To our families

The Mind of a Savant

Language Learning and Modularity

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BLACKWELL
Oxford UK & Cambridge USA

First published 1995

Blackwell Publishers, the publishing imprint of
Basil Blackwell Ltd.
108 Cowley Road
Oxford OX4 1JF

Basil Blackwell Inc.
238 Main Street
Cambridge, Massachusetts 02142
USA

British Library Cataloguing in Publication Data

A CIP catalogue record for this book is available from the British Library.

Library of Congress Cataloging-in-Publication Data

Smith, N. V. (Neilson Voyne)
The mind of a savant: language learning and modularity / Neil Smith and Ianthi-Maria Tsimpli
p. cm.
Includes bibliographical references and index.
ISBN 0–631–19016–3 (alk. paper) – ISBN 0–631–19017–1 (pbk.: alk. paper)
1. Psycholinguistics. 2. Second language acquisition – Case studies. 3. Language and languages – Study and teaching – Case studies. 4. Savants (Savant syndrome) – Case studies. 5. Modularity (Psychology)
I. Tsimpli, Ianthi. II. Title.
BF455.S544 1995
401'9 – dc20 94-28662
CIP

Typeset in 10/12 Plantin by Photoprint, Torquay, Devon.
Printed in Great Britain by Hartnolls Ltd., Bodmin, Cornwall.
This book is printed on acid-free paper.

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Introducing Christopher

Personal history and family background[1]

Christopher is unique. He is institutionalized because he is unable to look after himself; he has difficulty in finding his way around; he has poor hand–eye co-ordination, turning many everyday tasks such as shaving or doing up buttons into a burdensome chore; but he can read, write and communicate in any of fifteen to twenty languages.

Born in January 1962, he was diagnosed as brain-damaged at the age of six weeks. Although he was late in walking and talking, his main interest from about three years was books: never fairy stories, but books providing factual information, such as the telephone directory, dictionaries, and Ladybird books about flags or foreign currencies. At the same age his interest in the advertisements in the local newspapers provided his family with the first clear evidence that he could read; and read not only the usual way, but upside down or sideways on. At about six or seven he took an interest in technical papers written in foreign languages that his sister brought home from work, beginning an obsession with languages that was reinforced by watching the Mexico Olympics on television, and that has lasted all his life. Even his play-time (at school and at home) was frequently devoted to games in which he pretended to be from a foreign country, speaking a foreign language: for instance, he used a towel as a turban or as a bullfighter's cape, and pretended to be an Arab or a Spaniard. He had a precocious talent, but he was also afflicted with a minor speech defect, poor eyesight and a degree of clumsiness that seemed to confirm the diagnosis of mental handicap.

Most of his childhood was spent in 'special' (ESN) schools,[2] though as a result of his mother's efforts on his behalf he was later transferred to a

school for the physically handicapped, where he could receive greater individual attention. At school he was quiet and solitary; he showed no interest in the children's material on display, but rather read books on history and geography that the teacher had borrowed from the local library for herself. His future preoccupations were already visible in the fact that he could spell any word he was ever asked to; that he had a passion for identifying political figures; and that while other children did sorting and matching exercises for their mathematics, an enlightened teacher allowed Christopher to check share prices in *The Financial Times* and compare prices in different currencies.

At school as at home, his greatest love was reserved for foreign languages, for which he showed a surprising proficiency. On one occasion his teacher showed him a piece of card with printing on it in a language she did not recognize. Christopher immediately identified it as Polish and explained that it gave instructions that the garment to which it was attached should at all times be dry-cleaned and not washed. When asked who had taught him Polish, he replied: 'Nobody', and when questioned further about how he knew what it said, answered that he 'just did'. In fact his sister's husband speaks Polish, and it is clear that interacting with him was the source of Christopher's ability in this language. His apparent obliviousness to this fact is not untypical, even though his long-term memory is usually good.

For the last few years he has lived in a sheltered community (one of the Camphill Communities),[3] where he can lead a reasonably normal life, working in the garden, carding wool, watching television and endlessly studying languages. He receives consistent love, affection and support from his family, whom he visits regularly and who periodically take him on holidays abroad with them. Since we met him he has visited Canada, Turkey, Greece and Mallorca – where he acted as enthusiastic and much appreciated interpreter between German and Spanish for his fellow tourists – and he has visited Holland with us.

Double dissociation

There have been many cases of savants[4] documented in the literature:[5] calendrical calculators who can tell you on which day of the week any date in the last or next century falls; artists like Nadia (Selfe, 1977) or Stephen Wiltshire (Wiltshire, 1987; O'Connor and Hermelin, 1987; Hermelin and O'Connor, 1990) whose drawings are of professional standard, but who are otherwise incapable of leading a normal life and are virtually speechless; musicians who can play complex passages after a single hearing but cannot

look after themselves. Such savants are frequently autistic, and usually linguistically handicapped, with minimal command of any language or other communication skills. Treffert (1989: 66) writes that savants' skills, 'however many they have, do not include the acquisition of language'; and when they are occasionally described as having the 'gift of tongues' (for example, Howe, 1989: 10; Treffert, 1989: 9, 71–2), the context makes it clear that such people are merely good mimics who can repeat passages from various languages 'parrot-fashion' with minimal, if any, understanding.

Yet Christopher's talent is precisely in the area where the typical savant is defective: in the acquisition and use of language. Although no one else has been reported as displaying the multi-lingual prowess that Christopher does, these cases illustrate the same dissociation between linguistic and general cognitive abilities as is exhibited by such individuals as Laura (Yamada, 1990; see also Smith, 1991), by Williams Syndrome children (see, e.g., Bellugi et al., 1993), by 'chatterbox' children (see, e.g., Cromer, 1991), and by hyperlexics (see, e.g., Cossu and Marshall, 1986), all of whom have great linguistic ability in the presence of severe cognitive deficits. Examples in the opposite direction – cases of people with impaired language in the presence of normal intellectual ability – are provided by some deaf people, some aphasics, and by those suffering from SLI (Specific Language Impairment), where brain damage (in some cases genetically caused) occasions a language deficit independently of the rest of the cognitive profile (see, e.g., Gopnik, in press; Gopnik and Crago, 1991; for further discussion, see pp. 40–2 below).

The existence of these varied conditions provides a classical example of *double dissociation*:[6] language can be impaired in someone of otherwise normal intelligence, and – more surprisingly – someone with intelligence impaired by brain damage may none the less have normal, or even enhanced, linguistic ability. It is worth emphasizing that this latter possibility constitutes a refutation of any position that insists on 'cognitive prerequisites' for the development of language (e.g., Slobin, 1973; Piaget, 1970; cf. Cromer, 1991; Karmiloff-Smith, 1992a; Smith 1994).

Medical and psychological profile

In this section we provide a summary of Christopher's medical background, including an outline of his performance on a battery of psychological tests.

His medical history is somewhat opaque. Christopher, who is right-handed, was born when his mother was forty-five years old. Early in pregnancy she had contracted German measles, but was assured by doctors

that it was beyond the period when the baby could be harmed. Towards the end of pregnancy she had a bad fall, and towards the end of a long labour the nurses sent for oxygen, presumably because of foetal distress, though the record is not clear. During the first few weeks of life Christopher was difficult to feed and was always throwing his head around. At approximately six weeks he was admitted to hospital where, as O'Connor and Hermelin (1991: 674) report 'his mother was told that he was brain-damaged at birth', though no reason for such a diagnosis was given. Later institutional records suggest hydrocephaly, and an EEG carried out at the age of thirteen 'revealed some oddities including slow waves in the frontal lobes' (O'Connor and Hermelin, 1991: 674). A year later 'his intra-cranial pressure showed no abnormality but in 1982, at age twenty, he was diagnosed as "possibly having hydrocephalic brain damage and severe neurological impairment of his motor co-ordination, amounting to apraxia" ' (ibid.: 675). It seems reasonably clear that there is brain damage of some kind, but there is insufficient evidence to allow any causal correlation with his psychological profile. In August, 1993 he had an MRI scan, which revealed 'moderate cerebral atrophy with wide sulci over both hemispheres. The cisterna magna was slightly larger than usual and the cerebellar vermis was hypoplastic' (O'Connor et al., forthcoming). Such a configuration is not untypical of high-functioning autism (see Courchesne et al., 1988), but there is no obvious connection between cerebellar hypoplasia and the unusual pattern of cognitive abilities shown by Christopher. While it is gradually becoming possible to account for certain pathologies in neuro-anatomical terms, we are still far from being able to explain Christopher's (or any other subject's) enhanced performance in such a way.

Psychologically the picture is complex, but perhaps somewhat clearer. The most salient feature is a striking mismatch between his verbal and non-verbal abilities, supported by test results over a prolonged period and with recent documentation across a wide range of different tests. The basic generalization is that he combines a relatively low performance IQ with an average or above average verbal IQ.[7]

The standard 'performance' IQ test, which is supposed to involve no or minimal verbal ability, is *Raven's Matrices*,[8] on which Christopher has on different occasions scored 75 or 76 (where the average is 100), and the Wechsler Scale test *WISC-R, UK* on the performance part of which he has scored at different times 42, 67 and 52 (again, the average is 100). This is in striking contrast with the verbal part of the same test, on which he scored respectively 89, 102 and 98. On the *Columbia Greystone Mental Maturity Scale*, administered at age 29.2, he scored 68, indicating a mental age of 9.2 and an IQ of 56.

A further test which is supposedly independent of verbal ability is the

Embedded Figures Test (see Witkin, 1969), in which the subject has to match geometric shapes presented on a flash card with concealed representations of those same figures embedded in more complex designs by tracing out the relevant pattern on the latter. 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 twelve, and even this was of dubious validity, as his tracing of the figures was too clumsy to be convincing.

Similarly non-verbal is the Goodenough *Draw a Man Test* on which Christopher scored 40 (at age 14) and 63 (some years later). Some indication of his artistic ability is given by his drawing of the authors given overleaf (p. 6).

