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REFEREED PAPERS

T-1. Implicit and Explicit Memory for Faces in Dementia of Alzheimer's Type

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Face memory explicit deficit in DAT is related to semantic impairment. Our study investigated performance of 20 DAT patients compared to 22 controls on both implicit and explicit processing of faces. Implicit testing: priming task, two known or unknown faces, judgment: same person or not? Variables: similarity, priming, and celebrity. Explicit testing: episodic memory (presence in previous task?), celebrity, specific semantic memory. No priming effect for DATs, deficit in explicit episodic memory, slight deficit for celebrity, hierarchical deficit in specific semantic memory. Global impairment for face processing observed in DAT patients with preponderance of episodic memory deficits.

Memory impairment consitutes almost always the first cognitive deficit in Dementia of Alzheimer's Type (DAT). The explicit memory deficits have been extensively studied (Van der Linden, 1994). Patients with DAT have also been reported to show normal implicit memory abilities (Schacter, 1987) in various situations in which no conscious recollection of a previous episode is required, such as classical conditioning, skill learning and repetition priming.

Despite its importance on day-to-day memory, memory for faces in DAT patients has been only rarely studied. However, Greene and Hodges in a recent study (1996) have shown that DAT patients presented impaired performance on all cognitive components, with special emphasis on semantic knowledge, involved in explicit memory tasks requiring face processing. The present study aimed at investigating the performance of DAT patients on both implicit and explicit processing of faces.

Population

Twenty right-handed DAT patients (age: 69.6 ± 7.4, 17 women and 3 men, MMS: mean 21.7 ± 3.3, range 13 to 26). 22 right-handed normal sub-

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jects (age 66.3 ± 6.3, MMS > 28). No significant difference was found in terms of age or educational level.

Memory Experiments

Implicit memory. Implicit memory was assessed in a priming task adapted from Paller et al. (1992) that required a speeded response to photographs of faces displayed on a 24 × 15 cm card on a McIntosh portable computer. On each trial, subjects viewed two faces and the instructions were as follows: ÇÊ*Do the two faces correspond to the same person*? If the answer is positive, press the Yes key located on the lefthand side of the keyboard, if the answer is negative, press the No key located on the righthand side on the keyboardÈ.

In order to make things easier for the demented patients, the first sentence of the instruction as well as the Yes/No buttons were systematically displayed on the screen at each trial.

Thirty pairs were identical and 30 different to measure the *similarity effect* induced by the instruction. Twenty pairs (famous and non famous) were repeated to assess a *priming effect*. Forty-five famous and 45 non famous faces were used to assess a possible *celebrity effect.*

Explicit memory. In the explicit task, 60 faces (30 belonging to the implicit test, and 30 new faces) appeared one at a time and subjects responded to 5 questions: *Episodic memory*: did you see this face in the previous task? *Semantic memory for celebrity:* is this face famous or not? *Specific feature from semantic memory:* which category does he/she belong to (politician, actor . . .)? what is his/her name? and could you tell me more about him/her (semantic attribute)?

Results

Implicit task. By comparison to controls, performance was impaired in DAT patients in terms of reaction-times (DAT: 1.3 s; controls: 0.86 s) and errors (DAT: 5.8 errors and controls: 2.3 errors). A *similarity effect* was observed for both populations, identical pairs being processed faster ($p < .0001$) and better ($p < .01$) than different ones. *Priming effect* was found only for controls in processing of different pairs ($p < .05$). No *celebrity effect* was found either for DAT patients or controls ($p = .10$).

Explicit task: EPISODIC MEMORY. All subjects, whatever group, incorrectly classified new faces, being famous or not, as already presented (controls: 33% of false alarms; DAT patients: 38% of false alarms). By contrast, DAT patients missed significantly more faces already presented in the implicit experiment (47% of errors) than did controls (20% of errors).

SEMANTIC MEMORY FOR CELEBRITY. No difference was found between controls and DAT patients for non famous faces, even if present in the implicit part (very few errors). However, significant difference was observed for fa-

mous faces, gathering already presented and new items (15% of famous faces considered not famous by DAT patients vs 2% by controls).

SPECIFIC FEATURE FROM SEMANTIC MEMORY. Significant difference was found for category, naming and semantic attribute, DAT patients being more impaired than controls. The least impaired feature in DAT patients was the category (64% correct).

Discussion

The results from implicit and explicit experiments demonstrated a global impairment for face processing in DAT patients.

In addition to deficits of explicit memory documented by Greene and Hodges (1996), the present study showed that implicit memory for faces was also impaired in patients. In normal subjects, the priming effect was not influenced by celebrity. Consequently, this effect is better accounted for by episodic memory processes than semantic ones. As priming was not evidenced in DAT patients, it can be proposed that deficit of implicit memory is induced by disorders of episodic memory that was also evidenced, in the explicit experiment, by the number of false alarms and misses on episodic memory testing.

In spite of their general impairment in explicit tasks, patients demonstrated a relative preservation of two semantic stages, identification of celebrity and category. This finding might correspond to a relative sparing of most generic levels of semantic knowledge that was also observed in DAT patients for semantic tasks assessing knowledge for objects. In general, both experiments pointed to the preponderance of episodic memory in impairments of memory for faces that has been previously attributed to semantic deficits (Hodges et al., 1993).

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T-2. Semantic Mediation of Auditory Priming in Dyslexia

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Dyslexics are facilitated in forced choice visual lexical decision if they simultaneously hear the target word (identity priming). In two experiments we tested the possibility that orthographic activation by phonology is semantically mediated. In the first experiment a dyslexic was facilitated as much by hearing a word semantically associated to the target word (BLUE/sky) as he had been previously by identity priming (GOES/goes). In the second experiment we found that auditory identity priming produced greater facilitation for content words than for function words. Orthographic activation by phonology is at least partly mediated by semantics.

Introduction

Previously, in an attempt to validate the hypothesised activation of orthography by phonology in word recognition, we tested several surface dyslexics in a task of visual lexical decision with and without an auditory input. We found that when asked to indicate which of two orthographic items, a word and a nonword homophonic to it (e.g. goes/goze), was the 'real' word, dyslexics were considerably faster if they simultaneously heard a digitized recording of the word than if they heard a tone. This priming effect could be explained either as direct activation of orthography by phonology or as a semantically mediated effect.

Subject

The subject, IH, a 58-year-old male, suffered a cerebro-vascular accident 13 years ago. He presents a right hemianopia, is anomic and has reading and spelling difficulties.

Experiment 1

We looked at whether the subject could be auditorily primed in visual lexical decision by hearing a semantically related word.

Stimuli. The orthographic stimuli consisted of fifty word/pseudohomophone pairs (e.g. sky/skie). Digitized recordings of a word which was semantically associated to the target word (e.g. visual = sky/skie auditory = BLUE) were made for each orthographic pair. Each orthographic pair was presented once in each of two blocks. One half of the trials within each block were assigned to the neutral condition and the other half to the auditory prime condition. Words which were primed in one block were in the neutral condition in the other block and vice versa. Auditory condition was randomized within blocks. The visual stimuli were presented with the recording of

the semantic prime in the auditory prime condition and with a 1000 Hz tone that lasted 600 ms in the neutral condition.

Procedure. The visual stimuli appeared one above the other in the center of a computer monitor. The digitized recording was generated by the computer 16 ms after the visual stimuli appeared. The visual stimuli remained on screen until the subject responded. The subject was asked to indicate which of the two stimuli was the word by pressing one of two designated keys.

Results. IH made 4 errors on prime trials, and 2 on neutral trials. One trial with a RT more than three standard deviations above the subject's mean per condition was removed from the analysis. Analysis of his correct lexical decision times with auditory condition (prime, neutral) and order of presentation (block 1, block 2) as factors revealed a main effect for order of presentation [$F(1, 89) = 7.8$, $p < .01$] and an auditory condition by order of presentation interaction [$F(1, 89) = 4.0$, $p < .05$]. Simple effect analyses showed that semantic priming significantly reduced RTs in the first block [$F(1, 89) = 4.4$, $p < .05$] and the second block significantly reduced RTs on the neutral trials [$F(1, 89) = 11.7$, $p < .001$]. In the first block there was a semantic priming effect of 988 ms. There was an order of presentation effect from the first block to the second block for neutral trials of 1636 ms.

Discussion. The subject was facilitated by a semantic prime. The degree of facilitation (facilitation/RT for neutral condition = 24%) for IH was as great as he had previously experienced under similar experimental conditions with an auditory prime that was the same word (identity priming) as the visual word (24%). This suggests that perhaps identity priming is in fact semantically mediated.

Experiment 2

We evaluated the contribution of semantics in auditory identity priming by comparing the priming effect of content words (in this case nouns) and function words, considered to be, respectively, high and low in semantic content.

Stimuli. One hundred twenty word/pseudohomophone pairs for the orthographic stimuli were compiled. Sixty of the words were function words and sixty were nouns (content words). Function and content words were matched for word length and regularity. The median frequencies per million of the function and content words were 281 and 187 respectively. Half of the function words and half of the content words were assigned to the prime condition and the rest to the neutral condition. Digitized recordings were made of each word for the prime condition. Visual stimuli in the prime condition were presented with the digitized recording of the word and those in the neutral condition with a 1000 Hz tone that lasted 600 ms. The type of word and auditory input was randomized over trials.

Procedure. The procedure was the same as in the first experiment.

Results. IH had an overall error rate of 17%. This rate did not vary for word type or auditory condition. Reaction times three standard deviations above or below the mean per condition ($n = 5$) were not included in the analysis. Analysis of IH's correct reaction times with factors of auditory condition (prime/neutral) and word type (function/content) revealed a main effect of auditory condition [$F(1, 91) = 38.5\ p < .0001$]. The auditory condition by word type interaction approached significance [$F(1, 91) = 3.4\ p = .068$]. Simple effects analyses showed that whereas there was a significant effect of word type in the auditory prime condition [$F(1,91) = 3.9,\ p = .050$], there was none in the neutral condition [$F(1, 91) = .386,\ p < .54$]. IH's mean response times for content words in the neutral and prime condition were respectively 5212 ms and 2575 ms, a facilitation of 2637 ms whereas for function words it was 4923 ms and 3492 ms, a facilitory priming effect of 1431 ms.

Discussion. IH displayed significantly more auditory priming for content words than for function words. This indicates that the facilitation produced in visual lexical decision by phonology is in part mediated by semantics. However, because the subject was also facilitated by the auditory presentation of function words which have little semantic strength, it appears that direct orthographic activation by phonology also occurs.

T-3. The Independence of Letter and Word Processing in Letter-by-Letter Reading

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Recognition of words and of component letters of stimuli were examined in a letter-by-letter reader. Frequency and neighborhood density effects are present in word recognition but not in letter identification. There was no difference between single-letter reading times for words and nonwords, and there was no correlation between reading times for words and for individual letters off the same stimuli. LBL reading does not exclusively rely on sequential letter identification. Rather, LBL patients also have access to a whole-word procedure.

