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Proper Name Hypermnesia in an Autistic Subject

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The case study of an autistic ''savant'' subject with person names hypermnesia is presented. NM's performance in memorizing person names is compared to that of normal controls, IQ-matched controls, and one overtrained control. The data show a selective hypermnesia for both the free recall of person names and the recognition of faces. Recall of common names and of biographical informations linked to faces is unremarkable. NM's hypermnesia is restricted to list learning as low performance is observed in face-name learning tasks. A comparison of the data with that of the overtrained control indicates that training is not responsible for NM's pattern of results. These findings, when combined with previous results involving proper names, demonstrate a double dissociation between proper names and other types of semantic and referential information. However, aspects of NM's performance pattern are more compatible with a network model of proper names than with a sequential model. We propose that the contextual regularity of proper names in ecological situations can be responsible for their high memorization by NM.

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There are logical arguments to support a distinction between proper names and common names. First, common names refer to classes of objects (type-reference) while proper names usually refer to single objects (token-reference; Jackendoff, 1983, pp. 77–94). Second, the relationship between the word and what it represents differs for common names and proper names in that it is more ''rigid'' in the latter. For example, the word Smith is used to refer to the individual ''Smith'' in any situation or language. By contrast, the word ''chair'' can be replaced by ''something to sit on'' or by its French correspondent ''chaise'' according to the situation (Kripke, 1982). Third, most proper names, particularly ordinary person names, do not possess a meaning understood as a set of properties, like common names do (but see Strawson, 1959).

Psychological arguments in support of this distinction were provided by empirical studies of normal subjects and neurologically impaired patients. Indeed, it has been shown under numerous experimental conditions that person names are harder to access than common names. Normal subjects remember biographical information about individuals better than they remember their proper names (Cohen & Faulkner, 1986; McWeeny, Young, Hay, & Ellis, 1987). The tip of the tongue state (TOTS), which is manifested as the inability to retrieve a word when presented with the individual or object it refers to, occurs much more frequently for proper names than for other syntactic classes (Burke, McKay, Worthey & Wade, 1991). Diary studies and studies of laboratory-induced TOTS have demonstrated that during TOTS, the semantic information related to the missing name is frequently accessed (Cohen & Faulkner, 1986). Also, reaction-time studies indicate that normal subjects are quicker to categorize than to name a face (Young, McWeeny, Ellis, & Hay, 1986) and decide more rapidly whether two faces share the same semantic category rather than the same proper name (Johnston & Bruce, 1990). Deciding whether two famous people share the same occupation is also quicker when their faces are presented than when their names are presented (Young, Ellis, & Flude, 1988; Johnston & Bruce, 1990). Normal aging increases the dissociation observed in young subjects between memory for common names and memory for person names (Burke et al., 1991; but see Cohen & Faulkner, 1986). Finally, several authors have described brain damaged subjects who exhibit a pattern of performance that combines anomia for proper names with preservation of general semantic information or information related to the person to whom the proper name refers (Semenza & Zettin, 1988, 1989; Lucchielli & De Renzi, 1992; Flude, Ellis, & Kay, 1989). There is thus considerable empirical evidence to suggest that proper names, particularly person names, differ from common names in being more difficult to remember and more vulnerable to brain damage.

Difficulty in the recall of proper names has been related to different classes of explanations. First, the storage and processing of common names would differ from those of proper names by having a semantic representation. In

contrast to meaningful items, items stored as proper names would share only lexical relationships. This was suggested because the resolution of laboratory-induced TOTS usually involves providing morphological as opposed to semantic information regarding the missing name (Hanley & Cowell, 1988). Separate storage could also explain why an individual's profession is retrieved more often without his name than the reverse case (i.e., his name without his profession), even if it is the same lexical item (for example, in Mr. Smith is a *baker* vs in Mr. *Baker* is a driver; McWeeny et al., 1987; Cohen, 1990). It is worthy of note that famous names and place names are less difficult to remember than other types of proper names (particularly, person's names) (Cohen & Faulkner, 1986). This has been attributed to the fact that these particular proper names, unlike usual persons' names, probably possess some sort of semantic content (Cohen & Faulkner, 1986).

A related explanation attributes the difficulty in the recall of proper names, particularly person names, to their terminal position in sequential face processing. According to the Bruce and Young model (1986), naming a face requires the prior activation of three successive subsystems. The perceptual information extracted from a face activates a Face Recognition Unit (FRU), which is a structural description of the physical properties of the face. FRUs then activate the Semantic Information Units (SIU) relative to the face. This identity-specific semantic information is grouped and located in the Person Identity Node (PIN), a portion of semantic memory that has access to other nodes of information within semantic memory. PIN is accessed through various perceptual modalities. Finally, the SIUs that compose the PIN activate the proper name of the person. This sequential process is usually assessed by paradigms which require the memorization of names and biographical information in association with faces (McWeeny et al., 1987). The model predicts that semantic information should always be more easily retrieved than name information because the latter occupies the final position in the processing sequence (Bruce & Young, 1986; Young & Ellis, 1989). While proper name recall should be conditional upon accessing the semantic information of its reference, semantic knowledge could be accessed without name information being activated. This would explain the TOTS and would account for the absence of cases exhibiting inability to retrieve semantic information about individuals with intact access to their proper names. In this context, the discovery of patients showing proper names recall that surpasses the recall of common names or of biographical information relative to an individual shall have strong theoretical consequences for the models of proper name processing in normal subjects.

Another explanation attributes the difficulty in recalling proper names to the fact that proper names are ''arbitrary''; i.e., they do not intrinsically convey information about the object to which they refer (Cohen, 1990). The word ''baker'' conveys semantic information (for example, profession, hard work, related to bread, etc.) but the proper name ''Baker'' does not as such

convey informations about the characteristics of the individual it refers to (for example, large, grey hair, etc.). This hypothesis has been proposed because patients who are anomic for proper names also have problems learning other kinds of arbitrary labeling, such as titles of pieces of music (Semenza & Zettin, 1989).

Finally, Burton and Bruce (1992) have recently suggested that the main difference between proper names and common names is that the former are unique. For example, while there are many prime ministers, there is only one ''René Lévesque.'' Proper names would thus receive less activation from the PINs than common names which are shared by numerous PINs. In this distributed model, proper names would not be stored separately from common names.