Although number is sometimes thought to be parasitic on language (see, e.g., Chomsky 1991b: 50), Christopher fails on *Conservation of Number* tasks. 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 judgements on the same task by a number-conserving five-year-old child.

Despite this failure to conserve number, Christopher experiences no difficulty in counting arrays of items displayed either in a straight line or in a circle (see Karmiloff-Smith, 1992a) and he is able to carry out simple arithmetic calculations involving addition, subtraction and multiplication. The type and limit of his ability in this domain are illustrated in the following examples, where Christopher's contribution is shown in inverted commas:

1 (a) £6.12 +
2.23
'8.35'

(b) £14.99 +
1.66
'£16.55'

(c) £5.50 −
2.25
'3.25'

(d) £3.05 −
1.99
'£1.16'

(e) 17 ×
5
'85'

(f) 33 ×
6
'198'

Although Christopher has not been diagnosed as autistic[9] we discovered

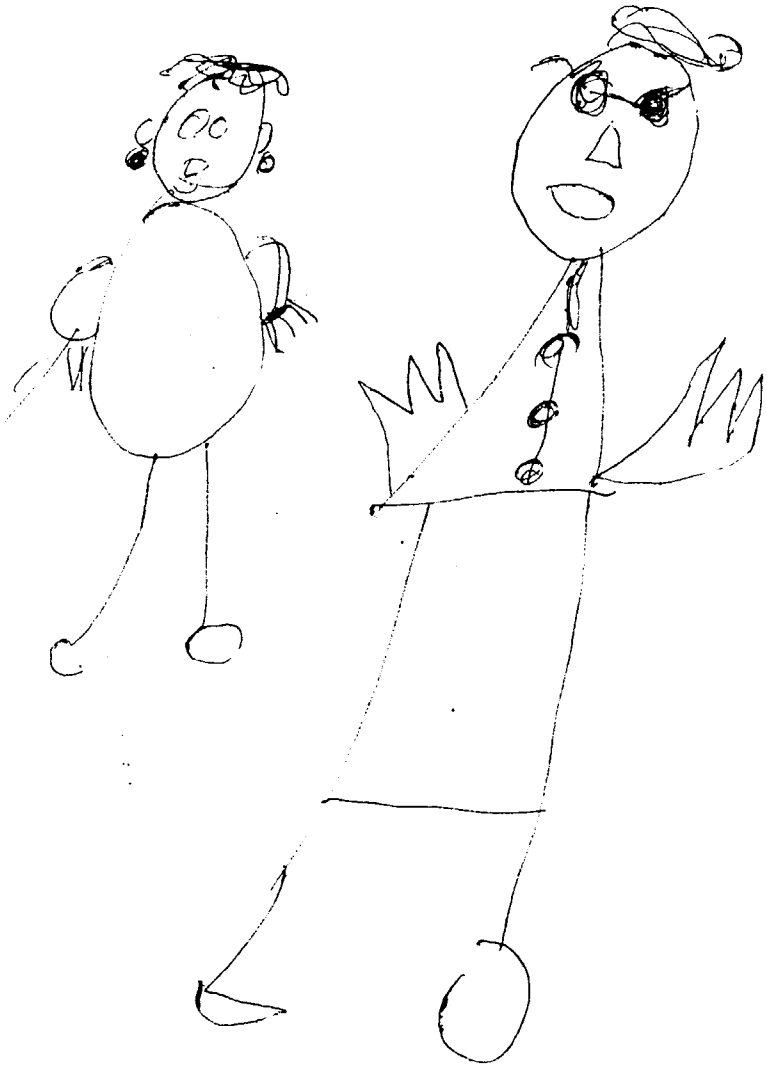


Figure 1.1 *Drawing of Ianthi and Neil*

with some surprise that he has difficulty with some tasks classically associated with autism. Specifically, on a simple version of the '*Sally-Anne*' *Test* (see Frith, 1989; Perner, 1991; Baron-Cohen et al., 1985; Leslie, 1987; Leslie and Frith, 1987) it appeared that Christopher consistently failed to impute appropriate beliefs to others. We tested him as follows. We 'hid' a

child's toy in full view of Christopher and a five-year-old child, Alexia,[10] 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 this result, Christopher performed entirely appropriately on the 'Smarties' test (see Perner et al., 1987; Karmiloff-Smith, 1992a), and a variant of the 'appearance/reality' test (see Flavell et al., 1986; Fodor, 1992). In the first of these tests 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. For the second of these tests, we presented Christopher with a plastic imitation of a chocolate biscuit. As expected, he identified it 'correctly' and even attempted to bite it. When he had realized that it was made of plastic, we asked him both what it was and what it looked like. He answered appropriately that it was plastic and looked like a chocolate biscuit, whereas three-year-old children typically reply that it looks like what it is: namely, a piece of plastic or whatever. As is evident from these results his performance is complex. However, his behaviour on further tests designed to establish his ability to impute (false) beliefs to others (the *Shapes Test* and the *Opaque Box Test*) was consistent with his performance on 'Sally-Anne'. We describe these tests and discuss their implications in chapter 5.

On many of these tests, Christopher performed at an impaired, sometimes at a severely impaired, level. This is in marked contrast with his performance on verbal tests. We have already noted his performance on the verbal part of the WISC scale test, and this behaviour is corroborated by his performance on, for example, the *Gapadol Reading Comprehension Test*. On this test Christopher scored at the maximum level, indicating a reading comprehension age of 16 years 10 months; a result consistent with his

performance on the *Peabody Picture Vocabulary Test*. O'Connor and Hermelin (1991) devised a multi-lingual version of this test on which Christopher scored as shown in (2):

(2)

English	121
German	114
French	110
Spanish	89

That is, his performance is consistently above the average of 100, not only in his native language, English, but in French and German as well. Even on Spanish he performs within normal limits and, intuitively, his Spanish is as good as his German, though not nearly as good as his French or Modern Greek, for instance.

This mismatch between verbal and non-verbal tests was borne out by his performance on the *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 is 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 with our own test.

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.[11] 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 per cent), so that the item represented was essentially unrecognizable. 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 1.2–1.4. Figure 1.2 shows the *earliest* representation on which either Christopher or one of the controls correctly identified the items concerned; figure 1.3 shows the *average* stage at which Christopher and the controls correctly identified the representation; and figure 1.3 shows the *latest* stage at which Christopher or any of the controls correctly identified the relevant item.[12]

The test consisted of some twenty-five items (see Appendix I for details), and subjects were told that the stimuli could be either words or objects, and

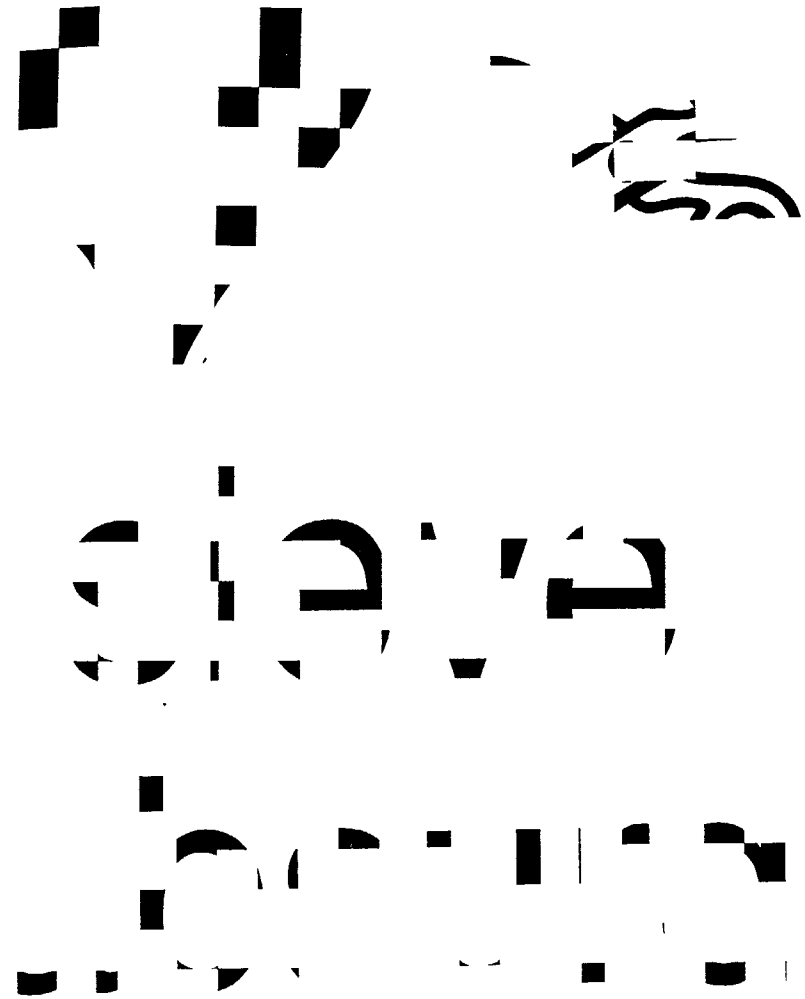


Figure 1.2 *The earliest stage at which the word/object was identified*

if words, in either English or Greek.[13] 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