Introduction

Letter-by-letter reading (LBL) is characterized by very slow reading with a large linear effect of stimulus length (i.e. number of letters) on latency. LBL readers seem incapable of the holistic and spatially parallel process observed in normals. It rather appears they must identify each letter in sequence.

Previous research on LBL (Bowers, Arguin & Bub, 1996; Arguin & Bub, 1994) has shown that letter recognition rests on a token or shape-specific representation system. Indeed, in a letter identification task, physically identical primes result in large response time benefits, but no effect is found from primes that are orthographically identical to the target but physically different (e.g. prime = a; target = A), even if prime durations are sufficient to allow prime identification. By contrast, abstract (i.e shape-independent) priming is found when the prime and the subsequent target are words, even though patients are unaware that a prime preceded the target.

This dissociation between letter identification based on a shape-specific code and word identification being affected by abstract orthographic priming suggests a dual-process in LBL: 1- a damaged abstract orthographic pathway wich can no longer support overt word identification but may still be partially active, thereby supporting abstract priming; and 2- a residual shape-specific pathway wich operates on individual letters and is mandatory for overt word recognition (cf. letter-by-letter reading) In word recognition, LBL readers are affected by stimulus lexicality, word frequency, and number of orthographic neighbors (i.e. words that can be constructed by changing just one letter from the target) in a way similar to normals. We compared the effects of these variables on word recognition and on the identification of the component letters of stimuli.

If the lexicality, frequency, and orthographic neighborhood size effects result from modulations of the compensatory letter-by-letter process in LBL readers, these variables should modulate the time required by patients to identify individual letters of stimuli. Instead, if these factors only affect the operation of the whole-word procedure assumed to be available to LBL readers, their effects on word and letter identification should dissociate (i.e. no effect on letter identification performance).

Method

The subjet, IH, is a 58-year-old right-handed male who suffered a left temporal-occipital haematoma in 1983. Following the haemorrhage, IH's main behaviour complaints were: right-homonymous hemianopia, anomia, surface dysgraphia, and reading problems. He shows an abnormally large increase in reading reaction times as word lenght increases (about 500 ms/letter).

The stimuli were 60 four-letter words and 60 four-letter non-words presented one at a time on a computer monitor. Words varied in terms of frequency (high/low) and on the number of orthographic neighbours (high/low). Non-words were created by randomly mixing the letters of the words used. In a first experiment, IH was asked to read aloud the four-letter words (word naming). In a second experiment, he had to identify only one letter of the word or non-word that was presented to him (letter identification).

The position of the letter to be read was indicated 250 ms before the presentation of the item by two vertical lines: one above the target letter and the other just below. The indicated position varied randomly from trial to trial and each letter of words and nonwords was tested once.

Results

In word naming, response times showed main effects of frequency [$F(1, 56) = 5.43$, $p < 0.05$] and number of orthographic neighbors [$F(1, 56) = 7.62$, $p < 0.01$]: responses were faster when words had a high frequency or a high neighborhood density. These effects did not interact [$F(1, 56) = 2.35$, ns]. By contrast, in the letter identification task word frequency [$F(1, 56) = 3.13$, ns] and neighborhood size [$F(1, 56) < 1$, ns] had no effect on response time. Moreover, there was no difference between single-letter reading times for words and nonwords [$F(1, 471) = 1.979$, *ns*].

The separability of the processes involved in word and in single letter identification was further substantiated by correlation analyses. No correlation was found between the time required to read words and the average time required to read individual letters off the same stimuli ($r = 0.1048$). Further, no relation between word and letter identification occurred when words were classified as a function of their frequencies and numbers of orthographic neighbors (highest correlation = 0.3065).

Discussion

The results show that frequency and orthographic neighborhood size effects are present in the word naming task and not in the letter identification task. Since the effects of these factors on word and letter identification dissociate, we conclude that they only affect the operation of the whole-word procedure, assumed to be available to LBL readers on the basis of previous word priming studies.

Moreover, no significant correlation was found between the time required to read words and the average time required to read individual letters off the same stimuli. This result occured also when words were classified as a function of their frequencies and numbers of orthographic neighbors. These results again point to a dissociation between letter and word processing in LBL.

The present results may explain why it has often been so difficult to find a word superiority effect (WSE) in LBL. Indeed, the standard procedure used to evaluate this effect (forced-choice task) requires letter identification instead of word recognition. In an LBL study by Bowers, Bub & Arguin, (1996), no WSE was found in the forced-choice task but a clear WSE occured in a free report task (requiring overt word recognition), thereby showing access to a whole-word procedure in LBL.

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T-4. Relative Preservation of Egocentric But Not Allocentric Spatial Memory in Aging

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There is indirect evidence for the dissociation of egocentric and allocentric spatial memory in aging. We directly examined performance of subjects on tasks of both kinds. Twenty young (18–30 years) and 20 older adults (64–76 years) were asked to recall the location of object pairs presented in two of six positions on a board. At recall, half of the subjects were given only one of the items in the pair to relocate (egocentric), and the other half relocated items paired at study (allocentric). The results supported the hypothesis that allocentric, but not egocentric, spatial memory declines with age.

Introduction

Previous research provides indirect evidence for the dissociation of egocentric and allocentric spatial memory in aging (Parkin, Walter, & Hunkin, 1996). Egocentric spatial tasks are those in which subjects are required to remember the location of objects relative to their own body position, either on their left or their right. Performance on such tasks has not been shown to decline with age (McCormack, 1982b; Ozekes & Gilleard, 1989; Uttl & Graf, 1993). Allocentric spatial tasks are those in which subjects are required to remember locations of objects relative to other objects, such as landmarks, or in configurations. For example, subjects have been shown arrays of 100 objects and asked to remember the relative locations of the objects. Performance on these tasks has been shown to decline with age (Cherry & Park, 1989; Cherry & Park, 1994; Zelinski & Light, 1988). One problem with earlier studies is that stimulus array sizes have not been equated between egocentric and allocentric tasks. The latter are subjectively more taxing on the memory of elderly subjects given the sheer number of items to be recalled. The goal of the present study was to examine egocentric and allocentric spatial memory performance in elderly adults on a configurational memory task that equated stimulus array size while differentially accessing these two systems.

Methods

Subjects. Twenty young adults (aged 18–30) and twenty older adults (aged 64–76) participated in this study. The former were recruited from the Psychology 100 subject pool at Erindale college, and received credit toward their coursework. The latter were paid $10 for their participation. Both age groups were matched for sex and years of education (a range of 12–17 years).

Procedure. The apparatus for this study consisted of a white posterboard measuring 50cm by 50cm and 120 small household objects (e.g. can opener, doll, ruler, etc.). Objects were sorted into 60 pairs of unrelated items, and were displayed such that no one semantic category was shown more often in one location than another on the board. Objects were shown in pairs on the board in two of six possible locations which were not clearly marked for the subjects but which the experimenter had mentally divided across the board.

For the study phase of the task, subjects were presented first with one of the 60 pairs of items, and they were to point to each of the items and name them. Pairs were shown for 4 seconds. A screen was then placed in front of the board and subjects were asked to count backward from a randomly chosen number from 100 to 999 for 4 seconds. They were then shown the next pair to name. This procedure continued until all 60 pairs were shown. The pairs were shown in the same fixed order for all subjects. Subjects performed other neuropsychological tests during a 1/2 hour delay, which were used for the analysis of another study. At the end of this delay, 1/2 of the subjects were given each object alone and asked to recall the exact location (egocentric condition, presumably because all they had to go on was whether the object was on the left or the right, and how far away it was). The other half were given the pairs as shown during the study phase, and asked to recall the location of both of the objects (allocentric condition, because they could use the objects as cues for each others' position). Subjects were provided with a grid of 6 positions in which objects were shown to aid their recall.

Results

All analyses were done using SPSS for windows. Results for the spatial task showed a significant main effect of condition on object location recall, $F(1, 36) = 1.877$, $p = .179$. There was no overall effect of age, $F(1, 36) = 6.874$, $p = .013$. There was, however, a significant Age x condition interaction, $F(1, 36) = 5.427$, $p = .050$. A priori contrasts showed that there was no difference in the recall scores of older and younger adults in the egocentric condition, $t(1, 18) = -.35$, $p > .05$, but with younger adults recalling more locations than older adults in the allocentric condition, $t(1, 18) = 2.85$, $p = .013$.

Discussion

The results provide direct support for the contention that egocentric spatial memory shows no decline with age on configurational recall tasks, while allocentric spatial memory in such tasks does show a relative decrement in older adults. This suggests that older adults have a harder time with spatial tasks that require the creation of arbitrary relations between the locations of pairs of objects than with tasks that simply require the encoding object coordinates relative to body position. It remains to be seen whether this is a deficit specific to spatial memory alone, or whether the creation of arbitrary relations declines generally across other types of stimuli.

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T-5. Limb Apraxia and Verbal Comprehension in Alzheimer's Disease

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The purpose of this research is to determine whether the gesture-language parallels occur in patients with a diffuse disease such as Alzheimer's. The results demonstrated a significant correlation between performance in pantomime to verbal command and a verbal comprehension deficit. A further qualitative analysis demonstrated that the most frequent errors for AD patients was using a body part as object. The data are interpreted to support a common symbolic representation shared by words and pantomime.

Introduction

Many studies have demonstrated a relationship between the frequency of aphasia and limb apraxia (LA) (Heilman, Rothi & Valenstein, 1982; Roy, Square,1985; Alexander et al., 1992) and, more precisely, a strong correlation between verbal comprehension and gesture to verbal command in patients with poor comprehension skills (Kertesz & Hooper, 1982). These results suggest that both disorders may arise from the same deficit (asymbolia). However, other studies have shown dissociations of apraxia and aphasia in aphasics (Papagno, Della Sala, & Basso, 1993; Lehmkuhl, Poeck, & Willmes, 1982) and in demented subjects (Della Sala, Lucchelli, Spinnler, 1987; Rapcsak, Croswell, Rubens, 1989). Although apraxia is common in AD, there are few systematic studies comparing the nature of apraxia and language disturbances in this population.

Rapcsak et al. (1989) studied apraxia in 28 patients with AD and did not find a significant difference between performance on verbal command nor on imitation of transitive movements. The authors concluded that ideomotor apraxia in AD may be apparent even in patients with good language functions. In contrast, a study of apraxia in 8 AD patients by Kempler (1988) showed significant correlations and qualitative parallels between pantomime and verbal comprehension. They concluded that there exists a common symbolic representation shared by words and pantomime.

The specific goals of this research are to (1) determine whether the gestural and comprehension deficits are correlated by testing verbal comprehension, pantomime to verbal command and imitation of meaningless gestures in a group of patients and matched-controls, (2) determine the most common apraxic error in AD patients, (3) compare these data with comparable reports on aphasic patients. Limb apraxia (LA) is defined as a difficulty in making gestures that is attributable to an inability to translate the concept of a motor sequence (temporal, spatial and sequential organization) into the correct motor action, in the absence of motor or sensory deficits.