In this paper, we describe an autistic man with mental retardation, NM, who exhibits an exceptional memory that is apparently specific to person's names. A high level of achievement in a circumscribed domain of ability associated with an autistic syndrome is usually known as the ''savant syndrome.'' Various special abilities, for example memory for lists of items, drawing abilities, or mental calculation, have been described in autistic subjects and have been specifically related to this affliction (Rimland, 1978; Healy, Aram, Horwitz, & Kesler, 1988; Rimland & Fein, 1988; Frith, 1989; American Psychiatric Association, 1994). Furthermore, special abilities are observed in the large majority of autistic subjects as exemplified by their exceptional performance level in the block design subtest of the Wechsler Intelligence scale (Tymshuk, Simmons, & Neafsey, 1977; Rumsey & Hamburger, 1988). The special abilities observed in autism would thus arise as the result of their particular cognitive impairment (Frith & Happé, 1994). Recent current accounts of autism suggest that some underlying neurobiological disruptive factors lead to the impairment of one or a restricted number of cognitive functions (Frith & Morton, 1994). We have argued that in-depth studies of savant capacities may represent a precious tool for characterizing these cognitive deficits (Mottron & Belleville, 1994). First, autistic subjects often have a low IQ and their general performance level is often at floor when using complex psychological experiments. In contrast, special abilities are easy to explore with sophisticated manipulations, because of the high performance level reached by autistic subjects in their areas of expertise. Second, understanding the precise properties that autistic subjects process in their areas of special ability may help to explain why they are so often restricted to prespecified domains. Finally, the study of special abilities has led to general hypotheses about the cognitive deficits in autism. Shah and Frith (1993) have shown that autistic subjects' abilities in the block-design task were enhanced when the to-be-reproduced figure was not segmented, thus suggesting a bias toward local processing in these subjects. Mottron and Belleville (1993) have previously observed hierarchical deficits in an autistic savant draftsman, a result that has been extended to a group of high

functioning autistic subjects (Mottron, Robaey, Stauder, & Burack, submitted).

The goal of this paper is thus manifold. First, we want to document this case as it appears to reverse the usual difference in difficulty between proper names and other types of verbal material. Second, the paper aims to assess what properties of proper names are relevant in NM's performance in order to shed light on the possible cognitive dysfunctions in autism. Experiment 1 will thus assess whether NM's exceptional memory is restricted to proper names or also encompasses other classes of information such as neologisms or common names, as well as whether the semantic load of to-be-learned items influences the subject's memory performance. Experiment 2 will examine the extent to which NM is influenced by lexical properties of names, here their frequency. Finally, Experiment 3 will explore whether NM's excellent performance is observed only in list recall or also in more typical face naming situations. This will allows a more formal assessment of NM's performance with regard to the Bruce and Young model for face naming.

CASE REPORT

Clinical and Social History

NM was 36 years old at the time of testing. He is a right-handed, unilingual French-speaking Canadian whose parents are farmers. He is the eldest of three children and all other members of his family, including his siblings, are healthy. While his mother was in her 4th month of pregnancy with NM, she was kicked in the abdomen by a cow, leaving her in pain for several hours. Otherwise, the pregnancy was uneventful. The delivery was normal and there were no neonatal complications. However, a decline in alertness was noted in NM at 2 years of age, after a bout of pneumonia. This marked the first suspicion of mental pathology. An exceptional musical memory and an ability to perform well on jigsaw puzzles were noted at around the same age. At the age of 3½ NM became restless, aggressive, and prone to running away. The development of language skills was delayed, accompanied by marked social withdrawal both at school and at home. Serial disposition of objects, and the inability to say sentences with ''yes'' and ''I'' was observed between ages 3 and 5. The presence of echolalia was firmly established at 9 years of age, at the same time that NM dropped out of the regular educational stream. At this age he was able to read and write but could not count. As he continued to encounter difficulties, a psychological evaluation was performed, subsequently revealing moderate mental retardation (nonverbal IQ with the Weschler Intelligence Scale for Children (WISC) = 62). Throughout his development, he seldom played with other children and preferred to independently pursue his favorite pastimes, such as searching for old magazines, reading the obituaries, and taking walks through cemeteries. Between 9 years and adulthood, he attended different occupational centers

and lived with host families or in night care houses. NM has never received psychotropic medications but is followed by psychiatrists.

NM presently lives in a small house neighboring his parent's. Thanks to the educational treatment program of his day-care center, he maintains a relatively autonomous existence. He cooks his own meals, and can perform simple duties such as shopping and withdrawing money from the bank. Nonetheless, his level of adaptation to everyday life is largely limited by his ritualistic behavior. For example, he needs several hours to get dressed as he frequently interrupts the course of current actions to return to previous ones. As a result, if he ties his shoes after having buttoned his coat, he will touch the buttons of his coat and look at them a dozen times while he ties his shoes. Once or twice a year he has to visit the hospital due to head banging and tantrums.

Biological and Psychiatric Exploration

A CT scan at the age of 35 years revealed normal intracranial structures and an enlargement of the lateral ventriculatory cavities within the normal limits. The EEG proved normal, as did the battery of biological examinations conducted, including a karyotype test. Clinical examination using the Rimland scale (Rimland, 1971) shows a clear high-level autistic picture. The Rimland scale is a standardized interview of the patient's family. It consists of 80 questions designed to regroup all the autistic signs, classified according to their age of occurrence. An a posteriori score for autistic symptomatology during childhood of at least +6 is required for a diagnosis of autism. Upon examination, NM obtained a score of +11, which meets the criterion for high-functioning autism (normal subjects, −20; low-functioning autism, +20; Rimland, 1971). On the autism subscale of the DSM III-R (American Psychiatric Association, 1987), NM obtained a positive score on 13 of the 16 items that define autism, which is 5 points above the minimum required for diagnosis. At the time of testing, NM's major autistic signs were hand stereotypical gestures, echolalia, echopraxia, tiptoe walking, ritualistic behavior, a ''sameness'' reaction when interrupted, and an obsessive preoccupation with lists of names.