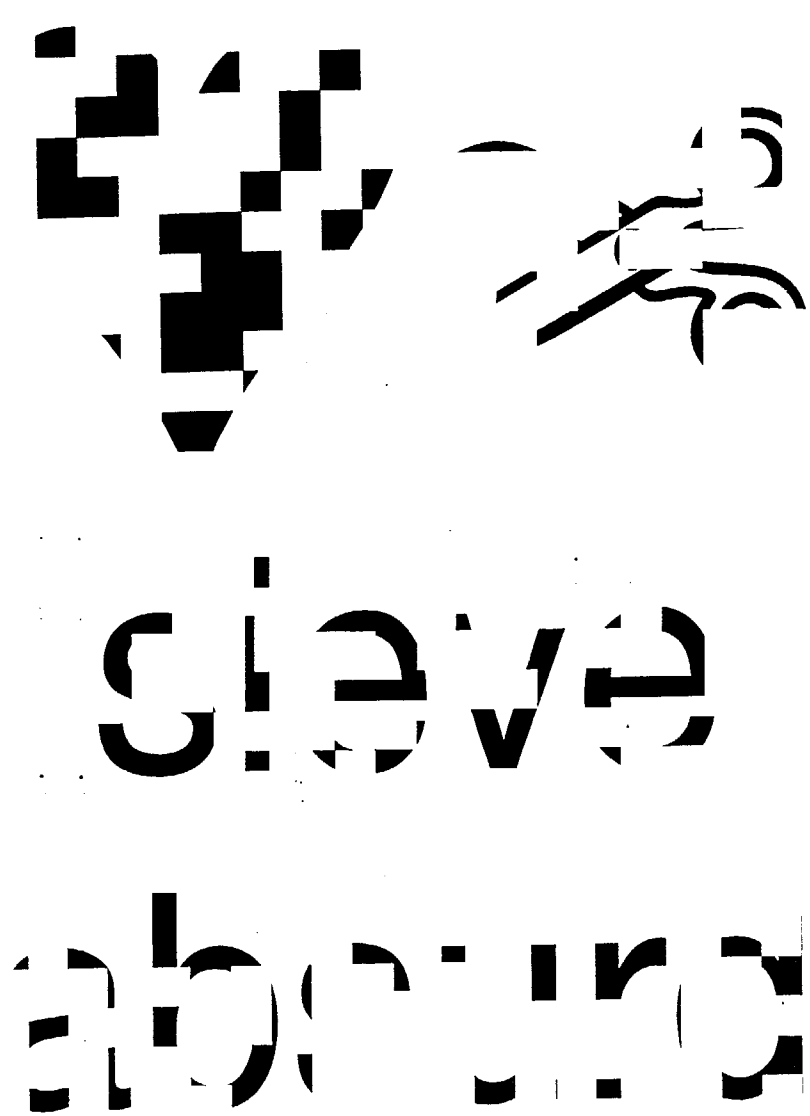


Figure 1.3 *The average stage at which the word/object was identified*

more than eight stages for Christopher to recognize was '1962' (his birth year). In fact he recognized 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

Figure 1.4 *The latest stage at which the word/object was identified*

with the expected ease with which he recognized 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 recognized 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 recognizing 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.

Linguistic prowess and non-linguistic disability

In this section we give an initial overview of the range and nature of Christopher's exceptional linguistic talent. He first came to scholarly attention because of his remarkable ability to translate from and communicate in any of a large number of languages. He has some knowledge (ranging from fluency to the bare elements) of: Danish, Dutch, Finnish, French, German, Modern Greek, Hindi, Italian, Norwegian, Polish, Portuguese, Russian, Spanish, Swedish, Turkish and Welsh. The passages listed here (taken from Smith and Tsimpli, 1991: 318–22) give a fair indication of the breadth and depth of his expertise:

(a) *Danish*
Men Jeg havde hverken onkler eller tenter i København, så jeg kom først dertil, da jeg var så stor, at jeg gik i skole og vidste, at det var Danmarks hovedstad og den største og vigtigste by i landet.

But I had neither uncles nor aunts in Copenhagen, so I didn't get to go there until I was old enough to be at school and learnt that Copenhagen was the Capital of Denmark and the biggest and most important city in the country.

'But I had neither uncles nor niece – nor aunts – in Copenhagen, so I came first there as I was a very big man, when I went to school and knew that it was Denmark's capital and the biggest and importantest – and the most important town in the whole country'.

(b) *Dutch*
'In elk geval,' zegt ze 'ik zal de ketel opzetten voor een kopje thee.' 'Ja graag, en dan moet ik eens opstappen. Ze zal niet weten waar ik blijf.'

'Anyway,' she says, 'I will put on the kettle for a cup of tea.' 'Yes thanks; and then it will be time for me to go. She'll be wondering when I'm coming.'

' "In any case," he – she says, "I will put the kettle on for a cup of tea." "Yes please, then I must stop. You know, you you you should not – she shall not know where I am." '

(c) *Finnish*
Mikon veli, kolmetoistavuotias Yrjö, tulee kirjakaupasta kirja kädessään, otsa rypyssä. Muuan herrasmies astuu tiellä häntä kohti. Poika ottaa lakin päästään: 'Hyvää päivää, tohtori!' 'Päivää, päivää, Yrjö . . . mikä tuo kirja on?'

Mikko's brother, the thirteen-year-old George, comes from the bookshop with a book in his hand, frowning. A gentleman is walking towards him on the road. The boy takes his cap off. 'Good morning, Doctor!' 'Good morning, George . . . What is that book?'

'On the thirty, the thirty-second year of George, the . . . a bookshop . . . Miss – what's a gentleman. "Good morning, Doctor!" "Morning, morning, George. How are you?" '

(d) *French*
Nous faisions pique-nique au bord de la route nationale qui s'étendait devant nous, toute droite et bordée d'arbres.

We were having a picnic beside the main road which stretched away in front of us, dead straight and lined with trees.

'We had a picnic at the route, at the board of the road, which ran behind us, straight and full of trees.'

(e) *German*
Wolfgang und seine Schwester machen einen Ausflug mit dem Zug. Sie wohnen in einem Dorf. Heute fahren sie in die Stadt. Sie gehen in ein

Warenhaus. Wolfgang kauft ein Radio, Sigrid braucht eine Lampe für ihren Schreibtisch.

Wolfgang and his sister are going on an excursion by train. They live in a village. Today they are going to the city. They go into a shop. Wolfgang buys a radio, Sigrid needs a lamp for her desk.

'Wolfgang and his sister are on a . . . with the train. They live in a village. Today they go and visit a city. They go in a shop. Wolfgang buys a radio. Sigrid buys a lamp for her writing-table.'

(f) *Greek*
Otan perase t'amaksi, epsakse ja tis pantufles tis, ala ena paljopedho ihe pari ti mja ki efevje jelontas.

When the car passed, she looked for her slippers, but a naughty child had taken one and was leaving laughing.

'When she passed the car . . . when the car passed, she was looking for her slippers but an old child had taken one away and left . . . and was laughing.'

(g) *Hindi*
Ek nadi: ke kina:re, ek baṛe se peṛ par, ek bandar rahta: tha: . . . Ek din ek magar tairta: hua: kina:re par a:ya:.

On the side of a river, on a large tree, lived a monkey . . . One day a crocodile came swimming along to the side.

'On the side of a road, a big something, a man fell down <NS – do you know what *bandar* is? C – 'monkey'> . . . One day, *but* one day <NS – OK *magar* is 'crocodile'>, the crocodile came to edge . . .'

(h) *Italian*
Per caso in quella stessa mattina un'amica era venuta a trovare la signora ed era rimasta a farle compagnia mentre finiva di vestirsi. L'amica aveva notato i cassetti aperti.

By chance, that very morning a woman friend had come to visit the lady and had stayed to keep her company while she finished dressing. Her friend noticed the open drawers.

'In case, just in case in this morning a friend came to find the lady and she was stayed while she was dressing. Her friend had noticed the open cassettes.'

(i) *Norwegian*
'Når kommer Per hjem?' 'Vanligvis til middag, litt over to. Å Hjørdis – du blir vel en stund? Du kan jo bli til middag hvis du vil. Tenk om du hadde ringt på forhånd – ja for telefon har vi da, på grunn av alle bestillingene.'

'When does Peter come home?' 'Usually for dinner, just after two. Oh Hjørdis – you will stay for a while I hope? You can stay for dinner if you like. What if you had phoned beforehand – yes because we do have a phone, because of all the orders.'

' "When is Peter coming home?" "Usually at midday, a little over two. Ah Hjørdis, you are well – an hour. You can stay till midday if you want to. Think that your phone [inaudible] beforehand. Yes on the telephone we have, on the ground of all orders." '

(j) *Polish*
Musiałem go wrzucić do wozu siłą. Położył się na podłodze i zamknął oczy, nie chcąc widzieć, co go jeszcze czeka.

I had to throw him into the car with force. He lay down on the floor and closed his eyes, not wishing to see what awaited him.

'I had to take him out of the car strongly and put – he put himself on the floor and opened his eyes – and shut his eyes, not wishing to see what was waiting for him.'

(k) *Portuguese*
O cão estava imóvel no passeio, olhando fixamente a luz vermelha. De súbito luz verde, automóveis a travar – e o cão atravessou para o lado de lá.

The dog was standing still on the pavement, staring at the red light. Suddenly a green light, cars braking – and the dog crossed to the other side.

'The dog was immovable in the passage, looking the light, of the green light. <IT: What does this [*fixamente*] mean? >Fixed – the green, the red

light. All of a sudden a green light, motor-cars crossed, and the dog crossed by by that side.'

(l) *Russian*
Oktyabr byl na redkost' xolodnyi, nenastnyi. Tesovye kryshi pochernely.

October was unusually cold and wet. The wooden roofs grew black.

'October was as careless cold and unhappy. The winter days were black.'

(m) *Spanish*
Hablaban todos al tiempo y sus voces se confundían con la del televisor sobre una banqueta minúscula, en el rincón que formaba la pared con la puerta de acceso al vestíbulo.

They were all talking at the same time and their voices merged with that from the television on a small stool in the corner between the wall and the door to the hall.

'They spoked they spoke once all at a time and their voices were confused with that of the television beneath a blanket, a small blanket, in a corner which won the wall – the wall with the with the access door to the hall.'

(n) *Swedish*
Mia sitter uppkruppen i kökssoffan med knäna uppdragna och fötterna instoppade i den randiga nattskjortan. Katten spinner i hennes knä.

Mia is curled up on the kitchen sofa with her knees drawn up and her feet tucked into her stripey nightie. The cat is purring on her lap.

'Mia is sitting, crouched down in the kitchen sofa with her knees bent and her feet tied up in the lovely night-shirt. The cat spins in her knee.'

(o) *Turkish*
Tatilde, herkes görmediği yerleri gezmeğe gider. Hem bilgilerini geliştirirler, hem eğlenirler ve hem de yeni yeni yerler görürler.

