Central system. First, it is clear that the nature of the representations over which the relevant computations are carried out is not perceptual, as with Fodorian modules, but conceptual. Second, the crucial characteristic of (Fodorian) modules is their informational encapsulation, whereby the direction of information flow is exclusively from the module to the central system, rather than vice versa (for interesting discussion, see Carston (1988)). Given the apparently inferential nature of operations of the theory of mind, it looks as if 'central' information is crucially involved. Accordingly, we think that the theory of mind should be located within the central system. That is, we are attributing a quasi-modular structure to the central system but one in which the vocabulary is derived from conceptual representations rather than from the sensorium or language.[9]

Christopher's failure on the 'Sally-Anne' test is then to be interpreted as a central deficit (on a continuum with that evinced by true autists[10]), which amounts to the inability to form and/or manipulate second-order representations (or 'meta-representations') in the language of thought.[11]

The conflicting results from the "Sally-Anne" and the "Smarties" tests present a problem. As documented in the literature (see e.g. Frith, 1989; Happé, in prep.), the average autistic child fails both tests, so Christopher's performance on the "Sally-Anne" test is typical of autistic behaviour while his performance on the

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[9]This suggestion is in the spirit of Shallice's claim (1988, especially ch. 12) that specific dissociations, such as those manifest in acalculia or selective semantic memory loss, provide evidence for the non-equipotentiality of the central system.

[10]For perceptive overviews of 'the autistic continuum' and the need 'to differentiate various forms of autism', see Frith (1991) and Wing (1991).

[11]In fact it is not yet clear whether the correct characterisation of the deficit is specifically as an impaired theory of mind, or as a more general inability to form second-order representations. This distinction has been addressed by Perner and Leekam (see Perner (1991:312) for brief discussion), where the crucial consideration is whether the deficit manifest by autistic children (and by Christopher) generalises to cases of non-mental representation. They tested for this by using a modification of Zaitchik's (1990) photo task and compared it with a matching false belief task. The autistic children were better at the former than the latter; normal children were better at the latter than the former, so Perner concludes that "this suggests that autism is not characterised by a general metarepresentational deficit" (ibid.).

"Smarties" test is atypical[12]. Moreover, recent work by Happé (in prep.) indicates that there is no significant age difference in successful performance on these two tests by normal children, so there is no explanation for his behaviour.

As a tentative solution to this problem we suggest that there are two possible ways of describing the process involved in a performance task such as the "Smarties" one. The first possibility is that, as with the "Sally-Anne" test, what is involved is the construal of 'second-order representations' by the subject. The second possibility is that the subject does not form or project any 'second-order representation', in that he does not consider any of the evidence of the other person's knowledge which may be available. Rather, the subject retrieves encyclopaedic information from his general knowledge store and attributes it indifferently either to himself or to any other individual. On this interpretation, when Christopher was asked what he (or anyone else) thought was in the 'Smarties' tube before he (or they) knew what was in it, he gave an intuitively sensible answer on the basis of his general knowledge about what is usually contained in "Smarties" tubes. That is, he provides the same answer regardless of whose opinion is assumed to be being tapped. In other words, his response does not take into consideration any information related to the referent other than that available in the encyclopaedic entry of the objects concerned (in this case, Smarties), which is presumably the same across individuals.

We are not yet in a position to give a final adjudication in the case of Christopher, but the assumption that he has a general difficulty with second-order representations is consonant with other of his characteristics. For instance, he has a considerable dislike of fiction in general (and children's books in particular), and he is invariably truthful, indeed, he seems to be unable to lie. Fiction and lying both involve representing states of affairs as other than they are, something apparently alien to him. Moreover, his behaviour displays a number of other idiosyncrasies, listed in (3):

(3)
- a. His inability to handle irony and metaphor
- b. His inability to understand jokes
- c. His insensitivity to the use/mention distinction
- d. His judgments of metalinguistic negation
- e. His judgments of 'scheduling' sentences

[12]Happé (in prep.) documents a number of cases in which children are differentially successful on the two tests, but the most striking generalisation is that performance on the two tasks is correlated. Although detailed discussion is beyond the scope of this paper, we nonetheless assume that there is a difference in complexity between the two tasks. We are grateful to Uta Frith and Francesca Happé for helpful discussion on this issue.

all of which involve what Sperber & Wilson term "interpretive use", a form of second-order representation. They write:

> any representation with a propositional form ... can be used to represent things in two ways. It can represent some state of affairs in virtue of its propositional form being true of that state of affairs; in this case ... the representation is ... used *descriptively*. Or it can represent some other representation which also has a propositional form - a thought , for instance - in virtue of a resemblance between the two propositional forms; in this case ... the first representation is an interpretation of the second one, ... it is used *interpretively* (Sperber & Wilson, 1986:228-229).

We illustrate each of the categories in (3) in turn. Confronted with examples such as those in (4), where the context or co-text made only an ironic interpretation plausible, Christopher provided only a literal interpretation, or in the case of (4c) simply rejected the sequence as unacceptable:

(4) a. He's a fine friend

b. John and Mary went to a party, where both of them became very sick, and had to go home early, because John gave Mary too much to eat and drink. John said: "What a wonderful party!" What do you think Mary said?

c. The judge told the traitor that he was "a credit to his country". Do you agree?