Methods

Subjects. Eight patients fulfilling NINCDS-ADRDA criteria for clinical diagnosis of probable Alzheimer's disease (McKhann et al., 1984) and 23 non-demented control subjects matched for age (patients, 78,8 $\pm$ 5,3 years; controls 74, 7 $\pm$ 5,2 years) and education (patients, 9,8 + 3,5 years; controls, 11,5 $\pm$ 3,4 years) participated in the study. The global deterioration scores (Reisberg et al., 1982) in AD patients ranged from 3 (mild) to 5 (moderate).

Tasks. The tests employed are part of a comprehensive neuropsychological battery (PENO) and have previously been described in detail (Joanette, Poissant, Ska, & Fontaine, 1989).

Comprehension test. This task was used to assess verbal comprehension. Each subject was shown four line drawings and was instructed to point to the picture representing the object or the sentence named by the examiner. The three distractor items were semantically related to the target. The test consisted of 47 items which were presented in order of difficulty.

Movement imitation test. This test was designed to assess LA and consisted of 10 non-symbolic gestures which were performed slowly by the examiner and reproduced immediatly by the subject.

Pantomime of transitive movements. This test assessed the ability to evoke a gesture specifically related to a single object. The subject was asked to pretend to use 10 objects of common use.

The subject's performance on the apraxia tests was evaluated qualitatively by classifying the errors in the following categories: (1) body part as object or a wrong position of hands to represent the object during gesturing, (2) inadequate movements, (3) inadequate relation between position of hands to body.

Results

The performances of patients and controls were compared using a variance analysis (ANOVA) group X test (repated measures on test factor) and a further analysis of simple effects. AD patients performed significantly worse than controls in verbal comprehension ($F = 34.65$, Df $= 1.36$, $p < 0,.001$), in pantomime to verbal command ($F = 38.11$, Df $= 1.36$, $p < 0.001$), and in a movement imitation test ($F = 8.83$, Df $= 1.36$, $p < 0.0053$). We examined the relationship between verbal comprehension and apraxia by computing Pearson's correlation coefficients (1-tailed signifiance) between verbal comprehension scores, pantomime to verbal command score and imitation score for AD patients. A strong correlation was established between verbal comprehension score and pantomime score for AD patients (rho $=$ 0.70, $p < 0,05$). The most frequent errors for AD patients in the pantomime test was using a body part as object or incorrectly positioning hands to represent the object (60%).

Conclusion

This study supports previous findings that AD patients are more impaired in pantomime to verbal command than in movement imitation (Kempler, 1988). As Willis and Behrens (1992) pointed out, pantomiming transitive movements is a complex task because it requires the simultaneous retrieval of the concept representing the object and the movement associated with the object. Our findings also show that limb apraxia is strongly correlated with language comprehension deficits in AD patients (Kempler, 1988; Taylor,

1994), as well as in focal left hemisphere patients (Kertesz & Hooper, 1982). The most common type of error was using a body part to represent an object, as reported in aphasics subjects. The results are interpreted by a disruption of the symbolic system which underlies both gestural and lexical abilities, in concordance with the model of praxis suggested by Rothi, Ochipa and Heilman (1991).

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T-6. Do Hemispheres Specialize in Processing Different Aspects of Visual Stimulus?[7]

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To test whether the two hemispheres process orientation (a dorsal system task) and shape (a ventral system task) with different paces, we flashed a visual stimulus into each visual field and in one set of trials we asked the subjects to decide its orientation and in another block of trials, its shape. We used three shapes (a rectangle, a triangle and an ellipse) in four orientations (vertical, horizontal and two obliques). The subjects responded with either left or right hand. We found that besides an overall better performance of right hand, there was only a superiority of right visual field over the left in orientation task and no significant difference between visual fields in shape task.

We think that our unexpected results seem reasonable if we break the tasks to finer blocks: the categorial spatial relations being processed better in the left brain than coordinative spatial relations though both dorsal system tasks.

T-7. The Effect Of Graphemic Parsing in Nonword Reading

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Dual-route models of reading suggest the existence of a sublexical graphemic stage which operates prior to graphophonemic conversion. We assume that the parsing of nonword letters in complex graphemes represents a part of the processing in the graphemic stage. We examined the effect of graphemic complexity on reading nonwords in normal subjects. Analyses show significantly longer reaction times for nonwords composed of complex graphemes than for nonwords whose graphemes corresponded to a single letter. These results support the existence of a sublexical graphemic parsing procedure, and are best viewed in the light of dual-route theory.

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Introduction

Dual-route models of reading suggest that there exist functionnally independant lexical and nonlexical mechanisms for processing words. The lexical processing route operates at the whole-word level, providing a direct link between orthography and phonology, while the nonlexical route relies on a sublexical process consisting of converting graphemes to phonemes. It is generally assumed that the lexical route allows irregular and regular words to be read, and that the nonlexical route is involved in the production of regular words and neologisms. As opposed to their earlier form, more recent versions of dual-route theory propose an interaction between the two reading mechanisms, as well as the involvement of units larger than graphemes (i.e. subsyllabic segments or syllables) in the conversion procedure.

Evidence for the existence of such routes is based on neuropsychological evidence and studies with normal subjects.

In its early accounts, little was known about the underlying processes of the phonological (sublexical) route. It was simply assumed that grapheme-to-phoneme conversion (GPC) rules were involved. A functional distinction between two stages in the phonological reading process, a graphemic and a phonemic one, was later made. Both stages were thought to be independant of the GPC process (Desrouesne and Beauvois, 1979; Beauvois, Desrouesne & Saillant, 1980). According to a recent model of reading (Lecours, 1996), the orthographic processing stage that occurs prior to conversion involves the segmentation of the individual letters of a word, which are then either converted directly into their corresponding phoneme or assembled into a multi-letter grapheme before being converted. For example, in the nonword ''tarcol'' (in French), each letter corresponds already to a grapheme, whereas in the nonword ''phegau'', the letters ''ph'' and ''au'' first have to be assembled into the graphemes [f] and [o].

The present study, conducted among a group of normal subjects, demonstrates the ''parsing'' effect that occurs in a nonlexical reading task. It seeks to elucidate the nature of a sublexical processing component inherent to dual-route theory.

Method

Thirty French university students served as subjects. All of them were right-handed, with no personal or family history of dyslexia.

The critical stimuli consisted of a corpus of 40 bisyllabic six-letter legal and pronounceable nonwords. The nonwords were presented for reading aloud singly in pseudo-randomized order to subjects.

Two lists of 20 nonwords each were selected so that nonwords were matched pairwise in terms of their sublexical bigram frequencies and their onset characteristics. One list was made of nonwords composed of bigrams which had to be assembled in two-letter graphemes (e.g. phegau), and the

other was made of nonwords composed of one-to-one letter-grapheme correspondances (e.g. tarcol). A grapheme was defined as being the graphemic equivalent of a phoneme. The limited number of stimuli was due to the fact that the latter were emphatically controlled. Also, since two-letter graphemes are not very common in French, a potential repetition effect was avoided.

Results

The results of a one-tailed t-test for paired samples indicate that the reaction times were significantly higher ($t = -9.414$, $p < 0.0001$ (29 d.f.)) for nonwords which required letters to be assembled in graphemes than for nonwords whose individual letters corresponded already to graphemes.

Discussion

Nonwords which required graphemic parsing were read significantly slower than nonwords which did not require such processing.

Intuitively, one would tend to think that nonwords composed of assembled graphemes are read faster than nonwords with direct letter-grapheme correspondances, because the former require the phonological integration of only four phonemes, while the latter call for the integration of six phonemes. However, results go in the opposite direction. This effect accounts for the existence of an isolated parsing procedure inherent in the sublexical mechanism. This processing feature of the graphemic stage is a necessary step for conversion to occur. The results are best interpreted in the eyes of dual-route theory, yet they do not interfere with analogy nor connexionnist theory.

Future attempts should be made at making explicit the underlying processes of a nonlexical route whose functionning still remains unclear. Such attempts could be beneficial to the better understanding of certain forms of dyslexia (e.g., phonological dyslexia).

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T-8. Aging, Working Memory, and the Development of Instance-Based Retrieval

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The aim of this study was to examine the interrelationships between adult age, working memory, and the development of instance-based retrieval in an alphabet-arithmetic task. Eight young adults (M = 19 years, SD = 1.4), 8 middle-aged adults (M = 41 years, SD = 2.6), and 8 older subjects (M = 69 years, SD = 3.1), all women, were given 4 sessions of training on an alphabet arithmetic task of the form, G [3] K [3] O . . . String lengths were varied, but only the initial letter-digit- letter triplet was relevant. Age differences in the rate of acquisition were not associated with measures of working memory.

Salthouse (1991, 1994, 1996) suggested that age-related changes on a wide variety of cognitive tasks can be attributed to age-associated deficits in working memory. Working memory refers to the ability to simultaneously process and store information. Salthouse reported that the magnitude of age-related deficits on selected cognitive tasks is greatly reduced by statistically controlling for individual differences in working memory. The aim of this study was to examine the interrelationships between adult age, working memory, and the development of instance-based retrieval in an alphabet-arithmetic task. It was expected that measures of working memory and learning would be associated early in practice, especially for older adults. However, no associations were expected between working memory and learning later in practice, after the transition from computational learning to memory-based retrieval of instances was established (e.g., see Logan, 1988).

Working memory ability was assessed using the digit-symbol substitution and the digit span (backward) subtests from the WAIS-R, and a Letter Order Task (SLOT) developed by Lewandowski (1996) and Huttenlocher and Burke (1976). The Syracuse Letter Order Task (SLOT) requires subjects to reorder lists of letters ranging in length from 2–9 letters. The letters were presented orally in random order, and subjects were required to say the letters in alphabetical order. Subjects were presented with 3 lists at each list length and received 1 point for each string of letters they correctly recalled in alphabetical order. The test was terminated when subjects failed to correctly recall at least 1 of the 3 lists at a particular list length. Age-related differences in instance-based retrieval were assessed by giving participants extensive practice with 36 alphabet arithmetic problems. The alphabet arithmetic task was similar to that used by Haider and Frensch (in press). The task required participants to verify alphabet strings (e.g., F[3]J, H[4]M[4]R, G[3]K[3]O[3]S) by judging whether or not the strings presented to them were correct or incorrect. The digit in brackets indicated the number of letters skipped in the

alphabet between the two letters composing the triplet (e.g., H[4]M is the same as H[I,J,K,L]M). The digit was either a ''3'' or a ''4.'' For incorrect triplets, the letter following the first digit in the string was the letter in the alphabet that followed the correct letter (e.g., H[4]N[4]S instead of H[4]M[4]R). Regardless of string length (i.e., either 1, 2, or 3 triplets), only the initial letter-digit-letter triplet was relevant. Performance was assessed across four sessions, and there were 720 trials per session. Each of 36 instances was repeated 20 times in each session.