On holiday everyone goes to visit places they haven't seen. Either they are strengthening their knowledge, or they are enjoying themselves, or they are looking at totally new places.

'On holiday when I was staying in different places I saw different places. The people were were scientists and some are students and some are new [inaudible] new places.'

(p) *Welsh*
Hylo, Tom. Sut mae? Ga i ddod i mewn? Cei, wrth gwrs. Dere i eistedd ar y fainc 'ma.

Hello Tom. How are you? May I come in? Yes (you may), of course. Come and sit on the bench here.

'Hello Tom. How are you? Can I come in? Of course you can. Come and sit on the bench here.'

Though he has a smattering of a few other languages as well, his knowledge of them is probably inadequate to make detailed exemplification worthwhile or even feasible. For instance, he claimed to know Hungarian, but was unable to translate a fairly elementary passage from that language; he knows a few words of Arabic, but can neither read it nor sustain a conversation for more than a moment or two; he began to learn Hebrew (see O'Connor and Hermelin, 1991: 676), but when tested was unable to do more than pick out the odd word in an O-level passage; and he can exchange greetings in Japanese, Thai and sundry other languages from around the world, but professes no greater expertise than that.

It is important to note that the languages concerned come from a wide range both genetically and typologically. Although the majority of them are Indo-European, Finnish and Turkish are genetically unrelated, being respectively a member of the Finno-Ugric group of the Uralic language family, and a member of the Turkic sub-family of the Altaic languages. Similarly, although most of them are spoken in Western Europe, this does not apply to Hindi, Polish or Russian, and while most of them are typologically SVO languages (that is, the canonical word-order is one in which the subject precedes the verb which in turn precedes the object), Welsh is VSO, Hindi and Turkish are SOV and the word-order of others is superficially mixed to a greater or lesser degree (for example, German and Modern Greek). Although Christopher professed to find the 'exotic' languages more difficult than the familiar ones spoken closer to home, it is also noteworthy that he coped remarkably well when confronted with Berber, which is typologically and genetically unlike most of the languages he already knew (see chapter 4 below for detailed discussion).

Furthermore, the languages he knows are written in different scripts: Greek, Cyrillic (for Russian) and Devanagari (for Hindi). Christopher's reading and writing of Greek is fluent, and he has no trouble with Cyrillic (although, as will be seen below, his knowledge of Russian is somewhat problematic). When we first met him, his knowledge of Hindi was largely

restricted to the spoken form of the language, but after being given a Hindi grammar (McGregor, 1972) he made rapid progress in learning the script and can now read the language as well, albeit without much fluency. Like most professional linguists Christopher can also identify languages from their written form without being able to speak or translate them, so he immediately, and correctly, identified Bengali, Chinese, Czech, Gujarati, Icelandic and so on, when presented with examples of them, and when given a postcard with 'thank you' written in a hundred languages on it, he identified twenty-nine of them.[14]

It is also striking that Christopher is not entirely reliable with regard to the breadth and depth of his own linguistic abilities. As we reported earlier (Smith and Tsimpli, 1991: 318), his knowledge of Russian is moot. Despite denying knowledge of the language, because of his failure to identify an elementary greeting correctly, he was none the less able to give a translation (albeit somewhat inaccurate) of a Russian short story written in Cyrillic script. It may well be that his frequent claims to 'know a language' are more an assertion of his ability to identify the language concerned, for example, on the basis of its distinctive writing system, than a claim for verbal fluency.

Another point to note in this overview of Christopher's expertise is the speed and facility with which he picks up[15] languages. Apart from the obvious fact that anyone who knows as many languages as Christopher does must acquire them fairly fast, we have both anecdotal and systematic evidence for his ability. In March, 1992 shortly before he was due to appear on Dutch television, it was suggested that he might spend a couple of days improving his rather rudimentary Dutch with the aid of a grammar and dictionary. He did so to such good effect that he was able to converse in Dutch – with facility if not total fluency – both before and during the programme. More impressively, when he began learning Berber (see Smith et al., 1993, and chapter 4 below) he took to the language enthusiastically, seeming 'thoroughly to enjoy teasing out the details of the subject agreement system; and after a few minutes he was able to suggest the correct verb form to accompany a masculine as opposed to a feminine subject (converting "teswa" to "yeswa") despite there having been only two relevant examples' (Smith et al., 1993: 286). Moreover, on the occasion of his second lesson (three weeks after the first), he was able to translate simple sentences on demand, despite having spent only an hour or so on revision in the intervening period.

In addition to his polyglot ability, Christopher shows considerable skill in playing sundry word games in various languages. Examples are provided by 'word-making'. In this game/exercise the subject is given a word and asked to construct as many words from it as he or she can in a given time.

Given the head-words in (3) in English, German, Greek and Dutch, Christopher produced the examples beneath them in a few seconds:

3(a) *DISASTER*
STAR, SISTER, DARE, TEA, ASTER, SID, RIDE, READ, TEAS, TEAR

(b) *REGENSCHIRM*
SCHIRM, ICH, MEIN, SCHNEE, REGEN

(c) *ΚΑΤΑΣΤΡΟφΗ*
ΣΤΡΟφΗ, ΡΟΗ, ΤΡΟφΗ, ΑΣΤΡΑ, [ΚΑΤΑΤΡΟφΗ], ΣΟΡΑ, ΣΟΡΟ, [ΟφΗΣ], ΚΟΡΗ, ΤΑΡΑΣ, ΤΑφΗ, [ΚΟΣ], [φΟ̄ΤΑ], Κ̄ΑΤΑ[16]

(d) *BARMAN*
BAR, MAN, MAAR, RAAM, NAAM, NAM, MAAN, MA

Given this ability, it is not surprising that Christopher is good at anagrams and crosswords. He was presented with the task in (4) (from a children's puzzle book) and completed it with enthusiasm and considerable ease (Christopher's answers are given on the right).

4 BIRD ANAGRAMS
Unjumble the letters and find 10 common seabirds

(a)	FUPNIF	PUFFIN
(b)	NANGET	GANNET
(c)	TREN	TERN
(d)	BOLLRAZIR	RAZORBILL
(e)	WELRUC	CURLEW
(f)	CARMORTON	CORMORANT
(g)	KAWITEKIT	KITTIWAKE
(h)	DIREE CUDK	EIDER DUCK
(i)	REHRING LULG	HERRING GULL
(j)	YESCHOTCARERT	OYSTERCATCHER

It took him 2 minutes 30 seconds to complete this task, but this time included his being prompted with the first letter for 'gannet', together with a discussion of their greedy habits, remarks on the fact that the Chinese used cormorants to catch fish for them (which Christopher knew), on the fact that eider ducks provide feathers for eiderdowns, questions about the Greek word for 'puffin', and so on. He was likewise able to complete a

crossword, whose clues are exemplified in (5). Christopher's answers are given in parentheses.

5 Where the Great Barrier Reef is found (9) (Australia)
A fish made in heaven (9) (Angelfish)
What the Great Barrier Reef is made of (5) (Coral)
The Great White and Basking are types of (5) (Shark)

This proficiency, matched by his ability to write backwards and locate words in hidden squares, is in marked contrast with his inability to master games such as word-ladders. Thus presented with several examples of how to get from 'HEAT' to 'FIRE' or from 'LOVE' to 'HATE' as illustrated in (6):

6 HEAT – HEAD – HERD – HERE – HIRE – FIRE
LOVE – HOVE – HAVE – HATE

he seemed never to understand the task. Similarly, we found it impossible to get him to give judgements about what was a possible word of English (or other languages). Given the list in (7) and asked to mark which words might be possible words of English, even though he might not know them, he simply crossed out everything, except 'TSIMPLI':

7

STORKIN	KLUWER	MUDMUD	OVALO
GNUT	TSIMPLI	SNOOVE	PLISS
BNICK	SKAGLISH	LSIP	FNUG
SPHENIC	GREFT	SPACK	BLICK
UNGLE	WOOOM	NTENT	MAWK
TSICK	PSACK	RPIG	GRUNBLE
KMOW	BPOAT	VROKE	

That he really has slightly better knowledge of possibility than this is attested to by the test given in (8):

8 The Unilever company has invented a new form of soap and wants a good name for it. Put the following suggested names in order of preference and add a new name of your own:

(a) Uni-sope
(b) Psoon
(c) Snoaf
(d) Kill-grime

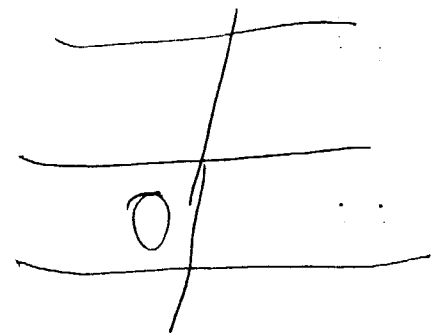
(e) Thirteen (unlucky for dirt)
(f) ?

If the soap was to be marketed in Greece, which order would you put the names in?

Although Christopher neither ordered the names nor suggested new possibilities, it is perhaps not insignificant that for English he ticked 'Uni-sope' and 'Kill-grime', whereas for Greek he ticked 'Psoon' and 'Thekatria'[17] while crossing out 'Uni-sope' and 'Snoaf'.

Finally, we should mention that Christopher has never been able to devise a winning (or non-losing) strategy for noughts and crosses (tic-tac-toe) or draughts (checkers), although he is quite happy to play them. Indeed, he is usually unable even to draw a grid for noughts and crosses and frequently tries to put in several marks at a time. A typical example of his attempts in this direction is given in (9):

9



However, if his opponent deliberately contrives to lose – by putting her crosses in inappropriate squares of the grid, so that Christopher's only option is to 'win' – he recognizes that he has won, and shows some pleasure in the fact.