In Sperber & Wilson's terms, irony and related tropes are examples of echoic "interpretive use" which involve "second-degree interpretations of someone else's thought" (1986:238). It is precisely such meta-representational ability which the Sally-Anne test shows to be impaired in Christopher. His reaction to metaphor is similar. Although he can cope to a limited extent with standardised metaphors - his response to "Why is Jesus called the Good Shepherd?" was "He herded people" - his reaction to being asked to explain the meaning of anything more creative, such as the examples in (5):

(5) a. No man is an island
b. Standing on the shoulders of giants

was a baffled "I don't know".

The case of jokes is similar. Whether all jokes are treated as involving interpretive use, as Ferrar (1993) has suggested, or as simply necessitating the accessing of two different interpretations (see e.g. Jodlowiecz, 1991), they clearly impose considerable cognitive demands on the hearer, demands that appear to be beyond Christopher's abilities. If he hears or reads a joke of an institutionalised form, as in (6):

(6) Diner: "Waiter, what's that fly doing in my soup?"
Waiter: "It looks like the breast-stroke, Sir"

he recognises it, on the basis of his general knowledge, as a joke, and gives a stylised "ha, ha, ha", but neither appreciates it nor is able to explain why one might find it funny. Similarly, if provided with both question and answer, he can recognise riddles (as in (7)):

(7) What animal can you never trust? A cheetah.

as such, and can access the two meanings of the phonological sequence involved, but is more taken with the incorrect spelling of the 'cheat' interpretation than with any possible wit. That this is not simply a reflection of sophistication in his sense of humour is seen in his reaction to examples such as those from Lukes & Galnoor (1987) in Appendix 2, all of which he took to be literal, and unfunny, stories, with no apparent inkling that they might be in any way bizarre, incongruous or humorous.

A further case involving the representation of a representation is provided by the **mention** as opposed to the **use** of linguistic terms. Christopher's interpretation of mention is less clear-cut, appearing to depend in part on whether appropriate orthographic conventions are respected or not. Thus he finds (8a) acceptable, but (8b) unacceptable:

(8) a. Dogs have four legs
b. Dogs has four letters

but he happily accepted both sentences in (9):

(9) a. Chris is a great linguist
b. "Chris" is a great name

Given his preoccupation with the written word and his sensitivity to typographical errors and punctuation, it may be that these examples are liable to alternative explanation.

A slightly different example of second-order representation occurs with metalinguistic negation. In examples of the kind in (10) the speaker is rejecting not the truth of the proposition involved, but the linguistic form of the representation by which that proposition is expressed. Christopher rejected all the examples in (10):

(10) a. I don't just like Alexia, I love her.
b. Fred didn't contract a disease, he fell ill.
c. He's not tall, he's a giant
d. John didn't try to translate the book into Armenian, he succeeded in translating it.

However, he responded positively to the example in (11), even though there were no scare quotes:

(11) He can't say tomahto, he says tomayto

presumably because the linguistic form being rejected was phonological rather than propositional. More surprisingly, he once accepted (12), even though the combination of (10a) and (10c) would lead one to expect him to reject it:

(12) John isn't just tall, he's a giant

On re-testing with comparable examples such as those in (13), (and their translational equivalents in Greek) however, he consistently rejected them:

(13) a. Goliath wasn't just tall, he was a giant
b. Goliath wasn't only tall, he was a giant

A final example of difficulty in this meta-representational domain arises with the interpretation of 'scheduled events', where the linguistic form used represents a plan for a future state of affairs rather than a description of that state of affairs itself. Such examples typically give rise to deviations from canonical temporal structure, as in the examples in (14), both of which Christopher rejected:

(14) a. John heard that his friend was coming tomorrow
b. John said that Harry is leaving the next day

The first of these involves a sub-sequence "his friend was coming tomorrow" which is superficially temporally anomalous, and the second is only interpretable as a historic present, another case of interpretive use (see Smith (1990) for discussion).

6.2 Knowledge representation and the role of the Specific Processors

From the putative deficit in his theory of mind, we turn to other aspects of Christopher's (dis-)abilities. While his performance IQ is depressed, Christopher has good general knowledge. He can identify political figures (Thatcher, Mitsotakis, Saddam Hussein, the Shah of Iran) from verbal or visual stimuli; he has an excellent knowledge of geography (identifying the location of countries and their capitals with great ease), current affairs and sport (correctly naming before the Barcelona Olympics the location both of those Games and of the 1996 Olympics [Atlanta]), and he is formidably well-informed on anything to do with languages (correctly identifying 'baht' as the unit of currency in Thailand, asking in the context of Berber what the status of Tifinagh[13] is), and so on.