Eight young adults (M = 19 years, SD = 1.4), 8 middle-aged adults (M = 41 years, SD = 2.6), and 8 older subjects (M = 69 years, SD = 3.1), all women, participated. All participants had 20/30 uncorrected or corrected-to-normal near visual acuity. Participants were asked to estimate their own general health on a 5-point scale, ranging from excellent (1) to poor (5). Mean self- ratings for the younger, middle-aged, and older adults were 2.0, 1.5, and 1.75, respectively. Participants were also asked to estimate the extent to which health- related problems limited their daily activities on a 5-point scale, ranging from not limited (1) to very limited (5). Mean self-ratings were 1.37, 1.37, 1.5 for the younger, middle-aged, and older adults, respectively. Participants were screened for the use of prescription drugs; participants reported taking one or fewer prescription medications (e.g., antibiotics or birth control pills). Years of formal education ranged from 12 to 16 (M = 13.2. SD = 1.58) for younger adults, 12 to 18 (M = 14.8, SD = 2.03) for middle-aged adults, and 12 to 22 (M = 15, SD = 3.6) for older adults.

As expected, an analysis of variance revealed a main effect of age for digit-symbol performance, $F(2, 21) = 8.28$, $p < .002$, MSe = 96.36; the correlation between age and digit-symbol scores was r = −0.66 ($p < .0001$). No age effects were obtained for Digit Span or SLOT scores. A main effect of Age was obtained, $F(2, 21) = 9.62$, $p < .001$, MSe = 29,983,652 on the alphabet arithmetic task, suggesting an overall age- related decline in speed of instance-based learning. For each participant, the Power Function Model (RT = a + bN − c) was fit to mean response times by session, collapsed over age, and the resulting rate parameters were correlated with Digit Symbol scores. According to the Power Function Model, the learning curve is a function of the amount of practice obtained and the learning rate, which are both denoted by N and c, respectively. The variables a (asymptotic performance) and b (difference between untrained and trained performance) function as scaling parameters designed to move the learning curves into positions occupied by the data. The rate of acquisition was not significantly correlated with Digit Symbol performance ($r = -.32$, $p < .12$). Correlations between digit-symbol performance and response times were calculated for each of the four sessions of training, collapsing over age. Contrary to our predictions, these correlations were reliable for sessions 2–4 (rs −.45, −.34, −.41 for sessions 2–4, respectively), indicating that measures of working memory and learning were not associated early in practice. Best-fit regression lines were also cal-

culated to examine the relationship between digit- symbol scores and mean response times for each session. The r2s ranged from .17 to .33, suggesting that digit- symbol scores were not good predictors of mean response times across sessions. Although age-related declines in working memory performance were obtained, there was no evidence to suggest a relationship between age, working memory, and the rate of acquisition of instance-based learning.

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T-9. Mediated Priming in High-Dimensional Semantic Space: No Effect of Direct Semantic Relationships or Co-occurrence

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Mediated priming (MP) presumably occurs via a mediating item (e.g., LION primes STRIPES via TIGER; Balota & Lorch, 1986). McKoon and Ratcliff 1988 argue that MP is caused by weak, but direct, prime-target relationships. Semantic relatedness and lexical co-occurrence underlie this effect. We replicate the MP effect (lexical decision and naming). Using the HAL memory model, we find that mediated to target semantic distances are greater than unrelated pairs, and find no relationship between strength of priming and lexical co-occurrence. McKoon and Ratcliff's claims find no support from these results. We conclude that MP occurs as a function of contexts shared (or mediated) by the mediating prime and the mediator itself.

Mediated priming is a subtle, yet reliable effect (Balota & Lorch, 1986, McKoon & Ratcliff, 1992). The mediated priming effect has traditionally been explained within a spreading activation framework of memory. Spreading activation works within a semantic memory network of interconnected nodes; each node represents a concept. These concept nodes are connected

if they are related by prior association or if they share semantic features. To retrieve a concept from memory, a node must be activated; this activation will spread to directly related concepts. Therefore, when presented with the prime-target pair LION–STRIPES, priming will occur because LION is closely connected to TIGER and TIGER is closely connected to STRIPES. Thus, activation should spread from the prime (LION) through the mediating concept (TIGER) to the target (STRIPES).

McKoon and Ratcliff 1992, using the compound cue theory of retrieval, suggest an alternative explanation for the mediated priming effect. They argue that mediated priming is not ''mediated,'' but instead, any priming is due to weak, but direct, relationships in memory. For example, McKoon and Ratcliff argue that (all) priming is guided by two factors, semantic relatedness and lexical cooccurrence which should positively correlate with mediated priming. Closer semantic relatedness and increasing lexical cooccurrence should predict larger priming effects.

McKoon and Ratcliff's claims raise theoretically important issues. Does true ''mediated'' priming exist? In an effort to address this question, we first replicated the mediating priming effect using both lexical decision and naming. In addition, we examined the explanation of mediated priming as suggested by McKoon and Ratcliff relying on the Hyperspace Analogue to Language (HAL) model of memory (Burgess & Lund, in press; Lund & Burgess; 1996) to generate a semantic relatedness measure and lexical co-occurrence frequencies.

Experiments 1 and 2 are replications of the basic priming effect. The critical manipulations are Experiments 3 and 4 which use the item priming data from Experiments 1 and 2 to address the claims of McKoon and Ratcliff concerning the weak, but direct relatedness of mediated primes and targets. Experiment 3 directly tests the semantic relatedness issue, while Experiment 4 addresses the issue of lexical co-occurrence frequency.

Experiment 1

Method. Thirty University of California, Riverside, undergraduates participated. All participants were right-handed, native speakers of English.

The stimuli were taken from Balota and Lorch 1986. There were three lists, each list contained 16 critical mediated pairs, 16 unrelated pairs, and 32 nonword pairs.

A trial consisted of a fixation point (500ms) followed by a prime word (350ms) followed immediately by a target. Participants performed a lexical decision task.

Results. All effects reported were reliable at $p < .05$. There was an overall mediated priming effect. Reaction times for mediated prime-target pairs (544ms) were faster than reaction times for unrelated prime-target pairs (566ms).

TABLE 8
Semantic Distances for Word Pairings (in RCUs)

Med-Target	Unr-Target	Rel-Target	Med-Target
672	432	372	322

Experiment 2

Method. Forty-five University of California, Riverside undergraduates participated with the same restrictions as Experiment 1. Experiment 1 materials were used with the removal of non-word trials and the addition of 16 directly related trials. Procedure was the same as in Experiment 1 except that participants named the target word.

Results. All effects reported were reliable at $p < .05$. Consistent with earlier results, there was a mediated priming effect and a direct priming effect. Reaction times to directly related pairs (548ms) were faster than for unrelated pairs (568ms). Reaction times for mediated items (558ms) were faster than for unrelated pairs (568ms).

Experiment 3

Method. Semantic distances (RCUs: Riverside Context Units; see Lund & Burgess, 1996) for all word pairs used in the experiments (mediated-target, unrelated-target, related-target) were calculated using the HAL memory model. Distances were also calculated for a condition not present in the experiments—the related-mediated condition (LION-TIGER).

Results. Table 8 contains mean semantic distances for all word pairings. As expected, both directly related conditions are closer than the unrelated condition. Contrary to McKoon and Ratcliff's prediction, mediated-target pairs (627 RCUs) are actually further apart in the high-dimensional semantic space than are the unrelated-target pairs (432 RCUs).

Experiment 4

Method: PROCEDURE. Lexical co-occurrence frequencies (frequency two items occurred in the corpus) for mediated-target pairs were extracted.

Results. Correlations were calculated between priming effect obtained and lexical co-occurrence frequency, for the lexical decision and the naming experiments. Again, contrary to McKoon and Ratcliff's predictions, there was no correlation between magnitude of priming and co-occurrence frequency for lexical decision ($r = .013$) or naming latency ($r = -.004$).

Conclusions. These results suggest that mediated priming does exist and cannot be explained by directly, but weakly related, prime-target pairs. McKoon and Ratcliff's claims that semantic relatedness and lexical co-occurrence guide the strength of this priming effect were unsupported.

Unrelated prime-target pairs had closer distances than did mediated-target pairs, suggesting that semantic relatedness does not predict priming. Furthermore, there is no correlation between magnitude of priming and lexical co-occurrence frequency.

Our results are consistent with a localist spreading activation account of mediated priming. However, distributed representations, that are context vectors (such as HALs), can also explain mediated priming. It is important to note, however, that instead of nodes representing a concept, distributed representations have vector elements that encode the contexts in which words appear. Thus, in a model like HAL, LION will prime STRIPES because LION has shared contexts with TIGER and TIGER has shared contexts with STRIPES (see basic relatedness effects in Table 8).

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T-10. Effect of Inversion on Perceptual Biases for Chimeric Faces

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Chimeric faces shown in free vision yield reliable left spatial field biases that have been attributed to the activation of the right hemisphere and a resulting leftward attentional bias. Inversion disrupts face encoding, and, in this study with 96 right-handed subjects, markedly reduced perceptual biases for emotionally expressive chimeric faces. Inversion did not affect biases for gender chimeras which have been shown to produce smaller biases with different sources of variance than emotion chimeras. Thus, the attentional bias for emotion chimeras seems to reflect a right hemisphere global face processing strategy, but the bias on gender chimeras does not.

Introduction

The right hemisphere (RHEM) excels at face perception, and its activation seems to be the basis for the robust perceptual asymmetries found for chime-

ric faces viewed in free vision (Christman & Hackworth, 1993; Gilbert & Bakan, 1973; Levy, Heller, Banich, & Burton, 1983; Luh, Rueckert, & Levy, 1991). Inversion of faces, which disrupts viewers' ability to accurately encode faces (Yin, 1969), disrupts RHEM but not LHEM processing (Levine, Banich, & Koch-Weser, 1988). Thus, it was predicted that inversion of chimeric faces will disrupt the usual perceptual biases.

In addition, Luh et al. (1991) showed that happy/neutral chimeras produce larger biases than male/female chimeras and have a unique source of variance, and argued that the presence of emotion in faces activates a distinct processing mechanism. If this is the case, then inversion may affect emotion and non-emotion judgements differently.

Methods

Right-handed undergraduates (44 male, 52 female) performed six free-vision tasks, each with 12 pairs of images. Stimuli were mirror-image pairs of happy/neutral and male/female chimeras, shown both upright and inverted. For both orientations, subjects were asked to judge which member of each pair looked happier or more feminine. Subjects also viewed pairs of nonfacial stimuli that yield perceptual biases: rectangles with an asymmetric distribution of dots, for which subjects estimated which rectangle had more dots; and rectangles filled with light-to-dark gradients of patterns, for which subjects judged which appeared darker. Half the subjects saw upright faces, then nonface stimuli, then inverted faces, and the other half performed the tasks in the reverse order; emotion chimeras preceded gender chimeras for half of each group. Sex of subject was balanced in each of the four resulting test orders.