Not the least remarkable aspect of Christopher's talent is that it has flourished in an institutional setting, prompting the question of how he has learnt his various languages. In many cases, for example the Scandinavian languages, he has simply devoured introductory books of the *Teach Yourself X* or *Y in Three Months* variety, and for these languages his pronunciation is fairly bad. Other languages he has picked up by interacting with native speakers: he gains great pleasure from using such people as linguistic informants. In these cases, such as Hindi, his pronunciation is somewhat better, though even here native speakers may

find it initially almost impossible to decode what he says. Finally, for some languages, for example, French, German and Spanish, he has received explicit instruction and even has formal qualifications (specifically GCE 'Ordinary' level). While still noticeably 'schoolboyish', his accent in these languages, as in Modern Greek for which he has had most practice over the last four years, is distinctly better than the others. It should go without saying that his slight speech defect, allied with a tendency when excited to speak faster than is advisable, can make his language hard to follow: particularly if, for instance, he is translating between languages one barely knows oneself.

Theoretical Background

To make possible an understanding of Christopher's case from both a psychological and a linguistic perspective we introduce certain fundamental notions of current linguistic theory, and embed them within a more general framework of a theory of cognition. We outline the innateness hypothesis[18] as it relates to language, and Fodor's (1983) modularity hypothesis, as reformulated in the light of Anderson's (1992a) cognitive theory of intelligence and Sperber and Wilson's (1986) theory of relevance.

Innateness

That some aspects of our linguistic knowledge are innate (more accurately, 'genetically determined') follows from a number of considerations. The most compelling of these are on the one hand, the existence of universal properties of language and, on the other, the poverty of the stimulus: the fact that as speakers of a language we know more than it is possible for us to have learned on the basis of the input we are exposed to.[19] In the present context, postulating the innateness of a body of information specific to language accounts for a variety of psycholinguistic phenomena: first, the uniformity of the mature state of linguistic competence attributed to all native speakers of a language; second, the existence of common developmental patterns in the process of first language acquisition; third, the occurrence of cases of neurological breakdown resulting in selective impairment to the linguistic component of our mental architecture. (cf. p. 3).

Principles and parameters The part of our linguistic knowledge that is innate, that is, available by biological necessity, is known as Universal Grammar (UG). UG consists of a set of principles, some of which are absolute and some of which are parameterized. Absolute principles, such as the principle of structure dependence, define the design characteristics of language. Parameterized principles, such as the null subject parameter, provide a set of alternative options according to which languages may differ; in this case for instance, whether they allow null-subjects. In other words, principles of UG are responsible for the underlying similarities across languages, while parameters are responsible for cross-linguistic variation (see Chomsky, 1986a). All languages constrained by UG are, by definition, 'possible' languages, and the standard assumption for first language acquisition is that linguistic development is constrained by principles of UG in the sense that all intermediate stages of development observe the restrictions imposed by UG.

Closely associated with the assumptions of the innateness hypothesis is the notion of 'critical period'. The idea is that biological systems, of which one is language, are particularly sensitive to incoming perceptual stimuli during a specific stage of development. If for any reason language fails to develop during this period, then normal linguistic competence may never be attained. The best-known example of such a case is Genie (Curtiss, 1977), whose isolation and severe deprivation over a period of twelve years resulted in her being permanently linguistically impaired.

The acquisition of one's first language takes place during this critical period, when the innately available body of information which constitutes UG interacts with linguistic experience to set parameters to their target value; that is, the value for the language being acquired. At this level of abstraction, there is general consensus among researchers working within this framework, but differences of opinion appear when details of the actual course of linguistic development are taken into consideration. Current debate is divided between two incompatible and competing theories of first language acquisition: the maturation and the continuity approaches.

Continuity vs. maturation A major issue in first language acquisition is identifying and explaining the child's transition from one stage of development to another. In a continuity framework (e.g. Pinker, 1984; Hyams, 1987), this development is viewed as a process in which the child matches parametric values with the appropriate syntactic categories when he or she is presented with relevant linguistic input. This presupposes the existence of a pre-existing structure with some parametric values associated with, for example, inflectional categories, underspecified (Weissenborn, 1990; Pierce, 1989; Hyams, 1987; Wexler, 1993). Child grammars are constrained by principles of UG and, in some versions of the theory, by initial parameter settings with a 'default' or 'unmarked' status (Hyams,

1986). When triggering data, that is, linguistic data that serve as triggers for parameter-setting, become available, the grammar gradually changes, signalling a transition from one stage of acquisition to the next. When this process is complete the mental representation of the grammar is said to have reached the mature or steady state.

By contrast, a maturational account necessarily presupposes that certain constructs of the innately available linguistic information are subject to a predetermined order of emergence. This implies that transitional stages in linguistic development result not only from mapping triggering input onto a given body of information, but also from intrinsic changes caused by a biological programme affecting the language module exclusively.

Depending on the syntactic theory assumed, different versions of this approach attribute maturational restrictions to different elements of the grammar. According to one school of thought, maturational constraints affect particular principles of UG (Felix, 1984; Borer and Wexler, 1987, 1988). An alternative view restricts maturation to the set of functional categories. This approach differs from the preceding one in that principles of UG are taken to be available throughout the process of language acquisition, whereas the set of functional categories (such as inflection, complementizers, determiners, case) is not available at the early stages of development (Guilfoyle and Noonan, 1988; Radford, 1990; Tsimpli, 1992). According to this approach, language acquisition does not consist in assigning appropriate features to an underspecified, albeit fully fledged structure; rather, it consists in a process of structure-building which correlates with the emergence of functional categories in the language module.

We will maintain that the set of functional categories constitutes a sub-module of UG, namely the UG lexicon. Each functional category is associated with an entry specified for relevant functional features (Tsimpli and Ouhalla, 1990). Parameterization is then defined in terms of a finite set of alternative values that a functional category can be associated with. Cross-linguistic variation is thus restricted to differences in the parametric values of functional categories (Chomsky, 1991c; Ouhalla, 1991; Pollock, 1989). These assumptions, in conjunction with a maturational approach to language acquisition, have certain implications: first, the inaccessibility of the functional module at the early stage of acquisition; and second, the lack of cross-linguistic (i.e. parameterized) differences in early grammars. Moreover, if we assume that the critical period hypothesis is correct, maturational constraints on the functional module can be interpreted as entailing its complete inaccessibility after the end of this period. The importance of this suggestion in the current context is that it has clear implications for adult second language learning: UG may still be available

but parameter-resetting can not be. We come back to this issue later in this chapter.

Although a detailed discussion of issues in first language acquisition is beyond the scope of this monograph (see Atkinson, 1992; Roeper and Williams, 1987; A. Smith, 1988; Tsimpli, 1992), we will briefly present some of the ideas relevant to our discussion of Christopher's performance in his first and other languages. In particular, the role of morphology and its status in the organization of the grammar is an issue that will be shown to raise interesting questions about Christopher's exceptional language learning abilities.

The morphological component as an interface level

According to some researchers, the claim that functional categories mature is supported by morphological evidence (see, e.g., Radford, 1990). The idea is that there is a systematic correlation in early grammars between the absence of functional categories in the syntax and the absence of their morphological realization. Early data from some languages, for example English, seem to support this correlation to a certain extent. Thus the absence of the functional category DET correlates with the fact that early noun phrases include no determiners; and inflectional morphology seems to be missing from the verbal form, mirroring the absence of the syntactic category INFL. Pushed to its logical conclusion, this correlation suggests that syntactic properties associated with functional elements can only be shown to be part of the child's grammar if these functional elements are morphologically realized in a consistent way.

However, data from languages which have a rich morphological system of case and inflection seem to counter-exemplify this strong generalization (see Tsimpli, 1992). Early data from Greek and Spanish, for example (Pina, 1984), show that agreement morphology is available from the earliest appearance of verbal forms. Similarly, aspectual distinctions in Greek, Spanish, Irish, German and English appear to be morphologically marked in a way similar to the corresponding adult grammars. From this, however, it does not follow that the corresponding syntactic categories have matured in the sense that they are able to project the relevant X-bar structure. Thus, unless one attempts to define morphological constraints as independent of syntactic ones it seems that the differences mentioned above require an independent explanation. In other words, if morphological realization corresponds to syntactic availability the question that needs to be answered is why the same functional category emerges or matures in one language earlier than in another. This problem is particularly evident in a

maturational approach where the effect of triggering data is not the only way of accounting for changes in emerging grammars. That is, if structure-building is the result of an in-built programme, morphological triggering alone cannot be a satisfactory explanation of the course of language acquisition. Nevertheless, if the availability of triggering data is a partial answer to this problem, what needs to be explained is the extent to which rich morphology is a 'stronger' trigger than impoverished morphology. Is it a universal rule that rich morphology has particular syntactic consequences or is it the case that variation in syntactic terms is not necessarily reflected in morphological properties? For example, although it is true that most null-subject languages exhibit rich subject–verb agreement morphology, languages like Chinese and Japanese are null-subject languages with no such morphological realization. Accordingly, Jaeggli and Hyams (1988) suggested the Morphological Uniformity Hypothesis, according to which languages could be pro-drop if they were morphologically consistent, either by having distinct forms for all members of the paradigm or by having the same form for all members of the paradigm. If the null subject of finite clauses is syntactically realized as pro in all null-subject languages, should we expect a difference in the acquisition process of these languages depending on the presence or absence of a morphological trigger? Further, should we expect languages like English, with almost non-existent agreement morphology, to exhibit patterns of acquisition parallel to those of morphologically similar but syntactically distinct languages? It is well known that linguistic elements with different syntactic feature specification may be homophonous: 'that' in relatives and embedded declaratives, for instance (see Rizzi, 1990). Presumably the 'acquisition' of these homophonous elements can be said to have occurred if the distinct features are acquired and associated (in this case) with the C head in the respective constructions. In the absence of definitive positive answers to such questions, it seems that morphological properties alone are inadequate to characterize the notions of 'strong' and 'weak' triggers in an account of language acquisition.