Further, he has excellent word-recognition and proof-reading ability, as manifest not only in the experiments described in section [3] but also in his almost instantaneous recognition of typographical errors in a range of languages, his ability to read upside-down, his rapid identification of different scripts, and so on. Despite his poor hand-eye coordination and generally depressed levels of performance on non-verbal components of standard IQ tests, these abilities suggest that his BPM operates within normal limits. This follows from two of Anderson's claims: first, that the BPM is crucial for the acquisition of knowledge; second, that the criterial measure of the speed of the BPM is Reaction Time or, more basically, Inspection Time, i.e. the time taken to process a stimulus. Indeed, it is the *psychophysical* nature of inspection time tasks that enables Anderson to claim that "there are low-level cognitive processes that underlie intelligent thinking" (1992:58). In the framework of Anderson's model, this further suggests that his knowledge base is viable and can be added to, in some areas at least, within normal limits.

If the BPM is essentially intact, the obvious place to look for the source of Christopher's disabilities is the Specific Processors. His poor hand-eye coordination and difficulty in finding his way around suggest strongly that the visuo-spatial SP is impaired. If so, however, it must be differentially impaired, as his reading ability shows that the 'visual' part must have been largely spared, and

[13]Tifinagh is an archaic Berber script. When we first introduced Christopher to Berber, he asked if it was written in Roman or Arabic script, and on being told 'both', then asked "What about Tifinagh?", which only our Berber colleague had heard of.

only the 'spatial' part is really defective. This suggests that Anderson's avowedly minimalist stance with regard to the number of Specific Processors which it is necessary to postulate is overly conservative,[14] and that we should countenance separate processors for the two functions specified. Even this may not be sufficiently fine-grained as the word/object recognition experiment shows a systematic difference in his capacity to carry out verbal and non-verbal tasks within the visual domain.

An alternative possibility is that the visual SP is not further selectively impaired depending on verbal vs non-verbal tasks but that the fetch-and-carry operations responsible for the retrieval of elements in the memory/knowledge store are enhanced in the case of verbal tasks or impaired in the case of non-verbal ones.

Christopher's linguistic prowess is *prima facie* an indication that his 'verbal-propositional' SP must be intact, indeed enhanced. However, the combination of his rapid retrieval of propositional information with his general difficulty in problem-solving suggests that his verbal SP is selectively impaired, just as we claimed his visuo-spatial SP was selectively impaired - with the same implications for the overall characterisation of the system. If this SP is correctly described as logical/ propositional or verbal/propositional (the two labels that Anderson ascribes to it), then the 'logical' part is clearly less well-preserved than the verbal or propositional part,[15] even though it is not self-evident whether his reaction to the perceived contradiction in metalinguistic negation, for instance, should be construed as a logical or a linguistic activity. In other words, the problem lies in determining whether "semantics" is to be subsumed under general logical processing or constitutes an independent level of linguistic representation. If the modularity thesis for the Language Faculty holds, where this includes "a rich array of conditions on semantic interpretation" (Chomsky, 1993:7), it follows that linguistic stimuli are analysed by means of language specific information responsible for the assignment of semantic values, e.g. contradiction, ambiguity, and so on. If this is correct, then we can maintain that Christopher's logical SP is distinct and selectively impaired with respect to the verbal one.

The differential preservation of sub-parts of the Specific Processors has potential implications for the development of Christopher's central store of knowledge. Specifically, if his knowledge base has been built up exclusively via one channel (or a sub-set of possible channels), because only that channel is

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[14]As is reasonably clear from the range of dissociations documented by e.g. Shallice (1988).

[15]As his efficiency in retrieving random facts from memory is as good for general knowledge as for facts of language, one can presume that his 'fetch and carry' module II is unselectively intact.

properly functional, this may partly account for his obsessional interest in things linguistic. That is, his knowledge base may have been skewed by virtue of receiving the majority of its input from a linguistic domain, rather than from the usual range of modalities.

6.3 The language module and its interface

What is most striking about Christopher is his outstanding ability to learn new languages. What is equally striking, however, is that this learning is characterised by a marked plateau effect, and that his mastery of morphology appears to be decidedly superior to his mastery of syntax.

The surprising fact about Christopher's behaviour when exposed to a new language is his fast and effective learning of new vocabulary items as well as morphological properties of the language. This may be attributed to his familiarity with a large number of languages and, consequently, his sensitivity to those differences that signal alternative ways of encoding inflectional or case distinctions. Thus, at a purely descriptive level, Christopher's L2 learning demonstrates an exceptional mastery of morphological properties, whereas his syntactic performance in any L2 which differs from his native language exhibits a consistent deficit. This renders any account of his L2 learning as involving parameter-resetting problematic (see Tsimpli & Smith (1991)).

A clear example of these generalisations can be provided from his performance in Modern Greek, a language with a rich case and inflectional system, including morphologically overt mood, aspect, tense and agreement distinctions. To a great extent, Christopher shows productive mastery of all such morphological distinctions, indicating that he knows what constitutes a morphologically well-formed verbal complex in the language. In this respect, his performance goes far beyond the rote memorisation of superficial patterns that might be expected from a behaviourist learning procedure. On the other hand, syntactic phenomena which do not involve obligatory morphological distinctions, such as focussing, dislocation, word-order variation, and subject extraction, are either not learned or are inadequately integrated into his linguistic system, despite massive positive evidence and repeated explicit instruction. Christopher's linguistic performance is thus exceptional, in part at least, in that he shows mastery of quite complex morphological requirements, while his L2 ability in the parallel syntactic component reveals a cut-off point in his learning process. By contrast, while his competence in his native language is not completely flawless[16], it does not in general exhibit this syntax/morphology mismatch.