History of the Special Ability

At an early age in childhood, NM began collecting newspapers. Later on, he began compulsively memorizing obituary columns, telephone directories, calendars, and copying lists of names. He now collects obituary columns and regularly visits the neighboring cemeteries. His room is cluttered with stacks of old newspapers. During a visit to his home for a testing session, NM was able, without hesitation, to locate from these stacks a newspaper containing the obituary of a person deceased years ago, whose name we evoked through a homonym. He spontaneously addresses people in the same

format as found in directory listings, with the second name preceding the first name. English- and French-sounding names are memorized equally, with proper pronunciation of English names. His hypermnesia for proper names was suspected as a result of his behavior related to obituary columns. When prompted, NM demonstrated the ability to recite the names of long lists of people buried in his local cemetery in the order of the plots or of names and birthdays of persons living in his town. He was also able to recall the name, birthday, and room number of all the patients concurrently hospitalized in the same unit as he had been two years earlier. NM's hypermnesia for proper names was confirmed by pretests upon which he showed very good performance in recall of lists of 15 proper names. NM also possesses moderate special abilities in mental and calendar calculation. He can calculate the 20 dollar change for any sum with remarkable speed. His calendar calculation ability was also assessed. NM could give the corresponding day to numerous dates from the past, but failed to do so for dates in the future. He was able to give a credible account of his whereabouts for those dates in the past where verification was possible (for example, dates of previous testing sessions dating months back or dates of previous appointments with the psychiatrist).

Neuropsychological Assessment

Formal testing was somewhat limited by the poverty of NM's language and by his ritualistic behavior. NM's linguistic production combines stock phrases and echolalia, yet is free of neologisms. Stock phrases are invariably repeated in the same circumstances. His language also contains many ritualistic phrases, such as ''Hello, how are you?'', which are pronounced with an odd and stereotyped intonation. A number of these phrases likely represent previous echolalias. NM does not understand puns and pleasantries, his vocabulary is stunted, and his language structure is asyntactic. Conversationally, he avoids the first person account and speaks of himself as *il* (he) or *on* (people). This corresponds to the pronoun reversal frequently described in autistic subjects (Schuler & Prizant, 1985). Finally, NM's oral production is slowed by gestured stereotypies and stuttering. His stuttering pattern involves repetition of either the first words of a sentence or of a complete sentence. Nonverbal communication is limited, as NMs face is either impassive or distorted with his eyes blinking. NM turns his head sideways when spoken to, although appropriate gestures (for example, waving good-bye) may be used in routine situations.

At age 35, NM's verbal IQ was estimated at 65 by a clinical psychologist on the basis of the information (scaled score = 5) and digit span (scaled score = 6) subtests of the WAIS-R. His memory was also assessed at that time with the Wechsler-Memory Scale (WMS). On the WMS he obtained a memory quotient of 72, which approximates his verbal IQ at the same age.

He had a perfect score on matching objects in noncanonical views. He also obtained a perfect score on a word-to-picture matching task, where he was asked to point to an object corresponding to its spoken name. In a pretest, a comparison between oral and written presentation of lists of proper names did not reveal any effect of presentation modality (recall of proper names auditorily presented, 7/24; visually presented, 8/24). Consequently, all testing was conducted in the visual modality since this is the modality that he naturally uses to learn proper names. The pretest also revealed a difficulty in separating the amount of time actually devoted to the task from the time occupied by the stereotypic behavior. Furthermore, NM was slow in progressing from one task to another and had a tendency to perseverate using previous responses. This was particularly noticeable in the span task, where he would report all the sequences previously given. For the above reasons, reaction times were discarded, and the number of different tasks used were reduced to minimum. When the tasks were clearly made distinct by, for example, a short pause or different instructions, NM was completely free from effects of interference (Mottron, Belleville, & Stip, 1991). During testing, NM's mood was pleasant and he showed an interest for the tasks, although at times he exhibited signs of anxiety.

CONTROL SUBJECTS

Three different types of subjects were used as controls: IQ-matched controls, normal IQ subjects, and one overtrained control. A group of nine control subjects with normal intellectual level (mean age = 26; mean score on the Similarities subtest of the WAIS-R, 13.7; range = 11 to 18) was used to assess whether our paradigms replicated the effects usually reported in the literature. Nine adult men of low intellectual level were selected as IQ-matched controls. Of these, one was discarded as his hospitalization prevented us from completing testing. The final group was thus composed of eight young adults (mean age = 29.25) paired with NM according to their IQ level (mean global IQ with the WAIS-R = 72.2). IQ-matched controls were used to ensure that any qualitative effect observed in NM was unrelated to his lower level of intellectual functioning. Finally, in order to control for a possible contribution of familiarity with proper names to NM's performance, we tested an overtrained control. This subject is a 49-year-old woman who worked for 8 years as a directory assistant in Canada's telephone company in Montreal. Her job consisted of receiving calls from customers requesting the phone number of particular individuals. She thus had a long-standing and intense exposure to proper names. As her intellectual level is above normal (she completed a university degree; score on the Similarities subtest of the WAIS-R, 17), her performance pattern will be compared to that of normal controls. If NM's performance is only attributable to his familiarity with proper names, the overtrained subject should exhibit the same

departure from normal controls as NM's from IQ-matched controls. The overtrained subject was tested on all the tasks that involved memory for proper names.

EXPERIMENT 1: NAME LIST RECALL

The first goal of this experiment was to examine NM's memory for different verbal items. This experiment compares his recall level for common names, which contain a semantic and lexical representation, to that for proper names and nonwords. As stated in the introduction, proper names do not convey semantic information about their reference while possessing a lexical representation. Nonwords have neither semantic content nor lexical representation. Experiment 1 also examines the influence of the ambiguity of proper names on NM's performance recall (McWeeny et al., 1987; Cohen, 1990). The influence of this last parameter on NM's memorization of proper names was assessed by comparing his recall for proper names which are not ambiguous (or meaningless, such as ''Mottron'') to that for proper names which are ambiguous (or proper names that can also be common names, for example, ''Baker''). It was hypothesized that NM would have an excellent memory for proper names regardless of their ambiguity, with the only condition being that they are recognized as proper names. In contrast, it was hypothesized that NM's memorization of common names would not attain the same level.