On the other hand, there do seem to be constraints defined exclusively on the basis of morphological properties. For example, the affixal nature of a functional morpheme is relevant in defining the obligatory movement of this element to an appropriate host category at the level where morphological constraints apply (Lasnik's Filter or the Stray Affix Principle: see Pesetsky, 1989). Moreover, in derivational morphology, morphological rules are standardly assumed to apply independently of the syntax; and much of inflectional morphology has been argued to be the result of verb-raising to inflectional heads in the structure of the clause (Baker, 1988; Pollock, 1989; Ouhalla, 1991; Chomsky, 1991c). Within a minimalist

approach, however, verbal forms are inserted as morphologically complex units and head-movement is motivated by syntactic (feature-checking) considerations (Chomsky, 1993a). We can thus conclude that syntax and morphology are to be kept distinct, with any possible interaction theoretically formulated in a specified way.

If this conclusion is correct, the alleged correlation between syntax and morphology in early grammars cannot be taken at face value. If functional categories, on one hand, and their morphological realization, on the other, belong to independent components of the grammar, the emergence of morphology and syntax could be argued to exhibit differences in virtue of the differences in the constraints that regulate each of the two components.

In an attempt to generalize beyond issues of first language acquisition, we suggest an extension of the traditional distinction between syntax and morphology. Specifically, we assume that the morphological component constitutes an interface level between the grammar and the conceptual/mental lexicon (see Tsimpli, 1992). Unlike the functional module, the mental lexicon is assumed to form part of the central cognitive system. One reason for distinguishing between a conceptual lexicon and a linguistic lexicon is that the former corresponds to the vocabulary used in the language of thought, in logical inferencing and indirectly in real (truth-conditional) semantics. Assuming that this vocabulary reflects mental properties which are not purely linguistic, and further that it does not need to refer to language-specific differences in the syntax proper, we suggest that mental entities featuring in this interface level of representation are not contained within the language module. The mapping of concepts and conceptual structure onto words and argument structure in a given language is carried out in the interface module, that is, the morphological component, the level that contains the morphological realization of both functional and substantive categories. The morphological component constitutes an *interface* in that it is accessible to both grammatical categories – functional categories and substantives – each set belonging to an independent component of the mental system.

The nature of the interface level that we have characterized as the morphological component can be further specified in the light of certain assumptions about concepts within a relevance-theoretic account of cognition.

Relevance and modularity

Relevance Intuitively, an utterance or other stimulus is relevant if it tells you something you didn't know, or weren't consciously aware of before.

Such information is context dependent, in that an utterance is relevant in a context if you can use it, together with that context, to deduce something which was apparent from neither of them taken alone: whether this is new information, the strengthening of a previously held assumption, or the contradiction of such an assumption. Every utterance has a variety of possible interpretations, not all of which are equally accessible to the hearer on a given occasion. Hearers are equipped with a single, general criterion for evaluating such interpretations as they occur to them; a criterion, moreover, which is sufficiently powerful to exclude all but a single interpretation. This 'criterion of consistency with the principle of relevance' starts from the general claim that human cognition is relevance-orientated. Relevance itself, as indicated informally above, is defined as a joint function of the achievement of contextual effects and the amount of effort needed to achieve them. The 'principle of relevance' states that communicated information creates an expectation of relevance: engaging someone's attention by speaking to them guarantees that (you think) what you are saying is worth their attention. (You may of course be wrong.) An utterance is 'optimally relevant' if it achieves enough effects to be worth the hearer's attention and does so without causing undue processing problems. An utterance is then consistent with the principle of relevance 'if and only if the speaker might rationally have expected it to be optimally relevant to the hearer on [a given] interpretation'. (Smith and Wilson, 1992: 6).

Relevance theory makes specific assumptions about the nature of what we refer to as the mental lexicon, postulating that each concept is characterized in terms of three entries: logical, encyclopaedic and lexical (Sperber and Wilson, 1986: 86). The logical entry can be best exemplified by reference to natural language connectives, such as *and*, *or*, *if*, which have been argued to be semantically equivalent to the corresponding truth-functional connectives (Grice, 1967; Carston, 1993; Smith, 1983a; Smith and Smith, 1988). The encyclopaedic entry refers to idiosyncratic knowledge associated with a certain concept; for example, the entry for 'cat' may include information about its domestic nature and that it is furry, as well as cultural or superstitious beliefs associated with it. The lexical entry includes phonological, morphological and semantic information as well as categorial features. In this respect, the lexical entry is used in the standard sense (Chomsky, 1965; see also Andrews, 1988).

Notice that not all conceptual addresses have entries of all three types. For example, the logical entry of a concept like 'cat' is unspecified, as it has no function corresponding to an element in formal logic. Similarly, natural language connectives have a logical entry and a lexical entry, including morphophonological properties, but probably lack an encyclopaedic entry.

Encyclopaedic entries differ widely from person to person, as they contain idiosyncratic information which, by definition, may vary across individuals. Logical entries and lexical entries, however, being associated with formal systems, logic and language respectively, vary minimally, if at all, across speakers of the same language.

Crucially, note that entries associated with the same concept do not necessarily belong to the same mental system. Lexical entries, for example, contain linguistic information and so belong to the language module, whilst encyclopaedic entries contain remembered information and so belong to the central system. If we define entries in terms of their functional properties, then logical entries belong to the level or levels at which (valid) inferencing and truth-conditions are relevant. If this level is post-LF but prior to at least some aspects of pragmatic analysis we can assume that it is not fully contained in the language component (Wilson and Sperber, 1986, 1993; Clark, 1991). Similarly, encyclopaedic entries refer to extra-grammatical information and are relevant to central processes, such as inferencing and pragmatic interpretation. Therefore, neither the logical nor the encyclopaedic entry fall within the language module properly speaking.

Let us now concentrate on the lexical entry. Following the discussion on pp. 25–7, it seems that the morphological component we characterized as the 'interface level' is a plausible candidate for the location of the lexical entries of concepts. Recall that the morphological properties of both substantive and functional categories are assumed to be realized at the interface. If this is correct, then what is standardly referred to as the lexicon is being interpreted in our terms as the morphological component. However, there are certain differences between the information contained at the interface level and that contained in what is standardly referred to as the lexicon. In particular, whereas the latter is understood to be the basis from which syntactic representations are formed, the former is not characterized as such. While interaction between them is possible, the two components are dissociated and parallel. In other words, morphological properties do not constrain syntax and thus need not necessarily reflect syntactic properties. The assumption that the lexical/morphological component is not the input to the syntactic structural level implies that the well-formedness of the syntax-morphology mapping must be checked independently, by means of an algorithm, most plausibly SPELLOUT in the sense of Chomsky (1993a). Moreover, the interface nature of the lexical component discussed here means that it is not necessarily the only level at which information related to the lexical elements is contained. If functional categories are part of the UG lexicon and substantive categories are part of the mental lexicon, the morphological representation of each member of

the two sets is uniquely available at the interface, even though their sources differ.

As will be seen later in this chapter, assumptions about the nature of the interface level, the language module, the central (cognitive) systems, and possible interactions between them, are directly related to our analysis of Christopher's exceptional language *vis-à-vis* his other cognitive abilities. In this respect, the above account of the interface level as including lexical information can be viewed as an example of interaction between different sub-systems of the mental organ. In terms of the Modularity thesis suggested by Fodor (1983), the mapping process suggested above can be understood as characteristic exclusively of interface levels, as the nature of modules, in particular their property of informational encapsulation, prohibits any other kind of interaction. Fodor's view of mental architecture makes explicit claims about perceptual systems, including language, while claims about central cognitive systems are relatively vague.[20] Christopher's case presents a challenge to us to reconsider and elaborate on Fodor's views in connection with the nature of the central systems.

Modularity According to the modularity hypothesis, the human mind is not an unstructured entity but consists of components which can be distinguished by their functional properties. The basic distinction relevant to cognitive architecture is that between perceptual and cognitive systems, where the former pertains to the sensorium plus language, while the latter refers to 'central' systems responsible for the fixation of belief, for thought and for storing knowledge.

Perception is carried out by *modular systems* which are domain-specific, fast, mandatory, subserved by specific neural architecture – hence subject to idiosyncratic pathological breakdown – and most importantly are *informationally encapsulated*. This notion refers to the impossibility of total interaction between intra-modular operations and the central system(s). More precisely, the claim is that operations within modules are inaccessible to central control; the flow of information is only bottom-up. A clear example is provided by the existence of optical illusions such as the Müller–Lyer illusion (in which a line with inward-pointing arrowheads is seen as longer than a line of the same length with outward-pointing arrowheads) which are still seen as illusions even when one knows the facts. In the case of the language module, informational encapsulation implies that certain levels of representation, for example syntactic and phonological representations that are completely internal to the language module, are inaccessible to central operations. Pragmatic interpretation in contrast is an interactive process involving the output representation of the language module and central systems, where general or encyclopaedic knowledge is stored.[21]

Modules also differ from central systems in being equipped with a body of genetically determined information specific to the module in question which, in the case of language, is UG. This information, in conjunction with algorithms necessary to account for language learning, constitute the basis for claims of innateness. Thus, modularity and innateness within Fodor's theory are intertwined notions.

Moreover, as indicated by Fodor's 'First Law' (see note 20), the central systems are assumed to be resistant to scientific theorizing, precisely because of their putative lack of modular characteristics. We shall argue later that some parts of the central system are quasi-modular in structure, but it is clear that central processes such as inferencing are qualitatively different from processes found in modules. That is, central processes are not domain specific and involve information drawn from the sensorium as well as knowledge couched in propositional form in the memory store. It follows that we cannot always generalize from what we know about modular operations to central ones.