The implication of the foregoing is that his (Fodorian) language module is intact,or even enhanced (if enhancement is a possibility for a module), and that (at least part of) his 'verbal' SP is very good. This combination of properties, in conjunction with deficits elsewhere, could also provide a basis for explaining how his knowledge base seems to be over-developed on the language side, so that with Christopher every dip into the mental bran-tub brings up a language related gobbet of information.

Christopher's talent was initially made manifest in his translational ability, but it is almost certainly true to say that translation as such gives a reduced indication of his linguistic knowledge. It is remarkable that his translation tends to be performed like an automaton (cf. Smith & Tsimpli, 1991:325). Rather than meditate over sub-parts of a text and attempt to fit them into a coherent whole, Christopher works rapidly from left to right (often picking out the words with his finger) translating word by word at high speed, but with little concern for the overall message or the felicity of the phraseology. Direct questioning and his spontaneous conversation sometimes indicate that his knowledge is better than this 'technique' would lead one to believe, but our previous characterisation of his behaviour as being an "alternation between the intelligent and the inept" (Smith & Tsimpli, 1991:323) still seems correct.

A striking example of the latter is provided by his reaction to different order approximations to English texts, of the kind illustrated in (15).[17] In these passages we have respectively seventh, fifth, second and tenth order approximations to English. (15a) for example was constructed by taking seven words from a passage, omitting the next seven words, taking the next seven, and so on. Christopher noticed nothing wrong with this text and happily translated it into French. With (15b) he observed that the text was 'jumbled' but still proceeded to translate it unconcernedly into Greek. Only with (15c), constructed by taking the first two words of successive paragraphs, did he baulk at translating.

[16]Specifically, Christopher has problems with the interpretation and judgement of dislocation structures and allied constructions. To account for this we assume an analysis trading on a distinction between LF and LF', (see Tsimpli & Smith, 1992).

[17]These examples were devised on analogy with the *k*-limited stochastic sources discussed in Miller & Chomsky (1963:427ff.), though we have ignored word-frequency.

(15) a. The Pharaohs had enough stone to build enough papyrus, too, so there was nothing as large as floating islands. The papyrus a modest fifth of the Sphinx's length. Of the underworld of mummies and stood it made us realise what giant structures.

b. In the year 1786, an at the High Court in discovery. He was Sir William an oriental scholar before reading, three years earlier, he had Sanskrit, the language in which texts of India are written, fourth to the sixth centuries, was no longer spoken but scholarship and literature.

c. The lawsuits in 1980 in a previously best but not my real the pope Woody was he was meanwhile she by Annie when Woody Mia found at the in February Valentine with still Mia Woody held the story people argued most courts in the one thing.

d. The idea of languages being related to one another was many of the languages of contemporary Europe - for instance Italian, in grammatical structure. Indeed in this case the explanation was was Latin, which of course exists today in written form.

It is worth emphasizing that this apparently unreflecting process of translation coexists with the ability to manipulate some aspects of language with pragmatic normality. We have documented before (see Smith & Tsimpli, 1991:328) his appropriate response to exchanges like that in (16):

(16) John said: "Would you like some coffee?"
Mary replied: "Coffee would keep me awake"
Do you think Mary accepted the coffee? Yes/No/Don't know

and have subsequently corroborated that his expertise extends to more complex examples such as that in (17):

(17) Mary said: "I have to work all night tonight"
John said: "Would you like some coffee?"
Mary replied: "Coffee would keep me awake"
Do you think Mary accepted the coffee? Yes/No/Don't know

in which he both reversed the judgement for (16) and explained why appropriately.

Following O'Connor & Hermelin, we have previously (Smith & Tsimpli, 1991) taken Christopher's flawed talent as *prima facie* evidence for Fodorian modularity. That is, there appears to be a dissociation of those operations internal to the language module (or the language module in conjunction with the verbal/propositional SP) from central control. However, this claim is scarcely coherent within Anderson's framework unless we can specify more precisely the respective roles of the (modular) language faculty and the (putatively central) verbal-propositional SP. We accordingly speculate on the possible roles for the 'verbal' part of an SP.