A second goal of this experiment was to understand how NM processes person names when they are encountered. Indeed, when NM comes upon a ''new'' person name it has one of two forms, that of never encountered lexical unit (if it is an unambiguous new person name) or that of a lexical unit already encountered as a common name (if it is an ambiguous new person name). A related question pertains to the kind of memory processing he performs when he encounters common names that can also be proper names: does he give them a proper name status even in the grammatical context of a common name? Thus, this experiment examines whether an explicit categorization of an item as a proper name or as a common name is sufficient to induce (or hinder) the high performance level that NM exhibits for proper names. For example, when given the neologism Glomi, is NM's recall performance improved if he is instructed that it is a proper name? In contrast, when given the ambiguous proper name *Boulanger* (''baker'' in French), is NM impaired if he is instructed that it is a common name? Previous paradigms have used the syntactic context of a sentence to orient the processing of ambiguous proper names as proper names or as common names (McWeeny et al., 1987). In the sentence ''Mr. Lawyer is a baker,'' the unit ''baker'' is processed as a common name, while in the sentence ''Mr. Baker is a lawyer,'' the same unit is processed as a proper name. Normal subjects usually exhibit better retrieval of the item ''baker'' in the first condition than in the second condition. This effect is known as the Baker–baker phenome-

non (McWeeny et al., 1987; Cohen, 1990). While relatively powerful in normal subjects, this strategy was not used in NM's case since it has previously been shown that autistic subjects fail to use the syntactic context to disambiguate words (Frith & Snowling, 1983; Snowling & Frith, 1986; Mottron & Belleville, 1994). Consequently, a different method was used to induce proper name processing: in the instruction set, the examiner presented lists explicitly as being made up of either common names or proper names.

Materials and Procedure

Eight 20-word lists were constructed and arranged as follows: (a) two lists of common names (mean frequency = 70.5; Baudot, 1970), (b) two lists of proper names which can also be common names (or ambiguous proper names, for example, the French name Boucher (in English, butcher); such names are extremely common in Québec), (c) two lists of unambiguous proper names (for example, the French name Jodoin), (d) and two lists of neologisms obtained anagrammatically from existing proper names. The four lists of proper names were equivalent in terms of their relative frequency in Québec. In order to assess the relative frequency of the names used, their number of occurrences in the phone directory of Montréal, the largest city in Québec, was measured in columns (approximately 130 occurrences per column). Certain proper names in Québec present the peculiarity of being extremely frequent. For example, there are more than 50 columns of ''Tremblay'' in the Montréal phone directory. Very frequent proper names, defined as those represented in more than 10 columns, were thus eliminated. The proper names used in this experiment were of intermediate frequency (mean frequency = 4.56 columns).

Each name was printed on a separate card to avoid the visual cueing effects of neighboring names and to control the speed of presentation. Each card was presented successively to NM, who was asked to read the name aloud and memorize it. The lists were presented in two learning conditions: in the ''common name'' condition, subjects were instructed that they would be presented with a list of common names to be learned; in the ''proper name'' condition, the instructions were modified to inform the subjects that the items to be learned were proper names. The two conditions (four levels of lists (common names, ambiguous proper names, unambiguous proper names and neologisms) and two levels of instruction sets (common names and proper names)) were crossed so that all four types of lists were learned with both instruction sets. The order of presentation was varied to induce NM toward the intended mode of processing. It was a concern of the experimenters that the instructions would not be sufficient to induce NM to process items in the form of proper names or in the form of common names. Thus, in the proper name condition, unambiguous proper names were presented first, followed by ambiguous proper names, neologisms and common names. For the same reasons, the order was modified in the ''common name'' condition. Common names were presented first followed by ambiguous proper names, neologisms and unambiguous proper names. Since NM was completely insensitive to proactive interference (Mottron, Belleville, & Stip, 1991), this difference in the mode of presentation was not considered problematic when comparing the two conditions. Furthermore, it did not influence the results (see below). However, a Latin square design was used to vary the order of presentation in the case of normal controls, in order to reduce the possibility of interference effects. Testing in each condition was separated by several days.

Results

For each list, the number of names correctly recalled was quantified. Table 1 presents these scores in the proper name (Table 1a) and common name

TABLE 1

Number of Correctly Recalled Items by NM, IQ-Matched Controls, Normal Subject, and One Overtrained Control in the (a) Proper Name and (b) Common Name Presentation Conditions (Range in Parentheses)

	Neologisms	Common names	Meaningful proper names	Meaningless proper names
		(a) Proper name condition		
NM	3	3	10	8
IQ-matched controls	.5	3.25	2.25	3.25
	(0–1)	(0–5)	(1–4)	(1–6)
Normal subjects	5.22	8.33	9.0	9.56
	(0–8)	(1–12)	(7–10)	(5–14)
Overtrained control	2	5	9	8
		(b) Common name condition		
NM	2	5	10	9
IQ-matched controls	1.25	3.38	3.38	2.88
	(0–2)	(1–6)	(1–5)	(1–5)
Normal subjects	5.8	7.78	8.44	8.56
	(0–9)	(4–11)	(6–10)	(6–10)
Overtrained control	1	6	9	7

(Table 1b) conditions for both NM, the two control groups and the overtrained control. For the groups of control subjects, an analysis of variance (ANOVA) was carried out with Group (IQ-matched controls and normal subjects) as a between-subjects factor, and Mode of Presentation (common name and proper name) and Material (neologisms, common names, meaningful proper names, meaningless proper names) as within-subjects factors. As expected, there was a significant Group effect, with IQ-matched controls recalling fewer words than normal control subjects in all conditions [$F(1, 15) = 56.84$, $p < .001$]. There was also a significant effect of Material [$F(3, 45) = 22.59$, $p < .001$]. Post hoc comparisons with a t test showed that at a .05 level, recall of neologisms was inferior to that of the other types of items. Recall of common names, ambiguous proper names, and unambiguous proper names did not significantly differ. There was no main effect of Presentation [$F < 1$], and none of the interactions reached significance. The performance of the overtrained control was within the range of normal controls of her intellectual level for all types of material used, including proper names. Furthermore, her performance pattern did not differ from that of controls: her recall of common and proper names (pooled over the two recall contitions) did not differ significantly [$\chi^2_{(1)} = 2.17$, NS] while her recall of neologisms (pooled over the two recall contitions) was inferior to that of common names [$\chi^2_{(1)} = 5.54$, $p < .05$] and proper names [$\chi^2_{(1)} = 14.46$, $p < .001$].