Results

All tasks yielded reliable scores (coefficient alphas ranged from .745 to .835), and were scored for the number of pairs on which a subject selected the image with the queried trait (happier, more feminine, more dots, darker) to the left. A laterality quotient was computed as proportion right choices minus proportion left choices. The resulting quotients range from -1 to 1, where -1 indicates a complete left spatial field bias. Leftward biases were significant for all tasks (all $p < .0001$). An ANOVA with grouping variables of order 4, and sex 2 and task 6 as a repeated measure, yielded only a significant effect of task [$F(5, 440) = 5.02$, $p = .0002$]. Perceptual biases were greater for upright emotion faces ($-.400$–$.549$) than for the other five tasks (Newman-Keuls pairwise comparisons, all $p < .01$); biases were equivalent for the other five tasks (means ranging from $-.160$–$.568$ to $-.239$–$.490$).

An ANOVA with only face tasks indicated that those who viewed the upright faces first had somewhat larger biases [main effect of group: $F(1, 92) = 4.15$, $p = .0446$; upright-first group mean $-.325$, inverted-first group

mean −.153]. As in the first analysis, perceptual biases were greatest for upright emotion faces [interaction of Orientation and Face Type: $F(1, 92) = 12.03$, $p = .0008$; all pairwisep $< .01$); there was no interaction with group, so, even though those who saw the inverted faces first had weaker perceptual biases for faces, the basic pattern of findings was similar for both groups.

These ANOVAs indicate that the processing of emotion-containing faces differs from other tasks. This is confirmed by correlational analyses. Although all tasks intercorrelate significantly (Pearson *r*'s vary from .223 to .556, all $p < .03$), upright and inverted emotion scores correlate more strongly with upright gender scores (*r*'s = .532 and .481) than with each other [$r = .357$, the difference between .532 and .357 is significant, $t(93) = 1.98$, $p = .05$, 2-tailed]. In contrast, upright and inverted gender scores intercorrelate well ($r = .556$), and also correlate better with nonface tasks than do the emotion tasks.

Discussion

The inversion effect for faces seems to reflect the employment of an orientation-specific strategy that relies on the interrelationships of the parts of the face; it disappears when subjects are induced to decompose faces for processing (Farah, Tanaka, & Drain, 1995). Although gender discrimination sometimes relies on global analysis of faces, and can be disrupted by inversion (Bruce, et al., 1993), performance on gender chimeras appears not to do so. Subjects may rely on local features to judge femininity since cues to sex such as hair style are not masked. Global features are being used to judge upright emotion faces; inversion reduces the typical biases on this task by more than half, and inverted emotion chimeras have less variance in common with the same faces viewed upright than with gender face chimeras. Thus all chimeric faces are not equal in activating right hemisphere face processing mechanisms.

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T-11. Separate Orthographic Input And Output Lexicons: Evidence from a Surface Dysgraphic

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A surface dysgraphic was investigated to determine: (1) the writing deficit within a cognitive model and (2) support for a single or separate input and output orthographic lexicons. Regular words and nonwords were spelt perfectly, unlike irregularly spelt words (66% errors). All of these words were read perfectly. These results, along with normal cross-case transcription (e.g. CaSe- cAsE) supported intact orthographic input and output lexicons. Written rhyme fluency and deciding if words that sounded the same were spelt the same (e.g., tough-buff) was poor. Results were most consistent with a disconnection between phonological and orthographic output lexicons was supported.

A surface dysgraphic was investigated with two issues in mind: (1) the location of his writing deficit within a cognitive model of writing (Patterson & Shewell, 1987), and (2) support for a single orthographic lexicon or separate input and output lexicons (Behrmann & Bub, 1992). D. S., a 29 year-old male, with a grade 12 education had neurosurgery involving removal of parts of the left occipito-temporal lobe to relieve severe epilepsy in 1986 and 1990. Written spelling to dictation revealed no errors in spelling regular words and nonwords. Whereas a dramatic deficit in spelling irregularly spelt words was found (66% errors). These errors often produced homophones (e.g. yoke-yolk) and the more frequent spelling of homophones was produced when required to spell low frequency homophones in the context of a sentence. No errors were produced when D. S. read the regular, and irregular words, and nonwords that had been used to test his spelling deficit. This performance indicated intact reading processes and a deficit specific to spelling irregular words. Lexical decision was assessed in which nonwords were pronounceable nonwords and pseudohomophones and revealed a normal pattern of performance, suggesting an intact orthographic input lexicon.

Normal facility at writing numbers to dictation and transcribing digit symbols, revealed a writing deficit that was specific to orthographic material. Words were presented in alternating case and the task was to transcribe the words in the alternative case (e.g., ChAiR- cHaIr). This performance was

also normal, supporting intact orthographic input and output lexicons and abstract letter identity processing. Importantly, D. S. was very good at discriminating between the correct spelling of words that he had incorrectly spelt and the incorrect spelling he had produced. Again this suggests an intact orthographic input lexicon and some deficit involving the orthographic output lexicon. We hypothesized a deficit of the afferents or efferents of the orthographic output lexicon.

A deficit of written rhyme fluency (Temple, 1986) was found with intact written semantic fluency, indicating intact semantics and general ability to generate words and write them down. However, D. S. was unable to generate written words that sounded like a target word. He also demonstrated poor performance in deciding if words that sounded the same were spelt differently when the first phoneme was removed (e.g., tough-buff or code-load). Clearly, a deficit involving phonological processing and spelling was indicated. Overall, D. S.'s performance pattern was most consistent with a disconnection between the phonological output lexicon and the orthographic output lexicon as his deficits depended on phonological processing of written material. As such, they support separate input and output lexicons.

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T-12. Preserved Artificial Grammar Learning in Parkinson's Disease[8]

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Parkinson's disease (PD) patients and matched control subjects were compared in an artificial grammar learning task. The test strings were constructed in such a way that grammaticality judgments could not be based on some superficial features of the learning strings: the grammatical and nongrammatical test strings did not differ according to different measures of chunk strength (based on the frequency with which their bigrams and trigrams appear in the learning strings). Results show that PD patients and controls performed at the same level during the first presenta-

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tion of the test strings series, which suggests that the striatum is not (crucially) implicated in the ability to abstract rules implicitly from exemplars generated by a finite-state grammar. However, and contrary to control subjects, the classification performance of PD patients was at chance during the second presentation of the test strings. We argue that this latter result could be the consequence of the attentional deficit of PD patients.

Introduction

Several studies have provided evidence for impairment of procedural learning in Parkinson's Disease (PD) patients, suggesting the implication of the striatum in skill acquisition. For example, implicit learning abilities have been investigated in PD patients using the serial reaction time (SRT) paradigm (e.g., Jackson et al., 1995), and results of these studies showed abnormal performances in PD patients. However, these results can be questioned because of the implication of an overt motor component in the SRT performance. The present experiment was designed to examine the basal ganglia hypothesis of procedural learning in PD patients with the artificial grammar learning paradigm, an implicit learning task in which no motor component is implied.

Method

Subjects. Seventeen patients (6 women and 11 men) with PD were studied and individually matched for age, sex and level of education with 17 neurologically intact control subjects. All PD patients and control subjects were right-handed and did not evidence any psychiatric symptom. PD patients were diagnosed on the basis of current criteria for probable Idiopathic Parkinson's Disease. All PD patients but one were treated with dopaminergic drugs at levodopa posology under 1000 mg, and none of them received anticholinergic or antidepressive drugs. Vocabulary scores (Mill Hill; Deltour, 1993), Digit Span and Mattis Dementia Rating Scale (1976) results did not differ significantly across the two groups. All subjects were also administered a 15 word learning test in order to assess their explicit verbal long-term memory. On this test, control subjects performed significantly better than PD patients.

Material and procedure. The finite-state grammar used to generate the items is illustrated in Fig. 11. Out of the 63 letter strings of 4 to 7 letters that the grammar could generate, 51 were selected for the learning phase, and 12 for the test phase. Twelve nongrammatical test strings were also constructed for the test phase. Grammatical and nongrammatical test items were the same according to different chunk strength measures, ensuring that classification judgments could only be based on the adherence of the test items to the rules of the grammar (Knowlton & Squire, 1994; Meulemans & Van der Linden, in press): [a] the global chunk strength (calculated, for each item, by averaging the different frequencies of its chunks in the learning items),

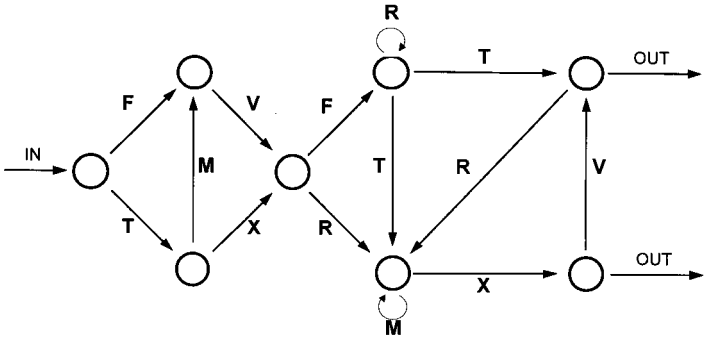

FIGURE 11

[b] chunk strength for the initial positions and [c] for the final positions, [d] chunk strength for anchor positions (calculated by averaging [b] and [c]), and [e] the chunk-novelty variable (a novel chunk being a chunk which never appeared in the learning items).

The experimental procedure comprised the study phase followed by the classification phase. In the study phase, the task was presented as an immediate-memory test, and subjects had to memorize 51 letter strings, one at a time.

At the classification phase, subjects were instructed that the letter strings they had just memorized a few minutes ago were constructed according to a complex system of rules. They were asked to classify 24 new items as grammatical or not. The whole string series was presented twice.

Results

For the first presentation, PD patients classified as grammatical 73.0% (*SEM* = 3.9%) of the grammatical strings and 60.3% (*SEM* = 4.4%) of the nongrammatical strings; control subjects classified as grammatical 69.1% (*SEM* = 3.4%) of the grammatical strings and 56.9% (*SEM* = 2.4%) of the nongrammatical strings. For the second presentation, PD patients classified as grammatical 64.2% (*SEM* = 4.2%) of the grammatical strings and 62.8% (*SEM* = 4.3%) of the nongrammatical strings; control subjects classified as grammatical 67.2% (*SEM* = 4.1%) of the grammatical strings and 54.4% (*SEM* = 3.2%) of the nongrammatical strings. A three-way ANOVA revealed a significant effect of the Grammaticality variable, $F(1, 16) = 10.43$, $MSE = 313.33$, $p < .01$, indicating that, on the whole, subjects classified more often the grammatical strings as grammatical than the nongrammatical strings, but no significant Group ($p > .35$) and Presentation ($p > .20$) effect. The analysis also showed a significant Group Grammaticality Presentation interaction, $F(1, 16) = 5.21$, $MSE = 56.49$, $p < .05$. No other interaction

was significant. A Newman-Keuls post hoc test showed that, for the first presentation, the Grammaticality effect was significant for both groups (ps $< .0005$) and that, for the second presentation, the Grammaticality effect was only significant for the control subjects ($p < .0005$), the performance of the PD patients being at chance ($p > .50$).