The language module itself is intelligence independent: geniuses and fools have much the same grammar; but some aspects of language use are clearly intelligence correlated, and some or all of these may involve the SP as well as the language module. We give a tentative selection in (18):

(18) a. General fluency and sophistication in what might be termed the rhetorical use of the grammar.

b. Knowledge acquisition 'using processes and representations that [are] verbal' (Anderson, 1992:88). It is presumably uncontroversial that the blind enjoy a poorer visual knowledge base than the sighted. Such differentiation is not exclusively a function of the input systems but, as we saw above, may be due to properties of the central system. In Christopher's case we suspect that his obsession with language is partly attributable to the efficiency of his verbal SP.

c. Most reasoning and inferential processes (deductive, inductive, analogical and syllogistic), which demand or can exploit a propositional as opposed to a visuo-spatial code.[18]

d. Some aspects of reading. In a programmatic typology of dyslexia, Anderson (1992:189ff.) suggests that different kinds of reading failure may be caused by any one of a slow BPM, a defective module, or a poor specific processor. One of the roles of the specific processor in this context might be the speed with which particular letters or words are "searched in short-term memory" (idem. p.190), something which Christopher's proof-reading skills indicate he is very good at.

e. Some aspects of parsing. In the absence of an integrated theory of parsing, it is difficult to be specific, but if a parser "incorporates the

[18]We do not wish to suggest that the choice between these is ever self-evident (see, for instance, Johnson Laird (1983)), but we assume that both are necessary.

I-language along with other elements - certain strategies and procedures, a certain organization of memory, and so on" (Chomsky, 1991:19), it is plausible to assume that these strategies and procedures are implemented in the verbal SP.

f. Metalinguistic judgement. Introspection on the well-formedness of one's own and others' output is necessarily dependent on non-modular processes (as well as the output of the module itself) and may involve the SP.

g. Translation from the Natural Language into the Language of Thought (where they differ). Assuming that there are some differences between the language one speaks and the language one thinks in[19], it is necessary to postulate some translation or transduction between them. Our discussion of the mind 'module' above suggests a multiply interactive process for the various components of the central system, and it is a natural assumption that the SP should be involved in the translation. More specifically, assuming that memories are coded in the Language of Thought, we suggest that the SP is involved in the exchange of information between the knowledge store and the language module whenver there is a difference in their representational systems.

h. Translation between different Natural Languages.

We have already suggested in the discussion of theory of mind that the central system must have considerable internal structure, as witness its possible selective breakdown. We further claim that the verbal SP, which we believe is implicated in translation between languages, is itself partially autonomous and hence may become divorced from central control.[20]

This suggests that Christopher's translation (including in particular lexical translation) takes place *within* some domain which is not monitored appropriately. This domain cannot simply be equated with the language module as such, because

[19]On the one hand, the Language of Thought is unlikely to have any equivalent of Natural Language pro-forms, as their use would give rise to indeterminacies in retrieval from memory; on the other hand, the Language of Thought clearly disposes of 'syntactic' devices, such as the possibility of visual rotation (see Metzler & Shepard, 1982), which are alien to Natural Language.

[20]This position is reminiscent of Karmiloff-Smith's suggestion that "metacognitive functioning may ... turn out to have domain-specific components" (1992b:5).

there is independent evidence that, in Christopher's case, this is heavily skewed towards English, and in any case is not standardly viewed as having access to (encyclopaedic) pairings of words. Rather, this view of translation builds precisely on the mediating function of the lexicon, considered as "a means of access to our non-linguistic knowledge" (Smith, 1989:6), and we wish to claim that translation takes place at an **interface** level of the kind mooted in Tsimpli (1992:33-34). This interface was suggested to account for the mapping between concepts in the Language of Thought (as in Fodor, 1975) and linguistic (especially morphological) representations. As an interface, we believe it has the property of (partial) encapsulation necessary to account for Christopher's translation. If translation, in the normal case, involves an interactive process between this (morphological) interface level and various parts of the central system (the SP, the mind module, inferencing, etc.) we want to suggest that Christopher's translating abilities diverge from the standard because the assumed interaction is considerably impoverished. If his translation lacks crucial information from the knowledge store, or whatever central system it is necessary to postulate in this case, we can account for his unusual speed in this task. That is, the interface has a quasi-modular status, which means that it operates fast and mandatorily, and - in Christopher's pathological case - in relative isolation from central control: a situation which at once speeds up, but renders less coherent, the process of translation.

Just as his flawed fluency in translation might lead to an underestimate of Christopher's linguistic ability, so also might initial exposure to his conversation, which tends to the monosyllabic, except when routinised, (for examples, cf. Smith & Tsimpli, 1991:326-7). Again, we take this phenomenon to be a manifestation of the dissociation of his linguistic from his central abilities. We assume that while his language module is normal or enhanced, linguistic representations passed up to the central system are slowed down by the partial isolation of the SP and the Interface, with the result that the system gets 'clogged up'.

It is desirable here to distinguish production and perception, even though conversation obviously involves both of them. In perception, the decoded linguistic signal is interpreted, presumably via the 'verbal/propositional' SP, and the resultant information integrated into (working) memory to make possible some response. The decoding proceeds normally, but the speed of interpretation - and consequent possible reaction - will be a function of the speed of central processing. In production, representations in the language of thought generated by the central system are passed to the language module for realisation. This 'translation' is relatively effortless, but can operate only when material is received. If representations are extracted from memory in routinised or pre-organised chunks, then his output tends to normality (except of course for the mixture of languages arising from his linguistic preoccupations); if no such advance organisation has taken place, then his performance is slowed down and halting, as the central system cannot process the material fast enough to feed the capabilities of the linguistic module.