NM's data were analyzed using a nonparametric χ^2 procedure. As in the control groups, method of presentation had no effect on NM's recall perfor-

mance. However, NM's recall was influenced by the material to be remembered. As Table 1 shows, NM's recall of common names was comparable to that of neologisms [$\chi^2_{(1)} = 1.88$, NS], and the recall for both these categories was exceeded by that for proper names [for common names, $\chi^2_{(1)} = 7.78$, $p < .01$; for neologisms, $\chi^2_{(1)} = 22.4$, $p < .001$]. There was no difference between NM's recall of ambiguous and unambiguous proper names. A qualitative comparison of NM and the IQ-matched controls shows that NM's performance is superior than controls for the recall of proper names, whether ambiguous or unambiguous. In contrast, he performs similarly to IQ-matched controls in recalling common names. Notably, NM's recall of neologisms is superior to that of matched controls when they are presented as proper names (see Table 1a).

Discussion

This experiment has confirmed NM's special ability in the recall of proper names: his recall of proper names is superior to that of the best matched controls, attaining levels obtained by individuals of much higher intellectual functioning. The experiment also showed that NM's special ability is limited to the class of proper names; indeed, NM's recall of neologisms and common names is unremarkable.

In both control groups, recall is at the lowest level for neologisms, items that have neither lexical nor semantic representations. This is congruent with the hypothesis suggesting that long-term semantic or lexical representations improve performance on memory tasks (Hulme, Maugan, & Brown, 1991). This effect appears to be independent of general intelligence since it is observed in both low- and high-IQ subjects. NM's performance is not influenced by the presence or absence of a representation in long-term memory of the items to be recalled. This factor appears irrelevant to his recall performance; this is supported by the finding that recall for common names was not found to be superior to that for neologisms, although common names have a representation in long-term memory, while neologisms do not. Rather, the relevant factor is whether the items can be subsumed under the class of proper names. Indeed, NM memorizes proper names better than any other class of items. The overtrained subject's performance pattern is unremarkable compared to that of other normal controls. Thus, NM's quantitative and qualitative performance can not be simply related to his high familiarity with proper names.

One result observed in normal subjects is that the ambiguity of proper names has no effect on their memorization, replicating McWeeny's (1987) findings. Similarly, NM's performance is also uninfluenced by the ambiguity of proper names. He performs equally well regardless of whether the proper names have been processed as common names or not.

The recall performance of the normal control subjects was not significantly

affected by the metalinguistic presentation of items at the encoding stage (like ''common names'' or ''proper names''). This differs from the results reported by McWeeny et al. (1987), who found that the same item (for example, Baker) was more accurately recalled when processed as a profession than when processed as a proper name. One possible account for this discrepancy is that the procedure described above was not sufficient to impose dichotomous processing as either a common name or a proper name. Procedures that take advantage of the syntactic context, such as those used in McWeeny et al. (1987) and Cohen (1990), may be more efficient in modifying recall performance. The difference between the two procedures may be related to the fact that the present procedure accessed primarily controlled (metalinguistic) processes, while those of McWeeny et al. and Cohen relied more on automatic (contextual) categorization. Another possible explanation is that the Baker–baker phenomenon occurs only in person-naming tasks and not in list learning. If this is the case, only person-naming tasks would activate or create person identity nodes. In contrast, list learning would exclusively tap lexical processes.

An identical pattern was observed in NM; the analysis revealed no significant effect of instruction. Consequently, it appears that NM cannot process just any incoming information as if it were a proper name. In fact, there is some evidence that NM's high level of recall for proper names occurs only when the material to be remembered is recognized as a belonging to an already-known set of proper names. An indication of how NM categorizes an item as proper name is found in NM's performance for neologisms. An inspection of the data indeed shows that NM's performance was superior to that of the best matched controls in the recall of neologisms, but only when these neologisms were presented as ''proper names.'' This may indicate that a new meaningless item, when presented as a proper name, can elicit a process that corresponds to that which occurs when actual proper names are encountered. However, it is worth noting that even in this condition, performance recall is at a much lower level than that for familiar proper names.

EXPERIMENT 2: FREQUENCY EFFECT

The above experiment shows that NM does not utilize the meaningful value of lexical units in order to memorize names. His performance recall is superior when the memorized items are recognized as proper names. The goal of this second experiment is to assess whether NM's recall reflects organized representations of proper names in long-term memory, as opposed to being the result of a photographic memory process (for a review of this hypothesis, see Hill, 1978). Given the nature of proper names, there is a possibility that NM's long-term representations for such material are organized along some lexical parameters. This would be compatible with the results of Experiment 1, which showed that semantic parameters did not

TABLE 2
Recall of Rare and Frequent Proper Names by NM, IQ-Matched Controls, Normal Subjects, and One Overtrained Control (Range in Parentheses)

	Material	
	Rare proper names	Frequent proper names
NM	9	15
IQ-matched controls	2.2 (0–4)	5.62 (5–7)
Normal subjects	7.66 (3–13)	11 (7–13)
Overtrained control	3	16

influence NM's recall for lexical items. Consequently, the effect of frequency, a variable well known to influence lexical processing, was examined in the second experiment. In normal subjects, frequently occurring words are easier to remember than rare words (Segui, Mehler, Frauenfelder, & Morton, 1982; Dobbs, Friedman, & Lloyd, 1985). It has also been shown that naming latency is reduced for frequent names especially if they are not familiar (i.e., belonging to a famous person) to the subject (Valentine, Brédart, Lawson, & Ward, 1991). If NM's recall is based on activation of units within a lexicon of proper names, this should also be reflected by the presence of a frequency effect.

Materials and Procedure

Two lists of 25 proper names were selected according to their frequency. One was made up of 25 frequent names (mean frequency = 21.7 columns) and the other of 25 rare names (mean frequency < half a column). The selection was restricted to French-sounding proper names. Across lists, names were balanced with respect to length and first letter. Subjects were identical to those of Experiment 1. The procedure was similar to the ''proper name'' condition of the first experiment.