Discussion

PD patients showed normal performance in the first phase of the classification task. However, whereas control subjects maintained their performance in the second phase of the classification task, the performance of PD patients fell to chance, a result which can be attributed to a diminution of attentional ressources (which could be due to a tiredness effect) in PD patients during the task. This normal ability to classify grammatical and nongrammatical items during the first presentation of the test items cannot be attributed to some superficial features of the items, because of the rigorous control of different chunk strength measures in both item types. On the other hand, PD patients were impaired in an explicit verbal memory task.

On the whole, the results suggest that the basal ganglia are not crucially involved in the rule-abstraction mechanisms engaged in artificial grammar learning.

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T-13. Planning Strategies and Control Mechanisms: Evidence from Closed Head Injury and Aging

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The ability to plan a sequence of actions in a fictious environment was studied in young adults, CHI patients and elderly. The planning task consisted in completing 10 errands on a map of a hypothetical town where buildings, shops and public offices were shown. Results revealed significant differences across groups. Error analyses revealed the presence of different heuristics at work when planning was performed by young adults, elderly (older than 80 years) and CHI patients. The results are thought to be relevant for detailing a componential analysis of the planning process and control mechanisms.

Introduction

In current neuropsychological research terms such as ''executive control function'' ''supervisor system'' ''dysexecutive syndrome'' relate directly to the psychological concept of frontal system function and recently many findings on the decline of frontal lobes functions in older adults and closed head injury patients (CHI) are reported (Daigneault, Braun & Whitaker, 1992).

The aim of our study is to compare the performance of CHI, elderly and young controls in a planning task in order to evaluate the performance of the different groups. Planning consists in the ability to organize behavior in order to achieve a goal.

According to some authors (Duncan, 1986; Vikki e Holst, 1991) planning (or programming) , i.e. the goal-based search for action structure, involves the selection of subgoals which would match the subjects' capabilities to the task requirements in a way leading to the final goal. According to this view the selection of subgoals is the process that transforms the preliminary plan representation into a pattern of activation and inhibition of available lower level schemata so that the resulting action structure is adjusted to the specific task conditions. It is now argued that in normal human activity plans when originally developed do not correspond to completely worked out courses of action. A consequence is that planning as a whole needs to be viewed as a more opportunistic process carried out on-line when opportunities arise or difficulties occur. It follows that it is necessary a continuos monitoring of activity.

A formalized model which may explain most of the planning activity is the Supervisor attentional system (SAS) proposed by Norman and Shallice (1986), and Shallice (1982, 1988, 1994) The model involves three levels. The lowest level consists of a psychological processing structure whose oper-

ation is controlled by action or thought schemas. Then the model distinguishes between two modes of action control: An automatic mode via a ''contention scheduling'' mechanism, and a deliberate attentional control via a supervisory attentional system (S. A.S.) which operates by biasing the contention scheduling selection process.

We built up a task in which subjects had to organize their morning in a new town with some shopping to do, an everyday type of errand-planning task. This kind of planning is a variant of what is known in the literature as ''the salesman traveling problem'' and studies on normal Ss has led to the identification of a certain number of heuristics namely Minimal local distance (MLD) and Clustering. MLD is an heuristic based on the choice from a given location of the nearest location. Clustering implies an analyze of the entire plan in order to identify which goals are to be executed in succession, it uses also MLD inside each cluster.

Normal subjects of different ages and closed head injury patients were evaluated in their ability to perform the task in terms of heuristic. The predictions are that young normal Ss will use heuristics in a flexible way in order to obtain the best result. The damage of frontal lobe will induce the other two groups to a deviant pattern.

Materials and Methods

Subjects were presented with a map of a town and asked to move around this hypothetical town. They were asked to perform an ideal journey for completing as many as possible of ten errands proposed in the instructions, using the shortest way. The subjects' task was to sequence errands, to time actions and logically order goals (Cohen, 1988; Hayes-Roth, Hayes-Roth 1979). Some constraints were given: The starting and return times (respectively 9.00 and 12.30 a. m.); the opening hours of shops, public offices (from 9.00 to 12.30 a. m.), and of the hospital (from 11 a. m. to 1 p. m.). Furthermore the subject might ask the experimenter how long it took to reach each goal from whatever point. The scores were calculated considering (1) the number of correctly performed errands (goals) and (2) the type of errors made by the subject. Errors were categorized in several types: omissions, rule breaking (i.e., not considering a given constraints; going to the post office before taking the money from the bank); perseverations (i.e., going more than once to the same place); intrusions (i.e., execution of errands which were not present in the instructions). (3) We also considered a score (optimization score) which consisted in the rate between goals and moves X100. This score indicates with a value of 100 the best way to perform i.e. achieving the goals (with no matter to the number) with the minimum of moves. (4) Finally we considered the heuristics used by the Ss. Three types of heuristic were examined. The global heuristic evaluates a first provisional plan to start the task, clustering and minimal local distance heuristics.

Subjects. We tested 4 groups of subjects. Group 1 consisted of 43 young adult ranging in age from 20 to 30. Group 2 consisted of 63 adults ranging in age from 70 to 80, Group 3 consisted of 43 elderly over 80 and Group 4 consisted of 22 CHI patients ranging in age from 20 to 30. CHI patients had IQ in the normal range , subjects belonging to Group 2 and 3 were screened not to present any sign of dementia.

Results and Conclusions

The main results were the following:

- Goals achievement did not significatively differ in young adults and CHI patients (97.2% vs. 95.8%) while was significantly different from the results of the elderly groups (89.3% and 83.2%) ($F(3, 167) = 9{,}9$, $p < 0.001$; a Tukey-B post hoc test showed the significant differences).
- The optimization index showed the difficulty of CHI patients to organize in the best way the goal achievement. ANOVA analysis and Tukey-B post hoc test revealed that their optimization index was significantly the worst ($F(3, 167) = 16{,}2$, $p < 0.001$, Group 1 97.9; Group 2 81.8, Group 3 79.1; Group 4 67).
- CHI patients made significantly more perseverative errors than the other groups ($F(3, 167) = 7{,}8$, $p < 0.001$) and Group 3 made more intrusions than the other groups ($F(3{,}167) = 4{,}1$; $p < 0.01$) indicating for subjects over 80 and chi patients a problem in controlling the contention scheduling mechanism by the SAS.
- For what concerns the heuristics used. Only subjects over 80 could not correctly use the global heuristic and only CHI patients misused clustering and MLD heuristics.

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T-14. Types of Interhemispheric Relations in Man[9]

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For the past few decades, the functional asymmetry of human and animal brain hemispheres has become one of the most actual and intensively studied problems. However, up to now there is no commonly accepted model of the functional asymmetry of the brain. The functional asymmetry problem gradually started to be interpreted not as static differences of the two hemispheres but rather as dynamic interactions with the aid of corpus callosum that provides for the work of the brain as a whole integrity (Cook, 1986; Gazzaniga & LeDoux, 1978; Kinsbourne, 1982; Sperry, 1962). Thus, the dynamic interrelation of hemispheres is considered the chief mechanism in the integrative brain activity.

Reciprocal Type of the Hemispheric Interrelations

The essence of reciprocal mechanism is that in case of inhibition of one of the hemispheres, the functions of the contralateral one are reciprocally facilitated. Manifestations of the reciprocal interaction mechanism were revealed in case of inhibition of one of the hemispheres using a unilateral > electroconvulsive seizure (UES) model. The US is a mild modification of ECT. After the UES the functions of the stimulated hemisphere were shown to be inhibited while those of the intact one, to be preserved or even facilitated (Balonov et al, 1979). After the right-sided UES, the hearing of speech and the speech activity was shown to be increased; at the same time, the rhythmico-intonational pattern of speech changed essentially and vocal disturbances occurred. Simultaneous problems appear with recognition of musical images and complex nonverbal sound signals (animal wails, traffic and housekeeping noises, etc.) as well as intonational and vocal components of the speech. On the contrary, when the left hemisphere is inhibited, the identification of voices, intonation, mimics, musical images. All this is accompanied by pronounced aphasic manifestations. Thus, the perception and produc-

[9]This work was supported by Russian Foundation for Fundamental Research; Grant 97-06-80294.

tion of speech, and recognition of nonverbal images reveals reciprocal relations between the right and left cerebral hemispheres.

One of the examples of the reciprocal Interhemispheric relations there may serve peculiarities in recognition images of faces changed by a angle of vision and emotional expression. The inhibition of right hemisphere turned out to seriously impair the efficiency of the face recognition. Under inhibition of left hemisphere, the recognition of faces became much easier, even higher than in the control series performed prior to UES.

We have also revealed the reciprocal facilitation of the activity of the right or left hemisphere when studying location accuracy of signals by means of a modified perimeter. During the reciprocal facilitation of activity of the left the area of location accuracy becomes narrower in the left inferior part of the vision field with a simultaneous widening and a shift in the right inferior part. The inhibition of the left hemisphere showed the narrowing of the accurate location in the right superior part, which is combined with its widening and a shift to the left and downwards.

Complimentary Type of Hemispheric Interactions

The above data indicate that the right hemisphere provides for the precise location of signals in the left lower quadrant of the visual field, while the left hemisphere, in the right upper quadrant. In other words, each hemisphere has its own contribution to organization of the field of vision, their contribution being of complimentary character.

The complimentary type of the brain hemisphere interaction was also revealed when studying the music perception and complex color images. The right hemisphere turned out to preferentially recognize melodies and color images. At the same time, the left hemisphere recognizes better the time order, duration of musical tone and the rhythm and provides genre classification of melodies and color images.

The combination of these data implies that the complementarity rules out duplication of information in two hemispheres and suggests participation of corpus callosum as a control structure combining an integrative analysis of speech signals, nonverbal auditory and visual images as well as synthesis of an integrated sensory field.

The Superposition-of-Errors Type of the Hemispheric Interaction

Studying perception of three-dimensional space we found that under conditions of right or left hemisphere suppression patients make systemic errors, which consisted in an underestimation or overestimation of the size of distant parts of the object. Hence, each hemisphere has to use a distorted projection. However, these projections are directed in opposite ways and are neutralized during superposition. Thus, a new type of Interhemispheric relations has

been discovered, the type of compensation (or superposition) of systemic errors.

This type of interhemispheric relations was unexpectedly revealed in the studies of peculiarities of real space depth perception when the right or left hemisphere is inhibited. Holographic images of two rods were briefly demonstrated to the observer. Then the observers reproduced the location of the rods at a model with the space depth identical to that of the hologram.

Under inhibition of the right hemisphere the position of the rods was perceived as more distant than in the control. Under inhibition of the left hemisphere the rods were perceived to be closer than in the control. Hence, it is the close part of space that is of a particular significance for the right hemisphere while the distant part, for the left hemisphere. The right hemisphere underestimates distances, while the left one overestimates them. The superposition type brain hemisphere interaction provides for the undistorted perception of the spatial depth.