This mismatch between Christopher's modular and central abilities is mirrored in the mixture of proficiency and incompetence seen in his pragmatics. On the one hand he appears to cope more than adequately with some implicatures (e.g. examples (16) and 17) above)) and the complexities of the Blakemore connectives (see Smith & Tsimpli, 1991:328-330; Blakemore, 1987); on the other hand, he seems to be unable to handle metalinguistic negation (e.g. examples (10) above), and his strategy with reference assignment is atypical of normal usage. For instance, he consistently interpreted the 'he' in both the examples in (19):

(19) a. John telephoned Bill. He needed to speak to him
b. John telephoned Bill. He refused to speak to him

as referring to John.

A partial account of this last phenomenon can be given in terms of the kind of 'central system overload' invoked above to accommodate some properties of his conversation. That is, in such cases he adopts a single simple heuristic which either works or crashes, because there is no central back-up space available.

The clearest evidence for the differential sophistication of Christopher's language module and central systems comes from his acquisition of possible and impossible languages (see Smith *et al.*). In particular, his failure to handle impossible constructions in the invented language Epun - constructions that the controls found easy - supported the hypothesis that his central system was inadequate to deal with phenomena which, despite their inherent simplicity, *ex hypothesi* fell outside the language module. That is, his language module is intact or enhanced, but he has insufficient central system back-up for when this fails.

7 Conclusion

We believe that exploiting our version of Anderson's model, even though it is clearly in need of refinement, allows us to make some programmatic generalisations about Christopher and other *savants*. Christopher's linguistic ability is essentially intact, despite his decreased general intelligence, because it is encapsulated in a Fodorian module, which operates independently of the central system. The independence is not complete, however, because not all linguistic ability is a function of the module. Two further crucial components are the Specific Processor devoted to verbal/propositional tasks, and the interface between them, as well as any further central 'executive' it may be necessary to postulate.

Anderson's discussion of *savants* is interesting, but in some respects misleading. One can agree that *savants* "represent cases in which generalised brain damage has selectively spared just one of three crucial mechanisms: a module, a specific processor of high latent ability, or, more rarely, the BPM itself" (1992:173); indeed, this provides a putative basis for distinguishing different types of *savant* ability. However, certain of his claims are problematic. For instance, he says that *savant* abilities cluster in 6 areas: calculation, art, music, language, spatial skills, and memory (1992:172), but this is somewhat disingenuous - language is not usually a *savant* ability, though language may be semi-normally preserved in the presence of severe damage elsewhere, as in Cromer's DH patient with 'chatterbox syndrome' (Cromer, 1991). In fact Anderson uses DH as a prototypical *savant*, but she is not a good example. Her linguistic ability is remarkable against the background of her retardation, but "her language use is indistinguishable from that of other young women her age" (Anderson, 1992:174). That is, her spectrum of abilities is not like that of Christopher, who has abnormal ability in the domain of second language acquisition.

Anderson also claims that (Fodorian) modules are the usual source of *savant* abilities, but they cannot be the only such source because of music and calendrical calculators, who presumably have enhanced non-modular functions. Moreover, it is odd to suggest that a spared module underlies artistic savant ability - in Fodorian terms there is no artistic module - and it also says nothing about the exceptional nature of the ability.

To provide a general account of *savant* abilities is beyond both the scope of this paper and our own expertise, but we think that the account we have given of Christopher's talents and handicaps gives some insight into his condition and into the nature of the human mind more generally.

Appendix 1: results for the Word/Object Recognition task

Table A: practice items. (The number in parenthesis after the word or object indicates the number of stages for that item; the number under the name of Christopher or the control (C1 - C16) indicates the stage at which the item was correctly identified.)

		Chris	C1	C2	C3	C4	C5	C6	C7	C8	C9
1. piglet	(9)	9	9	6	5	8	8	8	6	8	9
2. panda	(9)	9	9	5	7	9	9	8	8	9	5
3. peach	(6)	2	3	2	2	3	2	2	2	2	2
4. frown	(12)	10	10	5	8	12	12	10	7	12	5
5. blond	(17)	8	10	10	7	14	17	6	6	17	5
6. biscuit	(16)	5	5	6	10	6	5	7	6	4	7
7. planet	(18)	3	9	2	3	8	3	2	1	4	3
8. flower	(18)	8	9	7	16	18	6	15	18	10	11
9. spoon	(16)	7	16	4	4	12	4	3	2	6	4

		C10	C11	C12	C13	C14	C15	C16	C-Av
1. piglet	(9)	5	9	7	5	6	7	7	7.1
2. panda	(9)	9	9	9	9	7	7	9	8.0
3. peach	(6)	2	2	2	2	2	2	2	2.1
4. frown	(12)	5	12	12	5	6	6	5	8.3
5. blond	(17)	17	5	9	4	13	17	17	10.9
6. biscuit	(16)	5	8	8	4	2	4	7	5.9
7. planet	(18)	2	4	5	3	1	3	5	3.6
8. flower	(18)	5	6	5	4	6	4	1	8.8
9. spoon	(16)	4	4	8	4	2	4	4	5.3