Results

For each subject, the number of correctly recalled targets of each type (frequent and rare proper names) was summed. The results are shown in Table 2. A two-way analysis of variance was conducted using the results of normal subjects, with the between-subjects factor of Group (IQ-matched controls and normal subjects) and the within-subjects factor of Material (rare and frequent). A significant main effect of Group was found [$F(1, 15) = 39.53$, $p < .001$], with normal subjects recalling more words than IQ-matched controls. A significant main effect of Material was also obtained [$F(1, 15) = 40.08$, $p < .001$], with frequent names recalled more accurately than rare names (see Table 2). This was the case for both groups of controls

as no significant Group × Material interaction was found [$F < 1$]. The overtrained normal control also showed a strong frequency effect, with frequent names yielding a much better recall level than rare names [$\chi^2_{(1)} = 14.34$, $p < .001$]. A χ^2 procedure was also used to assess this effect in NM's results; the data revealed a marginally significant frequency effect [$\chi^2_{(1)} = 2.88$, $.05 < p < .1$]. Examination of Table 2 shows that NM's recall performance for more frequent proper names is superior to his performance for rare proper names, and that the effect size is comparable to that observed in the control groups but smaller than that observed in the overtrained control. The difference between NM and the overtrained control lay in the rare names, which are much better recalled by NM than by the control. Finally, the experiment also confirms NM's hypermnesia since his recall level for frequent and rare proper names is well above that of matched controls.

Discussion

In control subjects, the observed frequency effect for proper names is similar to that reported for common names in the literature: frequent proper names are generally more easily recalled than rare proper names. Again, this effect appears to be independent of general intelligence. It is worth noting that while semantic factors do not influence memory performance for the list recall of proper names (Experiment 1), lexical factors thus appear to have a strong influence. This is compatible with the hypothesis that proper names, particularily person names, are characterized by their absence of semantic links, as lexical parameters would be more descriptive of proper names. Like control subjects, NM is sensitive to nonsemantic, lexical parameters in proper name learning. The frequency effect provides evidence that he encodes and recognizes information according to preexisting units, in addition to indicating that some form of lexical organization within long-term memory plays a role in NM's memorization of proper names. This eliminates the presence of a purely mechanistic aptitude for memorizing any type of verbal sound in a manner similar to a recording device (i.e., tape recorder). However, it is of note that NM's frequency effect is smaller than that of the overtrained control. This is because his recall of rare names is particularly good. This suggests that proper names possess some special intrinsic properties that influence their memorization by NM regardless of their frequency.

EXPERIMENT 3: FACE NAMING

Experiments 1 and 2 studied the role of semantic and lexical factors in conditions where proper names are presented in isolation. However, in ecological conditions, proper names are used in relation to the individuals they refer to. In normal subjects, access to proper names through face recognition has been explored in paradigms where proper names are associated to a face and to semantic information related to the individual (Cohen & Faulkner,

1986; McWeeny et al., 1987). This showed that proper names are accessed through a sequential process (Bruce & Young, 1986). Information must proceed through the FRU in order for face recognition to occur and subsequently through the SIU, which contains the semantic information relative to this individual. Experiment 3 thus assesses NM's memory for proper names in a situation where proper names are accessed through face recognition and semantic information about their referents. This was done using both familiar and unfamiliar faces. If NM's hypermnesia depends only on the activation of the lexical units that define proper names, he may not memorize to a high level the association between a name and a face. As a result we predicted that NM would be impaired in naming faces, whether new or old, relative to list recall of names. It was unclear, however, whether face recognition would be normal or not.

(a) Face Recognition

Materials and Procedure

The task used to assess face recognition was the Face Recognition Memory Test (Warrington, 1984). The paradigm entails the presentation of 50 faces. Immediately afterward, the subject is presented with 50 pairs of faces. For each pair, one face was among those initially presented to the subject. The subject must identify which had been seen before. One normal subject was not tested on this particular task.

Results

Normal subjects obtained a score of 46/50 (range 43–48) on the Face Recognition Memory Test, which corresponds to the test norms for subjects of the same age and IQ level (Warrington, 1984). As expected, recognition performance was lower in IQ-matched controls (average = 35.37/50, range = 32–38; $t(14) = 12.591$, $p < .01$). NM's score on the test was 47/50, a performance far superior to that of IQ-matched controls. It follows that his ability to recognize a previously presented face exceeds what would be expected according to his IQ.

(b) Learning of Names and Biographical Information in Relation to a New Face

Materials and Procedure

Twelve fictitious characters were created, each defined by a face, first name, second name, and profession. For each character, a photograph was mounted on a card, under which biographical information about the subject was written. Subjects were presented each card in succession, and were asked to read the biographical information aloud and commit it to memory in association with the face. Immediately after exposure to the biographical information, subjects were presented with the face and asked to recall the respective first name, second name, and profession.

TABLE 3
Number of Correctly Recalled Items in the Face Naming Task by NM, IQ-Matched Controls, Normal Subjects, and One Overtrained Control (Range in Parentheses)

	Material		
	First name	Second name	Profession
NM	0	0	1
IQ-matched controls	0	0	1.75 (0–4)
Normal subjects	0.56 (0–2)	1.56 (0–3)	4.55 (1–7)
Overtrained control	2	2	4

Results

Table 3 shows the number of first names, second names, and professions correctly recalled. In the control subjects, an ANOVA was carried out with Group (normal subjects, IQ-matched controls) as a between-subjects factor and Material (first name, second name, profession) as a within-subjects factor. There was a significant Group effect [$F(1, 15) = 24.97$, $p < .001$], which is explained by the superior recall of normal subjects over IQ-matched controls. A Material effect was also present [$F(2, 32) = 30.23$, $p < .001$]. Subjects showed better recall performance for professions than for both first and second proper names. Additionally, a significant Group × Material interaction was found [$F(2, 30) = 4.07$, $p < .05$], most likely because the effect of Material is more apparent in normal subjects [$F(2, 30) = 29.5$, $p < .001$] than in IQ-matched controls [$F(2, 32) = 6.18$, $p < .01$]. However, this interaction must be interpreted cautiously, as it may be explained by a floor effect in the IQ-matched controls. The normal overtrained control exhibited a similar pattern of performance as shown in Table 3, with professions better recalled than first names and second names. There were more occasions when subjects were able to recall the profession but not the name (IQ-matched controls, average = 1.62; normal subjects, average = 3.33; overtrained control = 3) than vice versa (IQ-matched controls, average = 0, normal subjects, average = 0.5; overtrained control = 0).