Anderson's theory of intelligence

Despite this widespread pessimism about the tractability of non-modular systems to investigation, Anderson's (1992a, 1992b) theory of intelligence is an attempt to formalize properties of central systems within a (modular) theory of mind. Anderson's model (see figure 1.5) 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 chapter 5). 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, 1992a: 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.[22]

As modules are, by hypothesis, informationally encapsulated, their

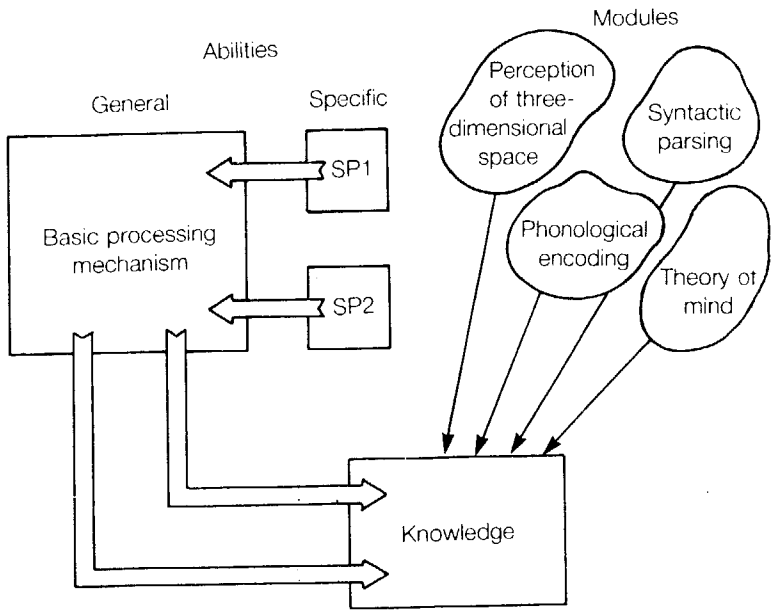


Figure 1.5 *Anderson's model*
Source: *Anderson (1992a)*

outputs must be evaluated by considerations of *relevance* before they can constitute appropriate input to the Knowledge Base. Although Anderson is somewhat reticent on the subject, we assume that this *evaluation mechanism* is mediated by the third main component of the model consisting of 'specific processors' (SP), of which Anderson postulates at a minimum two. While these both (all) have Turing machine power (see Anderson, 1992a: 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 each one 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 pre-eminently devoted to *successive* processing, which 'takes place in a temporal sequence' (Anderson, 1992a: 83), and is held to underlie proficiency in serial recall, digit span, and so on. The 'visual' SP is pre-eminently 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 visualization and perhaps tests such as Raven's Matrices. As the operation of the SPs is mediated by the BPM (see figure 1.5), 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.[23] 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 has little to say about the place of skills in his model, it is hard to be more specific.

While we agree with Anderson on many aspects of the overall structure of his model, there are areas of disagreement as well. An important case in point is provided by his assumptions about the theory of mind and its location in the system. For Anderson it is a (Fodorian) module, whereas we consider it to be part of the internal structure of the central system. (See Smith and Tsimpli, 1993, where we suggest the model in figure 1.6 to replace Anderson's in figure 1.5, and especially chapter 5 for justification and further modification.)

A crucial characteristic of the theory of mind is that it involves the formation of second-order representations, enabling subjects *inter alia* to project other people's thoughts. We would like to argue that such projection is carried out by embedding one proposition under another which, by means of a modal predicate, attributes the statement to a referent distinct from the subject.

We shall come back in chapter 5 to a detailed discussion of this issue in relation to Christopher's performance in psychological and linguistic tests involving second-order representations. For the moment, it suffices to say that a common claim in the literature on autism is that a general characteristic of autistic people is their inability to form second-order representations (for discussion, see a number of the contributions in Baron-Cohen et al., 1993). In terms of a theory of the central systems this could be viewed either as a malfunction of the subcomponent referred to as theory of mind or as the reflex of a more general deficit (see Smith and Tsimpli, 1993: 428).

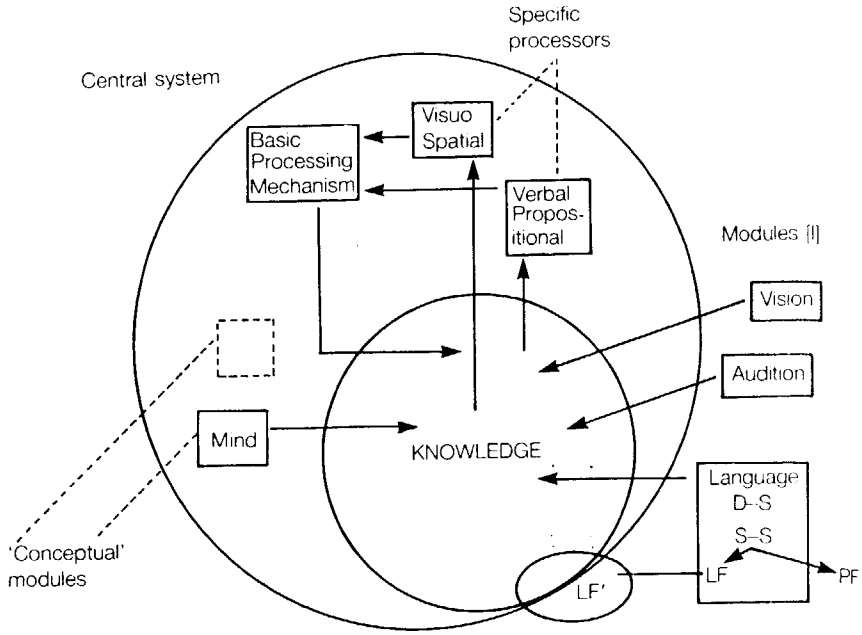


Figure 1.6 *Anderson's model revised*
Source: *Smith and Tsimpli (1993)*

If pathological disorders involve selective impairment of parts of the central system, we can use them to gain insight into its structure. More importantly, such evidence would indicate that Fodor's assumptions about some of the characteristics of the mind-brain need to be reformulated in order to accommodate mental components which satisfy only some of the defining criteria of modules. In any case, the property of informational encapsulation appears to characterize modular rather than quasi-modular central systems, even if the existence of the latter casts doubt on the assumption that the properties of central systems resist scientific theorizing.

In this context we need to reconsider the assumption that the lexical entry of concepts is contained within the morphological component. Such an assumption is consistent with the claim that central systems have limited access to modules only if the morphological component constitutes an interface between the language module and the mental lexicon. This position is at variance with standard assumptions about the lexicon according to which it constitutes the base from which syntactic structures

are projected. If 'lower' levels are less accessible to cognition, it would follow that lexical information is similar, in terms of encapsulation, to syntactic information. We will argue, however, that whereas syntax seems to be impenetrable by central systems, i.e. it is strictly modular, lexical information is not.

Second language acquisition

Recent research in second language acquisition within the principles and parameters framework has addressed a number of controversial questions. The most important of these are the respective roles of UG and of the first language in the process of second language acquisition. Different possible answers to each of these questions have considerable theoretical consequences and make powerful predictions with regard to the L2 data.

There are certain radical differences in an individual's acquisition of his or her first and subsequent languages. First, while negative evidence in the form of explicit instruction and correction is implausible (for both empirical and theoretical reasons – but see Bowerman, 1987, and Braine, 1963) in first language acquisition, it is not totally excluded in second language learning. Second, the fact that, pathological cases aside, adult second language learning is at least temporally related to cognitive maturity distinguishes it from first language acquisition, where cognitive development is still under way. This relates to the first point because, if negative evidence does play a role in second language learning, this can be attributed to the fact that the availability of a hypothesis-formation and confirmation procedure which is sensitive to all types of evidence (including negative evidence) presupposes a certain cognitive maturity. The third and most crucial difference between first and second language acquisition concerns the question of ultimate attainment (Birdsong, 1992). The usual failure to achieve native-like competence in a second language contrasts sharply with one of the basic characteristics of the first language: namely, the uniform attainment of a mature steady state in a deterministic fashion.

One well-known approach (Clahsen and Muysken, 1986; Bley-Vroman, 1989) suggests that the acquisition of a second language is qualitatively different from that of a first language. The core idea is that for first language acquisition the language module, i.e. UG and parameter-setting, can provide an adequate description of the process involved, whereas learning a second language crucially involves general learning mechanisms. That is, inductive learning strategies are crucially operative in the processing of L2

input data, and the construction of the L2 grammar is mediated by mental mechanisms which lie outside the language module.

However, this hypothesis has been challenged by recent experimental studies which suggest that principles of UG constrain L2 grammars much as they constrain L1 acquisition (White, 1989; Schwartz, 1993; Schwartz and Sprouse, 1993; Eubank, 1993). This alternative view holds that second language acquisition is similar to first language acquisition in all the theoretically important respects: namely, in the role of principles of UG and in the availability of parametric choices. More precisely, the assumption is made that parameter-resetting does take place, albeit in a comparatively delayed fashion, as the parametric values of the first language have already been set. 'Transfer errors' are then accommodated within this approach as reflecting transitional stages in the development of the second language.[24] Crucially, however, knowledge of the first language does not prevent L2 learning from operating under the same principles that L1 acquisition does.

Assuming our earlier claims about the maturation of functional categories in first language acquisition are correct, they have specific implications for any language learning process which occurs after the critical period. If the functional module is subject to maturational constraints and the possibility of parameterization depends on the accessibility of the functional module, it follows that adult second language learning cannot involve parameter (re)setting (see Tsimpli and Roussou, 1991; Tsimpli and Smith, 1991).

If maturational constraints are operative, the idea is that the linguistic sub-module affected becomes inaccessible after the relevant period. Accordingly, as principles of UG constitute a universal template on which any human language is based, they always constrain language acquisition, be it L1, L2 or L*n*. In the event that a learner's L2 grammar appears to approximate to that of a native speaker, the theory assumes that it none the less does not have the same status. Rather, where the first language differs from the second language, native-like performance is taken to be a function of an alternative choice regulated by UG and adopted by the L2 grammar (cf. Sorace, 1992). Needless to say, this assumption can be justified only if the second language learner's performance diverges from that of the native speaker in some relevant respect. In sum, while this approach to second language acquisition is theoretically not implausible, its validity depends crucially on the issue of ultimate attainment. Thus, although investigations of the developmental process of second language acquisition can be fruitful with regard to the two basic issues in the field, namely the role of UG and of the first language, it seems that questions concerning the absence of parameter resetting can be answered only in the light of what constitutes a possible final state in second language learning.

Hypotheses

Keeping in mind the above discussion of modularity and linguistic theory we can now view Christopher's case in perspective. The relevant questions are the extent to which Christopher's linguistic and other behaviour can be described within the bounds set by Fodor's theory of mental architecture; and whether any reformulations of the theory are necessary for an adequate descriptive account of this unique case.