Table B

			Chris	C1	C2	C3	C4	C5	C6	C7	C8	C9
10.	TELEPHONE	(21)	18	21	7	5	6	5	9	4	10	8
11.	weary	(20)	7	7	2	5	9	6	5	2	7	3
12.	squid	(21)	7	10	10	10	8	8	10	10	5	10
13.	*telos*	(21)	6	7	/	/	/	/	6	/	/	5
14.	FLOWER	(22)	16	5	5	5	9	4	5	17+	5	5
15.	chris	(16)	4	8	7	10	8	4	9	10	6	6
16.	STAR	(21)	2	5	3	5	6	3	3	5	7	4
17.	grocer	(18)	4	5	13	3	15	3	3	12	8	7
18.	*lathos*	(21)	5	2	/	/	/	/	2	/	/	2
19.	DIAMOND	(22)	22	7	6	5	6	11	3	22	22	2
20.	SCISSORS	(18)	17	6	4	4	9	4	6	6	6	6
21.	sieve	(21)	5	*18	11	9	10	14	10	6	14	10
22.	*karavi*	(21)	9	12	/	/	/	/	5	/	/	10
23.	CLUB	(21)	18	3	2	4	2	1	3	2	4	3
24.	uncle	(19)	8	18	12	12	9	10	10	19	17	11
25.	HAND	(21)	14	9	14	14	14	14	5	12	14	14
26.	*pleno*	(21)	8	11	/	/	/	/	8	/	/	10
27.	1962	(20)	12	8	6	6	7	8	6	6	8	6
28.	*selida*	(21)	10	7	/	/	/	/	6	/	/	7
29.	AEROPLANE	(21)	8	2	2	1	3	2	3	1	3	1
30.	absurd	(20)	6	9	9	9	11	9	8	7	12	4
31.	wrench	(21)	5	8	6	9	6	2	7	2	9	8
32.	ARROW	(22)	16	6	6	5	5	8	5	4	6	5
33.	HEART	(22)	10	7	7	8	7	8	3	2	8	2
34.	*fagito*	(21)	9	4	/	/	/	/	2	/	/	8

			C10	C11	C12	C13	C14	C15	C16	C-Av
10.	TELEPHONE	(21)	7	7	11	2	7	9	10	8.0
11.	weary	(20)	5	5	3	8	3	2	5	4.8
12.	squid	(21)	5	10	4	10	10	10	7	8.6
13.	*telos*	(21)	/	/	/	/	/	/	/	6.0
14.	FLOWER	(22)	6	3	5	5	5	19	7	6.9
15.	chris	(16)	6	4	9	9	9	3	4	7.0
16.	STAR	(21)	3	3	6	4	2	3	5	4.2
17.	grocer	(18)	7	18	7	18	5	3	5	8.3
18.	*lathos*	(21)	/	/	/	/	/	/	/	2.0
19.	DIAMOND	(22)	6	4	22	3	21	4	10	9.6
20.	SCISSORS	(18)	4	4	6	6	3	2	4	5.0
21.	sieve	(21)	9	12	18	6	7	5	11	10.6
22.	*karavi*	(21)	/	/	/	/	/	/	/	9.0
23.	CLUB	(21)	1	2	4	1	1	2	2	2.3
24.	uncle	(19)	19	19	14	19	13	10	10	13.9
25.	HAND	(21)	14	4	14	12	5	7	14	11.3
26.	*pleno*	(21)	/	/	/	/	/	/	/	9.7
27.	1962	(20)	7	7	6	4	7	6	7	6.6
28.	*selida*	(21)	/	/	/	/	/	/	/	6.7
29.	AEROPLANE	(21)	2	3	3	3	2	5	2	2.4
30.	absurd	(20)	10	11	10	11	8	4	11	8.9
31.	wrench	(21)	8	6	8	1	3	6	7	6.0
32.	ARROW	(22)	3	7	6	5	3	3	6	5.2
33.	HEART	(22)	8	8	8	6	2	3	2	5.6
34.	*fagito*	(21)	/	/	/	/	/	/	/	4.7

Table C

	Chris	C1	C2	C3	C4	C5	C6
11. weary	14	14	2	9	17	12	9
12. squid	4.5	12.5	12.5	12.5	6.5	6.5	12.5
15. chris	3.5	10.5	9	16.5	10.5	3.5	13.5
17. grocer	5	7	14	2.5	15	2.5	2.5
21. sieve	1.5	16.5	11.5	6.5	9	14.5	9
24. uncle	1	13	8.5	8.5	2	4.5	4.5
30. absurd	3	8.5	8.5	8.5	14.5	8.5	5.5
31. wrench	5	13.5	7.5	16.5	7.5	2.5	10.5
Average Rank	4.69	11.94	9.19	10.06	10.25	6.81	8.37