As is evident from Table 3, NM performed at the same level as his IQ-matched controls when required to match proper names and professions to new faces. Given NM's low recall, it was not possible to measure the number of professions recalled without names or names without profession. However, the number of correct items recalled was recalculated without taking into account whether they were appropriately matched to the face, in a method roughly similar to a list recall. Here, NM performed much better than controls for proper name recall. He provided numerous first names (NM = 10; IQ-matched controls, average recall = 0.37; normal subjects, average

recall = 0.66; overtrained control = 3), and second names (NM = 8; IQ-matched controls, average recall = 0.12; normal subjects, average recall = 1.88; overtrained control = 2). However, his recall of professions was within the range of that observed in matched controls (NM = 6; IQ-matched controls, average = 4.5, range = 4–9; normal subjects, average = 4.88, range = 3–7; overtrained control = 6). Of note was NM's ability to correctly associate first and second names (8/12), reporting them as a whole unit. This was not observed in controls (matched controls average = 0.14; normal subjects average = 0.33; overtrained control average = 2).

(c) Famous Faces

Materials and Procedure

In order to test the recall of previously encoded information, a famous faces naming task was also performed. Twenty-nine black and white photographs of local and international celebrities were shown successively to each subject, whose task was to name each face.

Results

Normal subjects were able to correctly name an average of 25.33 of the 29 famous faces (range = 11–29; overtrained control = 29). Their performance was superior to that of IQ-matched controls, who recalled the names of an average of 15.37 faces (range = 4–24). The difference between these groups reached significance [$t(15) = 2.2$, $p < .01$]. NM correctly named 25 of the 29 famous faces, a performance slightly above that of the best matched control. NM's ability to provide the occupations of these famous people was also tested. He exhibited an unusual pattern of responses: 5/29 responses were absent or wrong and 11/29 were correct (for example, Prime Minister for Brian Mulroney). However, he provided idiosyncratic responses for the 13 remaining faces, such as ''on television'' for an announcer or ''at the song'' for a singer. These answers appear to be related to a possible lexical encoding as opposed to an encoding involving the SIU and are likely not related to the subject's low level of intelligence. Only a subgroup of five IQ-matched controls was tested on the occupation condition, yet these controls provided 21/29 correct professions, all of which were clearly identifiable. Of the correct responses provided by the controls, 20% were professions recalled without the respective names, while 2.7% were names recalled without the respective professions. The examination of NM's data was hindered by a difficulty in establishing strict criteria for judging the appropriateness of the professions he provided. Nonetheless, when applying liberal criteria by accepting his idiosyncratic answers, NM was able to recall 6% of professions without the respective names and 6% of the names without the respective professions.

Discussion

The finding that control subjects are more accurate in the recall of professions than proper names when both types of information are associated with a face provides converging evidence with previous studies (Cohen & Faulkner, 1986; McWeeny et al., 1987). This phenomenon is usually used as evidence in the argument that proper names are processed differently than common names. The observation that controls sometimes have access to information about the profession without accessing name information, while the reverse pattern is very rare, also shows congruence with numerous observations from the literature. Our findings with subjects of low IQ again confirms that this effect is independent of general intelligence. The fact that the overtrained control shows the same pattern of performance is important as it shows that the effect is not mitigated by a large familiarity with proper names in normal subjects.

NM's recall pattern is clearly different: he shows a high level of performance in memorizing new faces. In this sense, face memory represents another form of special ability for NM. He is also able to recall person names independently of the faces that they refer to; in fact, his ability to perform this task is superior to that of the best normal subject. In contrast, NM's performance is not particularly good on tasks that require linking a name or a profession to a face. On such tasks, he performs at the level predicted by his IQ. NM's very low recall of the professions of famous faces may also indicate that he has some difficulty in encoding semantic information. It may thus be hypothesized that the FRU and the proper name store components are hyperfunctioning relative to the PIN in NM.

Importantly, and contrarily to normal subjects, NM's performance in face naming is not indicative of a sequential process, as evidenced by his similar performance when recalling the semantic information of a known person and when recalling their name. Rather, NM either has no information about the face or is able to recall both name and profession information. This may suggest that the professions provided by NM are encoded at a shallower level, as in a lexical form, which is apparently the case for proper names. A close examination of NM's responses is congruent with this hypothesis. Indeed, rather than stating the profession of the individual, NM generally provides elements pertaining to the context of the encoding of these faces; an example of this is the response ''on television.''

GENERAL DISCUSSION

In this general discussion, we shall first discuss the implications of the different findings observed in NM and in normal subjects for the theoretical models of proper name processing. We will also provide hypotheses concerning mechanisms which may account for NM's unusual performance profile.

Finally, we will relate NM's performance to general explanations of cognitive impairment in autism.

Relation with the Theoretical Models of Proper Name Processing

Among the data described here for NM, different findings are both sufficiently explicit and sufficiently remarkable to require theoretical explanation: the first is the specificity of NM's hypermnesia for proper names and his ability to name faces for which he cannot provide biographical information; the second is NM's inability to link proper names to faces; another is NM's inclination to implementing list learning in a face-naming task. As will be shown, the underlying explanations of these three findings demonstrate a great deal of convergence.

One of the main theoretical models that describes the special character of proper names is the sequential model of face naming proposed by Bruce and Young (1986). Our findings in normal subjects are largely congruent with this model: on face-naming tasks normal subjects do report more professions than names and they more frequently access semantic information about famous people when not recollecting their names than the reverse (Experiment 3). It is noteworthy that the higher recall for common names was found only in a face-naming procedure. In a list-learning task (Experiment 1), normal subjects recalled proper names just as well as common names. This can clearly be related to the fact that in list learning, subjects do not access proper names through PINs.

The observation of a hypermnesia specific to proper names in NM is in line with the suggestion that proper names are of a special nature among lexical items. The selective impairment of proper names following a brain lesion has been described in the literature and suggests that proper names may involve a storage component separate from common names (Semenza & Zettin, 1988, 1989; Flude et al., 1989; Lucchelli & De Renzi, 1992). At least for person names, no convincing evidence has been reported of patients with the reverse dissociation, that is the impairment of common names without a proper name deficit. This may lead to the interpretation that proper names are different from common names only inasmuch as they are more vulnerable to a lesion. NM's pattern of impairment challenges this interpretation since proper names yield superior levels of performance than common names. Accordingly, it is certainly compatible with the Bruce and Young model, in which a separate storage component is dedicated to proper names.