Conclusions

It seems reasonable to suggest that the interhemisphere interaction types depend on whether the inhibitory transmission occurs via corpus callosum or the excitatory effects predominate during the interhemispheric transmission of information. The reciprocal interaction mechanism appears to be a realization of preferentially inhibitory regulatory corpus callosum effects. Complimentary type hemispheric interaction may be explained by predominantly excitatory regulatory effects of corpus callosum. The superposition-of-errors type of hemispheric interactions can be explained as the interhemispheric transmission of excitation from the right hemisphere responsible for the primary procession of the visual-spatial information into the left one in which its own procession of the visual-spatial information takes place. A complicated matters is that a zone of inhibition develops, according to the induction principle, around the excited areas in the left hemisphere. In turn, the inhibitory impulses are transmitted via corpus callosum into symmetric zones of the right hemisphere; here a zone of excitation appears around the area of inhibition in the right hemisphere.

Thus, the primary activation of the right hemisphere at earlier stages of the visual-spatial perception is later replaced by an alternating excitation of the left and right hemispheres that facilitates an optimal orientation inside the three-dimensional space.

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T-15. Changing Relations between Intelligence and Brain Activity in Late Childhood: A Longitudinal Event-Related Potential Study

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In studying the relationship between Raven intelligence and event-related brain potentials to a visual oddball task in the same children, at respectively 9, 10 and 11 years of age, dramatic changes were observed with age. The event-related amplitude data suggest a shift in relation between intelligence and brain components reflecting early perceptual brain processes at age nine towards components reflecting evaluation and decision processes later on.

The notion that electrical activity recorded from the scalp may be modulated by the level of intelligence dates from the very first publication on the human electro-encephalogram (EEG) by Berger (1929). Early studies addressing the relationship between EEG and intelligence reported controversial results (for a review Gale & Edwards, 1986) most probably due to methodological and technical concerns. During the last decade a growing number of studies seem to agree upon the existence of a relation between electrical brain activity and intelligence, although the exact nature of such relation is far from established. In using multiple electrodes ERPs studies reported both level changes (ERP latency and amplitude changes) and qualitative changes (changes in ERP scalp topography) with age. In general both the latency and the amplitude of the cognitive ERP components decrease with age (Wijker, Molenaar, van der Molen 1989). Stauder et al. showed in a cross sectional (Stauder, Molenaar, van der Molen, 1993; 1995) and longitudinal study with 5 to 11- year olds that specific developmental changes in the anterior scalp distribution of late cognitive ERP components were more associated with sudden changes in the level of Piagetian development than with chronological age. This suggests that the relation between general intelligence and brain activity may change during development. This issue was, to our knowledge, never adressed before and constitutes the aim in the present study.

Methods

Participants. Thirty-six healthy girls from public schools (mean age = 9.5, sd = 0.3 years) participated at the first session, thirty-one girls (mean age = 10.6, sd = 0.2 years) at the second session and twenty-six (mean age = 11.5, sd = 0.3 years) in the third session. Only the children that participated in all three sessions (n = 26) are included in the present study.

Procedure. Testing took place in a dimly-lit and acoustically-shielded room. The child reclined in an easy chair at a distance of 1.6 m in front of a viewing screen on which slides were back-projected by two Kodak S-AV 2000 projectors. The oddball task presented 100 stimuli for 100 ms with a fixed inter-trial-interval of 2000 ms. The FREQUENT stimulus was a line drawing of a dog (n = 70) and the RARE stimulus of a cat (n = 30). The child was instructed to silently count the RARE stimuli. After the ERP recording the intelligence level was determined by the individually administered Standard Progressive Matrices (Raven, Court, Raven, 1983).

The EEG was recorded from F7, Fz, F8, T3, C3, Cz, C4, T4, T5, P3, Pz, P4, T6, O1 and O2 fixed in an electrocap. Reference was the left mastoid. Electrode impedance was kept below 8 Kohm. The EOG was recorded for eye-movement artifact correction. The EEG and EOG were sampled at 100 Hz, starting 210 ms before stimulus and extending 1070 ms after the stimulus. Amplification filters set at 0.16 Hz low and 30 Hz high cut-off. Data acquisition and stimulus presentation were controlled a Keithley System. All sessions were administered in the same experimental rooms, using the same equipment, and under supervision the first author. Mean, baseline and EOG-artifact corrected ERPs were calculated for all electrodes and conditions for each subject separately. The latency and amplitude for the P1, P2, N2, P3 and SW component were determined with a peak-picking procedure.

Results

Behavioral measures. The averages of the raw SPM scores of the 26 girls were 37.15 (sd = 7.56) at age 9, 40.46 (sd = 6.77) at 10 and 43.27 (sd = 5.49) at 11 years. This increase was significant between all ages.

AGE AND ERPS. The P2 and N2 amplitudes showed a dip at age 10, while the P3 and SW amplitudes decreased gradually with age. The latencies of the P1, P2, P3 and SW reduced most markedly between 9 and 10 years.

INTELLIGENCE AND ERPS. The regression analyses between the SPM score and the peak measures showed significant positive correlations for P1 amplitude at occipital sites and a single significant effect at the right temporal site for the P3 at age nine, with negative correlations for N2 and SW latency. At age ten N2, P3 and SW amplitude showed positive correlations with intelligence, while the peak latencies for all components, except the SW, showed negative correlations with intelligence. At age eleven the children showed also positive correlations with intelligence for the amplitude of the N2, P3,

and SW component. The latency measures showed negative correlations with intelligence for the N2, and the SW component, while the P1 showed a positive correlation at the right temporal region and the P2 and P3 at the right frontal region. All mentioned correlations were significant and ranged between .4 and .6.

Discussion

The results indicate that correlations between ERP amplitude and SPM scores shift to later components with increasing age. The latency measures revealed a more complicated pattern: At age 9 there were only negative correlations with some of the component, at age 10 most correlations, exept one, were also negative. Finally at age 11 there were both negative and positive correlations. Albeit more complex to interpret do the latencies, similar than the amplitude measures, reveal marked changes with age.

The present correlations between ERPs and Raven IQ do not allow for a causal interpretation, but the fact that the relation between SPM scores and ERPs changes quite dramatically between 9 and 11 years suggest that the relation is cannot be as simple as ''faster brains have higher IQ's'', as suggested in the literature Any feasible biological intelligence hypothesis should be able to explain this kind of developmental changes in the relation between brain activity and intelligence. Future the studies may want to use more complex tasks that challenge the intelligence more than the simple oddball task used in the present experiment. The main finding of changes in the between intelligence and ERPs, even within a relatively small age range, provides an important warning for developmental and intelligce ERP studies.

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T-16. Goal-Directed Movement Control in a Case of Hemiparesis[10]

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The role of vision in the control of goal-directed movement was examined in a 37-year-old right-handed male who had suffered a left parietal stroke. Aiming movements with the contralesional and ipsilesional hands were made on a digitizing tablet to targets presented on a computer monitor. Differences between the hands became prevalent only when visual information was absent. In this condition aiming movements with the contralesional hand were differentially executed. The role of visual, kinesthetic, and motor programming mechanisms in goal-directed movement are discussed.

Case Report

R. F. is a 37-year-old, right-handed male who suffered a left parietal stroke in June 1995. This individual presented a mild to moderate anaesthesia in his right hand as well as a moderate degree of astereognosis. His performance with the contralesional hand was impaired on tasks of grip strength, finger tapping, and grooved pegboard. His left ipsilesional hand was also found to be impaired on a finger tapping task and borderline impaired on the grooved pegboard. The nature of R. F.'s sensory and motor deficits yielded several questions of interest for this study. These questions were concerned with (1) the role of vision in the control of goal-directed movement, (2) the impact of removing visual feedback on the control of the contralesional and ipsilesional hands, and (3) the effect of visual experience on the control of movements performed with vision.

Method

Aiming task and procedure. Movements with the contralesional (R) and the ipsilesional (L) hands were made to four targets presented on a computer monitor. Aiming movements were made with a computer mouse on a digitizing tablet which recorded the kinematic measures of interest. The four targets included two sizes (small and large) and two amplitudes (10 cm and 20 cm) and were presented in a random order. In addition, three conditions of visual

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feedback were used: (1) no vision, (2) vision, and (3) no vision. R. F.'s hand and arm movements were made behind a curtain to prevent visual information about the moving limb. Visual feedback during the experimental task was manipulated by presenting or removing vision of the cursor on the computer monitor. The three feedback conditions were presented in the above order by the contralesional (R) hand followed by the ipsilesional (L) hand. The target remained visible throughout.

Data analysis. Kinematic measures including movement time, peak velocity, time to and after peak velocity, and error were examined.

Results

Vision (V) vs. no vision (NV). In the presence of visual feedback, movement time (NV = 1135 msec; V = 1913 msec), and time after peak velocity (NV = 675 msec; V = 1466 msec) were longer and peak velocity was lower (NV = 328 mm/s; V = 238 mm/s) supporting other work showing that visuomotor tasks are performed more slowly with more time spent in deceleration. When visual information was available, no performance differences were found between the hands for any of the dependent measures.

Feedback condition and hand. An interaction occurred between condition and hand where the contralesional hand (R) was differentially affected by the removal of visual feedback. In the absence of vision, the right hand exhibited a longer movement time (R = 1295 msec; L = 976 msec) and time to peak velocity (R = 693 msec; L = 531 msec) as well as a lower peak velocity (R = 266 mm/s; L = 390 mm/s) suggesting some difficulty in the preprogramming or force generation phase of the movement. Further analysis supported this idea by revealing an interaction between hand and amplitude in which the contralesional hand was much more affected by movement amplitude. The contralesional hand demonstrated a longer movement time (R = 1706 msec; L = 1354 msec), a longer time to peak velocity (R = 728 msec; L = 563 msec), and a lower peak velocity (R = 275 mm/s; L = 413 mm/s) when moving to the far amplitude target (20 cm). Analysis of the effect of visual experience on accuracy (resultant error) revealed that visual experience enhanced performance with the ipsilesional left hand (NV1 = 23 mm; V = 1 mm; NV2 = 12 mm) whereas performance with the contralesional right hand actually deteriorated (NV1 = 14 mm; V = 3 mm; NV2 = 20 mm).

Discussion

These findings support other work (Jeannerod, 1988; Jeannerod, Michel & Prablanc, 1984; Levin, 1996) showing the effects of hemiparesis and parietal lesions on the control of goal-directed movement. Movements performed with the contralesional hand are largely dependent on the availability of visual feedback. In the presence of vision, movements with the affected hand

are executed in a normal, efficient manner. In the absence of vision, however, movements are characterized by increased movement time and time to peak velocity as well as decreased movement speed. The increased time spent in the pre-programmed phase of the movement (e.g. time to peak velocity) and the lower peak velocity exhibited by R.F.'s contralesional hand, particularly when moving to a far amplitude, suggest that his movement difficulties are related to a difficulty in programming the force parameters of the movement.