As regards linguistic theory, in particular as it involves second language learning, the issues are equally if not more complex. Can Christopher's linguistic performance in his non-native languages be described independently of his general cognitive abilities or is there some parasitic relation between the two? Further, is this interdependent relationship evident at all stages of his 'second' language learning or does it become relevant only in the later stages? How can such suggestions be accommodated in a general theory of second language acquisition?

Modularity

Assuming that the basic thesis concerning the modular status of the language faculty is correct (but see chapter 5 for some modifications and reservations), Christopher's case is important for obvious reasons. The sharp contrast between his verbal and non-verbal performance in a range of psychological tests gives clear *prima facie* support to the claim. In particular, his average or above-average performance in tasks involving language shows that whatever his impairment may be it has not affected those mental operations that crucially or exclusively involve language.

Assuming further that the biological development of modular, perceptual systems is independent of the development and level of attainment of the central systems, Christopher's native language competence is of vital importance. If it can be demonstrated that his knowledge of his first language is comparable to that of any other native speaker of the language, we can conclude that the underlying language-specific mechanisms are basically intact. This, however, represents just a first and fairly naive approach to the problem. As we are dealing with linguistic performance, there are certain phenomena, of sentence processing for example, that cannot be explained on an exclusively linguistic basis. Recall that constructing higher levels of representation on the basis of contextually

determined pragmatic inferencing involves an interactive process between language, the central knowledge store and real semantics. Given that the nature of the interface levels and of central operations is to a large extent unclear, a performance deficit involving pragmatic or logical structures in relation to a linguistic input may muddy an otherwise clear picture. Specifically, performance limitations may in Christopher's case obscure the initial distinction mentioned above between 'language' and 'central cognitive abilities'.

In an attempt to dissociate core linguistic, i.e. modular, from interactive, i.e. non-modular levels of representation, our aim was to test Christopher on syntactic phenomena in English which have received a plausible account within the framework of current syntactic theory. If his performance is comparable to that of other native speakers we can claim that an account of his linguistic knowledge requires no stipulatory assumptions added solely to accommodate his exceptional case. In order to clarify the areas in which Christopher's linguistic performance may deviate from that of a normal speaker, we have therefore carried out further investigations of his linguistic behaviour. In some cases, for example metalinguistic negation, we argue that this crucially involves extra-linguistic knowledge. If we conclude that there is indeed such divergence from the norm, this need not necessarily impugn the initial claim that his competence is intact. More precisely, the modularity thesis can still be supported even if in certain respects Christopher's linguistic behaviour appears to be abnormal, provided that the relevant respects are not strictly internal to the language module. The question of clarifying the nature of the deficit concerned remains, of course.

With respect to operations carried out by the central systems, the issues are much more complex. Christopher's translating abilities, although remarkable in terms of speed, are unusually flawed in terms of sensitivity to contextual information and linguistic constraints. If such linguistic constraints are observed in other tasks involving his knowledge of other languages, we have to assume that the particular task of translation makes only restricted use of linguistic information. We therefore face the question of how to identify the areas that are actively involved in translation and, to the extent that the output is deviant in Christopher's case, of how to describe the deficit in relation to other areas of his performance which exhibit similar shortcomings. We will discuss Christopher's translations in more detail in chapter 5.

Psychological tests standardly associated with the investigation of autism (see pp. 5–7) raise interesting questions about the quasi-modular nature of the central systems, for instance, the theory of mind. Christopher's performance in such tasks, especially when compared to his ability in, for

instance, pragmatic inferencing, is indicative of the distinct status of the underlying mechanisms involved in carrying out central operations. Such results from Christopher's performance are crucial in specifying what constitutes a deficit in his non-linguistic cognitive abilities. One of the puzzles that any case of the savant syndrome presents is the contrast between a specific, enhanced mental talent and an otherwise subnormal mind. The picture in Christopher's case would be particularly elegant if the language module was normal, some processing mechanism associated with linguistic decoding was enhanced, and the rest of his cognitive abilities were severely damaged. However, any evidence that some central operations may be more or less affected than others complicates the picture and requires a more elaborate theory of the central systems to accommodate Christopher's case. For instance, in addition to his quasi-autistic performance on some tasks such as the 'Sally-Anne' test, Christopher fails to conserve number (see p. 5), and it is tempting to attribute this too to a deficit in some dedicated sub-part of the central system.

Second language learning

Christopher's linguistic talent is characterized as exceptional for various reasons. First, the speed with which he learns a new language and his ability, after minimal exposure to the new data, to construct sentences observing morphological and syntactic requirements is remarkable[25] (see chapter 3). Second, his knowledge of vocabulary in the languages he knows (which naturally varies depending on the time he has spent on each) and his ability to access this knowledge instantly are unusual when compared to standard cases of second language learners.

To formulate testable hypotheses about Christopher's second language learning we need first to find similarities, if any, between his production data and well-formedness judgements, on the one hand, and those of average second language learners, on the other. If it transpires that the status of Christopher's 'second' languages is comparable to that of other learners we can assume that any theory of second language acquisition that accounts for them would also account for him. However, as is well-known, there are distinct stages in the process of second language learning, each of them characterized by such considerations as the occurrence of 'transfer errors', the degree of deviance from the target second language, and the nature of that deviance, that is, whether it corresponds to an option made available by UG, albeit not that of the target grammar, and so on (see White, 1989, among others). As already discussed (see pp. 35–6), one of the most crucial questions on which much of the issue of the nature of second

language learning, as opposed to first language acquisition, depends is the notion of ultimate attainment. Assuming that in the standard case second language learners may achieve considerable fluency or even near-native-like competence,[26] Christopher's case raises the question of whether it is plausible to characterize his knowledge of French and Greek, the languages he is most fluent in, as near-native-like or not? If not, as our results so far show, then he is not comparable to other second language learners in that he exhibits a cut-off point beyond which any further restructuring of his L2 grammar becomes impossible. Our hypothesis on this issue involves characterizing the difference between Christopher and others in terms of the nature of the underlying mechanisms responsible for this contrast. Thus we need to determine whether his limitations are properly linguistic, revolving around the inaccessibility of parameter-resetting, or whether they are the result of an interactive process. In the latter case this might involve a deficit in some processing or evaluation mechanism responsible for filtering out unanalysable data and reassessing them on the basis of options which are made available by UG and which may or may not be instantiated in the first language. This is perhaps a normal result of constructing interlanguage grammars, and Christopher's peculiarity is in part that his progress is subject to premature 'completion'.

Christopher in context

There are now several well-documented cases of dramatic dissociations between linguistic and general cognitive abilities which serve as an instructive comparison with Christopher's case. These include cases of fluent language in the presence of severe cognitive deficit, and seriously impaired language in the presence of high non-verbal intelligence. The former include Williams Syndrome children (see, e.g., Bellugi et al., 1993; Thal et al., 1989), 'chatterbox' children (see, e.g., Cromer, 1991); hyperlexics (see, e.g., Cossu and Marshall, 1986), and the case of Laura (Yamada, 1990). The latter include some aphasics, who may be 'severely impaired in aspects of their language, but can often perform normally on other cognitive tasks' (Karmiloff-Smith, 1992a: 169, citing Shallice, 1988), many autistic people, who may combine impoverished language with otherwise normal intelligence (see, e.g., Fay, 1993; Frith, 1991), and SLI children (van der Lely, 1994; van der Lely and Stollwerck, in prep. a, in prep. b), who are in some sense the mirror image of Christopher in that they exploit central processes to get around their linguistic deficit.[27] The most striking example, however, is the case of the family, half of whose members have (over a period of some three generations) been documented

as suffering from a morphological deficit (Gopnik, 1990 and in press; Gopnik and Crago, 1991; Hurst et al., 1990). Gopnik and her colleagues hypothesize that 'one particular level of grammar that represents abstract morphological features[28] is impaired' (Gopnik and Crago, 1991: 34), and that 'apparent competence exhibited by the adults appears to be a result of a lexical learning strategy rather than the construction of rules' (ibid.: p. 47), as 'grammatical rule-processing and lexical memorization are two psychologically, linguistically and neurologically distinct processes, one of which can be impaired relative to the other' (Gopnik, in press: 40). As will be seen in chapter 5, we suggest a model of the mind and the language faculty which includes a 'functional lexicon' of syntactic categories and an interface between the language module and the central system. Gopnik and her colleagues suggest that the family's deficit resides precisely in that morphological domain in which Christopher excels, suggesting strongly that it is indeed an autonomous component that can be selectively impaired or spared. For Gopnik's subjects it seems to be the case that the deficit in the morphological component stems from the lack (or unavailability) of the primitives of the morphological system. That is, the rules which specify lexical representations and derivations from these representations (for example, by defining their boundaries in the sense of Kiparsky, 1982, and Gordon, 1989) are inaccessible. This shows trivially that the acquisition of morphological entities, as suggested here, does not consist in memorizing level 1 units separated off by # boundaries.

Despite the dissociational similarities among these cases, Christopher is distinct in at least two, related, respects. First, his ability in English is normal and as his intellectual deficit is nowhere near as severe as that of some Williams Syndrome subjects, for instance, the remarkable aspect of his talent resides entirely in its multi-lingual nature. Second, his English is normal, whereas that of the other categories mentioned is remarkable only in contrast with the subjects' other deficits. That is, although Williams Syndrome children have remarkable linguistic ability, their knowledge of English is none the less inferior to that of normal subjects (see Bellugi et al., 1993). Similarly, Laura's ability in English is impressive in comparison with that of other subjects of a comparably low IQ, but is very far from normal (see Smith, 1991, for discussion); and the remarkable linguistic abilities of hyperlexics are again remarkable only in contrast with their other (dis)abilities.

Two further points need to be stressed. First, in contrast to the SLI cases, there is no evidence that Christopher's disability is in any way genetically determined. Second, the linguistic complementarity between Christopher and the other cases cited is not perfect. Although SLI children appear to have a deficit in that (morphological) domain where Christopher's