	Chris	C1	C2	C3	C4	C5	C6
10. TELEPHONE	16	17	7.5	3.5	5	3.5	11.5
14. FLOWER	15	7	7	7	14	2	7
16. STAR	1.5	12.5	5.5	12.5	15.5	5.5	5.5
19. DIAMOND	15.5	10	8	6	8	12	2.5
20. SCISSORS	17	12	5.5	5.5	16	5.5	12
23. CLUB	17	12	7.5	15	7.5	2.5	12
25. HAND	12.5	5	12.5	12.5	12.5	12.5	2.5
29. AEROPLANE	17	6.5	6.5	2	12.5	6.5	12.5
32. ARROW	17	12	12	7	7	16	7
33. HEART	17	9	9	13.5	9	13.5	5.5
Average Rank	14.55	10.30	8.10	8.45	10.70	7.95	7.80

	C7	C8	C9	C10	C11	C12
11. weary	2	14	5	9	9	5
12. squid	12.5	2.5	12.5	2.5	12.5	1
15. chris	16.5	7	7	7	3.5	13.5
17. grocer	13	12	10	10	16.5	10
21. sieve	3.5	14.5	9	6.5	13	16.5
24. uncle	15.5	12	7	15.5	15.5	11
30. absurd	4	17	1.5	11.5	14.5	11.5
31. wrench	2.5	16.5	13.5	13.5	7.5	13.5
Average rank	8.69	11.94	8.19	9.44	11.50	10.25

	C7	C8	C9	C10	C11	C12
10. TELEPHONE	2	13.5	10	7.5	7.5	15
14. FLOWER	16	7	7	12	1	7
16. STAR	12.5	17	9.5	5.5	5.5	15.5
19. DIAMOND	15.5	15.5	1	8	4.5	15.5
20. SCISSORS	12	12	12	5.5	5.5	12
23. CLUB	7.5	15	12	2.5	7.5	15
25. HAND	6.5	12.5	12.5	12.5	1	12.5
29. AEROPLANE	2	12.5	2	6.5	12.5	12.5
32. ARROW	4	12	7	2	15	12
33. HEART	2.5	13.5	2.5	13.5	13.5	13.5
Average rank	8.05	13.05	7.55	7.55	7.35	13.05

	C13	C14	C15	C16
11. weary	16	5	2	9
12. squid	12.5	12.5	12.5	4.5
15. chris	13.5	13.5	1	3.5
17. grocer	16.5	7	2.5	7
21. sieve	3.5	5	1.5	11.5
24. uncle	15.5	10	4.5	4.5
30. absurd	14.5	5.5	1.5	14.5
31. wrench	1	4	7.5	10.5
Average rank	11.62	7.81	4.12	8.12

10. TELEPHONE	1	7.5	11.5	13.5
14. FLOWER	7	7	17	13
16. STAR	9.5	1.5	5.5	12.5
19. DIAMOND	2.5	13	4.5	11
20. SCISSORS	12	2	1	5.5
23. CLUB	2.5	2.5	7.5	7.5
25. HAND	6.5	2.5	4	12.5
29. AEROPLANE	12.5	6.5	16	6.5
32. ARROW	7	2	2	12
33. HEART	7	2.5	5.5	2.5
Average rank	6.75	4.70	7.45	9.65

Appendix 2: selection of jokes submitted to Christopher

a. On the other side of the moon the Russian and American astronauts met, and said:

"Endlich konnen wir unsere Muttersprache sprechen"

When asked why the astronauts spoke in German, Christopher replied "because they were on the moon", and ended saying that the story "doesn't make sense".

b. A Russian minister visits a car factory. The manager goes out of his way to show him around and at the end of the tour offers the minister a free car.

"Oh no", says the minister, "I can't accept it".

"In that case I'll sell it to you for five roubles".

The minister hands him a ten rouble bill:

"In that case, I'll have two".

After Christopher had insisted on translating this story into Greek, the following conversation ensued:

NS: Why didn't he accept the car?
C: Because it was only five roubles
NS: But he then said he'd want to buy two. So why do you think he said that?
C: Because five roubles times two is ten roubles.
NS: And why do you think that story's there?
C: Pass.
IT: Is this a joke?
C: Yes.
IT: Why?
C: Dhen ksero [I don't know]

c. Castro visits Moscow and is taken on a tour by Brezhnev. First they go for a drink and Castro praises the beer.

"Yes, it was provided by our good friends from Czechoslovakia".

Next they go for a ride in a car and Castro admires the car.

"Yes, these cars are provided by our good friends from Czechoslovakia".

They drive to an exhibition of beautiful cut glass, which Castro greatly admires.

"Yes, this glass comes from our good friends in Czechoslovakia".
"They must be very good friends", says Castro.
"Yes, they must", says Brezhnev.

We again interrogated Christopher about this story, and he was able to tell us without hesitation that Castro was "the Cuban leader", but probing about the punch line produced the following result:

NS: Why do you think he says that?
C: Because they ARE very good friends.
NS: Why are they very good friends?
C: Because they live next door to Brezhnev.
NS: So why does that make them good friends?
C: Because they like each other.
NS: Is this a serious story or a joke?
C: It's a serious story.

(See Smith, 1989, ch.8 for an analysis of such jokes.)

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