However, there are other aspects of NM's data that are not easily accounted for within a sequential model of face naming. In a name–face learning task, he was indeed able to recall proper names independently of reference and semantic information. Furthermore, NM was unable to provide precise semantic information about famous people despite being able to name them. These results are not easily accounted for by a sequential model

in which naming depends on semantic knowledge activation (SIU). Yet, the results are compatible with the Burton and Bruce ''IAC'' model, as explained below.

NM's hypermnesia is strictly limited to list-learning tasks. NM's recall advantage over matched controls completely vanishes when the task requires the association of a name to a face. In the face-naming task, NM appears to use a list-learning strategy where names are activated without their referent. NM's hypermnesia thus depends on the condition that person names are processed in the form of lists. This is probably related to the fact that person names are usually encountered in this form, for example in telephone directories, necrological obituaries or cemeteries. This may orient us toward some hypotheses about the memorization strategies employed by NM. In the Burton and Bruce alternative model (1992) of face naming, proper names are more difficult to retrieve than biographical characteristics because they are related to a unique PIN. By contrast, common names which carry biographical information, are shared by numerous PINs (for example, we know several different prime ministers). Thus in this model the number of connections that a given unit shares with other units predicts its recall level, with a larger number of connections yielding a better recall through a higher level of activation. This alone suffices to explain the more difficult recall of proper names in normal subjects without having to postulate different storage components that are sequentially organized. It is therefore possible that the list-learning strategy used by NM allows person names to be learned in connection with a large number of other person names. This would result in a rich and largely interconnected network of person names, which may explain NM's hypermnesia in the context of list recall. The Burton and Bruce model can thus account for NM's performance because it does not involve a sequential processing-based access to proper names and because it explains NM's hypermnesia through a higher number of connections between proper names.

That the overtrained control failed to manifest NM's pattern of performance suggests that it is not a mere familiarity with the material that accounts for his behavior. Rather, it is essential to postulate that a cognitive deficit allows this type of performance to occur. The lists of proper names that NM learns are characterized by their high level of regularity and redundancy as well as their important degree of phenomenal organization. Moreover, NM also memorizes calendars, which are another highly structured and redundant type of material. In contrast, common names and other lexical items are used in sentences, where redundancy is absent, at least at the phenomenal level. It is thus possible that contextual redundancy of person name lists is what underlies both NM's choice of material and his proficiency for list learning. When two items are too different from one another, NM would not be able to extract enough regularity in order to build the connections between them. This could explain why NM exhibits difficulties in relating elements such

as faces and profession, or faces and proper names, while easily linking first and second names.

General Models of Cognitive Impairment in Autism

The following section examines how the performance pattern observed in NM relates to that reported in autistic subjects with other special capacities. It also discusses its relevance to theories of the cognitive defect in autism. Indeed, special abilities in autism have been proposed as a domain for an in-depth investigation of the cognitive processes of autistic subjects in general (Shah & Frith, 1993; Mottron & Belleville, 1994; Frith & Happé, 1994).

NM's special capacity for list learning is not particular to this subject. Hypermnesia for lists of items, such as bus numbers, train timetables, and calendars has been frequently observed in savant autistic subjects (Rimland & Fein, 1988). There is thus a clear predilection in autistic subjects for information that has a redundant form of organization. This is supported by different findings showing that they memorize regularly structured sequences of items more easily than randomized ones. For example, autistic musicians have a better memory for tonal than atonal tunes (Sloboda, Hermelin, & O'Connor, 1985). A similar influence of the phenomenal structure at encoding on autistic memorization has been shown with bus number memorization: savants who memorize bus numbers are prone, when given a number, to give the number of another bus belonging to the same garage. This latter result was interpreted as providing evidence for the influence of ''some sort of semantic organization'' on the memory performance of savants (O'Connor & Hermelin, 1989, p. 110). Our findings confirm the influence of structure in NM: his memorization relies on the knowledge of the proper names in the sense that he most accurately memorizes elements pertaining to this lexicon and is influenced by their frequency of occurrence. However, his recall is not improved by the semantic or referential value of items. Thus, in both NM and bus memorizers, the structure used emerges from and retains phenomenal properties. This mitigates the term ''semantic organization'' used by O'Connor and Hermelin (1989). It is also congruent with data showing that autistic subjects do not improve their recall when words are grouped into semantic categories (Hermelin & Frith, 1971).

Frith (1989) has recently proposed that the lack of a ''central coherence'' in autistic subjects is responsible for their pattern of performance in perception as well as in long-term learning. Central coherence conceptualizes the tendency to connect parts of a stimulus in order to integrate these parts into a more general structure. Central coherence postulates a multimodal level of integration. For example, absence of central coherence would also be manifested as an inability to integrate peripheral processing (such as surface information like the phonetic form of words, or the structural description of

spatial objects) in high-level processes (like contextual or semantic processing). NM's proficiency in memorizing lists of proper names without using semantic strategies may be partially explained by the central coherence theory. NM indeed relies on the surface characteristics of the items he memorizes: he does not include proper names in a more general (or, in Firth's terms, central) framework. Furthermore, NM can relate elements that belong to the same class, like the different names on a list or the first and second names of an individual, but not when they are of a different nature, like faces and names.

NM's results are also compatible with the hypothesis of an anomaly in the hierarchization of information (Mottron & Belleville, 1993). Hierarchization reflects the fact that aspects of a stimulus, for example its outline, are processed with more efficiency than other aspects, such as texture or inner local details (Palmer, 1977; Navon, 1977; Lamb, Robertson, & Knight, 1990; Peretz, 1990; for a review, see Robertson & Lamb, 1991). This results in an imbalance between processing of local and global aspects of stimuli in favor of one or the other level depending on the properties of the stimuli (for example, the visual angle they subtend). In the absence of a hierarchy, all of the different subcomponents of a unit occupy an identical status. It has been proposed that autistic subjects' basic information processing consists of linking subunits into larger ones without imposing any hierarchy upon them (Mottron & Belleville, 1993). Subsequently, each subcomponent is processed in a randomized order and with a similar ''weight.'' NM's results are compatible with this hypothesis. He learns elements that possess the same status (they are all proper names) and combines them into larger units, the lists, which have no inner organization.

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