The findings related to the effect of visual experience on end-point accuracy were of particular interest. R.F.'s left hand improvement in accuracy indicates his ability to use visual information to calibrate the proprioceptive system and improve his performance in a later no vision condition. His right hand decrement in accuracy reveals his inability to calibrate proprioception with vision in order to increase the accuracy of his movements when vision is removed. This finding supports Jeannerod's 1988 model of visuomotor control emphasizing the importance of a connection between the visual and proprioceptive systems. A disruption to this connection or within one of these systems will result in impaired control of goal-directed movement.

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T-17. Aging and Working Memory in Gesture Imitation[11]

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The performance of older and younger adults was compared in concurrent and delayed gestural imitation tasks. Although the older adults were less accurate than the young on all measures and also took longer to inspect the modelled gesture before imitation, the recall delay did not differentially affect their performance. One explanation is that by taking more time to process task components, the older adults were effectively able to improve the functional storage capacity of working memory to match that of the younger adults.

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Current models of working memory generally follow Baddeley and his colleagues (e.g., Baddeley, Lewis and Vallar, 1984) and include a limited-capacity central processor, the central executive, which selects and controls the flow of information into two subsystems: the articulatory loop, for maintaining verbal material, and the visuospatial scratch pad, for maintaining visuo-spatial information. A third subsystem is specialized for maintaining the configurational aspects of body movement (Smyth and Pendleton, 1989). Working memory for movements utilizes both the visuospatial scratch pad to process the dynamic aspects of the movement (i.e., the spatio-temporal co-ordinates), and the third, 'configurational', subsystem to process the static constituents (i.e., the shape of body parts involved).

It is this 'configurational' subsystem that is of interest in the current research which employs concurrent and delayed gestural imitation tasks. It is proposed that, once derived from the perceptual synthesis of the critical gestural features, a gestural representation must be held in working memory and mapped onto the motor system in order to carry out the movement organization and movement execution stages in a gestural imitation task. In a concurrent imitation condition while the demands on working memory are reduced because the modelled gesture is continuously available, working memory processes are still required for temporary storage as critical features are processed and integrated to form the gestural representation.

Current views consider the capacity of working memory in functional terms, or the capacity that is effectively left over for temporary storage once the requirements for the computational or processing aspects of the task have been met. This perspective suggests a trade-off between processing and storage functions, such that individuals who require more capacity to execute processing would have less residual capacity for storing the intermediate and final products of those processes. Thus, inefficient processes will result in a smaller functional storage capacity (Daneman, 1987).

Dimeck, Roy, and Hall (1996) have demonstrated that older adults are less accurate in imitating a static hand gesture. One explanation is that the reduced accuracy of the older adults is related to a difficulties in maintaining an accurate percept of the gesture in working memory for the purposes of guiding motor execution. Therefore, the goal of the current study was to examine the ability of older adults to retain gestural information in working memory. Given age-related reductions in simple speed of processing (Salthouse and Babcock, 1991), no demands were placed on initial encoding time. That is, in both the concurrent and delayed imitation conditions, subjects were allowed to take as long as they wished to inspect the gesture.

Method

Subjects. Ten older (mean age = 71 yrs, 6 mo.) and ten younger adults (mean age = 25 yrs, 4 mo.) participated in the study. All were physically fit and had normal vision. All subjects were right handed and used their right hand.

Gestures. Nine meaningless hand gestures were modelled by the examiner (Dimeck et al, 1996). Subjects imitated the gesture while present (concurrent imitation) or immediately after it had been removed (delayed imitation).

Procedures. All subjects were seated at a table and performed the delayed imitation tasks before the concurrent imitation tasks. The order in which the gestures was presented was randomized independently for each subject. All gestural performance was videotaped for later analysis.

Data analysis. The subjects' performance was scored according to the percent accuracy of each of three static constituents of the gestures: hand orientation, finger position, and location. The amount of time taken to inspect the modelled gestures in the delayed condition was also recorded.

Results and Discussion

Accuracy. Analyses revealed a significant main effect for Group on all constituent scores: finger position $F(1, 16) = 7.202$ $p < 0.016$; location $F(1, 16) = 7.350$, $p < 0.015$; and hand orientation $F(1, 16) = 30.518$, $p < 0.001$. The older adults were consistently less accurate than the younger on finger position (older mean = 93%, younger mean = .96%), on location (older mean = 87%, younger mean = 99%), and on hand orientation (older mean = 73%, younger mean = 97%). Analysis also revealed a significant main effect for Condition in the finger position scores, $F(1, 16) = 54.053$, $p < 0.001$, with percent accuracy being significantly better in the concurrent condition (mean = 99%) as compared to the delayed condition (mean = 90%).

Inspection time. Analysis of the amount of time taken to inspect the stimulus gesture in the delayed condition revealed a significant effect for Group, $F(1, 18) = 8.531$, $p < 0.009$, with the older adults taking longer (mean = 3.38 sec) than the younger adults (mean = 1.52 sec) in both modes of presentation.

These findings revealed that the older adults were less accurate in gestural imitation, consistent with previous findings (Dimeck et al., 1996). Although the effect of a delay was, in general, to lower subjects' scores, particularly the accuracy of their hand orientation, it did not appear to differentially affect the older adults. The older adults did, however, take longer to inspect the gesture in the delay condition, suggesting that increased time was needed to process the gestural information in order to hold in working memory. Further investigations are planned to determine if this encoding strategy enabled the older adults to improve the functional storage capacity of working memory to match that of the younger adults.

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T-18. Pantomime and Imitation of Hand Gestures following Stroke[12]

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One hundred twenty-five stroke patients and 20 age-matched healthy adults pantomimed and imitated eight transitive gestures. Analyses examining five dimensions of performance revealed impairments were apparent following a stroke to either hemisphere, although the impairment was greater with left-hemisphere stroke. These impairments were apparent for both pantomime and imitation, and the degree of this impairment did not vary as a function of these conditions. Based on our model of apraxia these impairments in both pantomime and imitation reflect a disruption in the later stages of the production system, with the left stroke patients being more impaired overall and particularly on the location and hand posture dimensions.

Limb apraxia is an inability to pantomime or imitate common gestures. This disorder is frequently observed following stroke most often to the left hemisphere (Rothi, Ochipa & Heilman, 1991; Roy, 1996; Roy & Square, 1994). Our recent work, however, has revealed that deficits in gesturing were observed in patients with right hemisphere damage (Roy, Black, Blair & Dimeck, submitted; Roy, Black, Winchester & Barbour, 1996), particularly when using a detailed analysis of various dimensions of performance (e.g., location, posture and action). These previous studies focused on either gestural pantomime (Roy et al, submitted) or imitation (Roy et al, 1996). The purpose of the present study is to compare pantomime with imitation using a comparable detailed analysis of performance.

Method

Gestural task. Participants were required to pantomime to verbal command and then imitate 8 transitive gestures used in our previous studies (Roy et al, submitted).

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Participants. One hundred and twenty-five (125) consecutive stroke patients participated in this study within 60 days of admission to the acute stroke unit at Sunnybrook Health Science Centre. Sixty-four (64) had right hemisphere strokes, while 61 had strokes to the left hemisphere. All patients had a unilateral CT-confirmed lesion. Twenty age- and sex-matched healthy adults also participated as normative controls. All participants were right-handed.

Procedures. All participants were seated at a small table facing a video camera with the examiner seated to the right of and facing the patient. Two large mirrors were placed on either side of the subject. The examiner's modelled gesture (in the case of the imitation task) as well as parts of the subject's movement not directly visible to the camera (e.g., lateral aspect of arm/hand) were reflected in the mirrors. The participants first attempted to pantomime each gesture with each hand and then to imitate the same gestures modelled by the examiner. The control participants performed with both hands, half starting with the right hand. The stroke patients performed with both hands where possible, always beginning with the ipsilesional hand.

Data analysis. Each subject's performance was videotaped and scored on five dimensions including orientation of the hand, action, posture of the hand, plane of movement of the hand, and location of the hand in space relative to the body (see Roy, Square, Adams & Freisen, 1985; Roy et al, 1996, submitted). Each dimension was rated on a three point scale reflecting the degree of accuracy, that is, two (correct), one (distorted), or zero (incorrect).

Performance was examined for each dimension across the eight gestures. Performance on each dimension was expressed as a percentage of the total possible score across the eight gestures. A composite score, the percentage of the total possible score across all dimensions and gestures, was also calculated.

Results and Discussion

Analyses of the controls revealed a significantly more accurate performance for imitation than pantomime for the composite score, $F(1, 38) = 25.44$, $p < .01$, (P = 98.36, SD = 1.57; I = 95.80, SD = 2.89) and for location $F(1, 38) = 25.22$, $p < .01$, (P = 96.81, SD = 3.24; I = 99.24, SD = 1.79) and posture $F(1, 38) = 10.58$, $p < .05$, (P = 93.69, SD = 6.14; I = 97.84, SD = 3.77). There were, however, no hand differences in performance. Comparisons of ipsilesional hand performance for the left and right stroke group with the average of performance of the two hands in the control group revealed a significant group effect for the composite score, $F(1, 77) = 4.65$, $p < .05$, and for the location, $F(1, 77) = 6.98$, $p < .01$, and posture, $F(1, 77) = 8.90$, $p < .01$, dimensions. Subsequent analyses on each of these dimensions revealed the two stroke groups to be significantly less accurate than the control group, with the left stroke group being significantly less

accurate than the right. Pantomime was again significantly less accurate than imitation, although there was no interaction between group and performance condition.

These findings generally corroborate our previous work (Roy et al, 1996, submitted): impairments were apparent following a stroke to either hemisphere, and the impairment was greater with left-hemisphere stroke, particularly in performance dimensions reflecting location and hand posture. These observations also extend our previous work. The impairments with stroke in either hemisphere were apparent for both pantomime and imitation. Left-hemisphere stroke was associated with a greater impairment in both these performance conditions and the degree of this impairment did not vary as a function of these conditions. Based on our model of apraxia (Roy, 1996; Roy and Hall, 1992; Roy and Square, 1994) these impairments in both pantomime and imitation reflect a disruption in the later stages of the production system, although the degree and nature of the disruption differs, with the left stroke patients being more impaired overall and particularly on the location and hand posture dimensions.

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T-19. Evidence for a Domain-Specific Component of Attentional Control in Skilled Performance

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This study investigated whether domain-specific, individual differences in attentional control underlie individual differences in complex skilled performance (second language (L2) reading). Subjects were 28 English speakers with varying levels of French reading skill. An RT-based measure of attentional flexibility (AF) was

obtained in French and English with linguistic versions of the Wisconsin Card Sorting Task. A significant partial correlation between French-AF and French reading speed with English-AF partialled out indicated that L2-specific components of attentional control underlie differences in L2 reading speed. The results have implications for an understanding of attention control mechanisms.

This study investigated whether domain-specific, individual differences in attentional control underlie differences in complex cognitive skill performance (here, second language (L2) reading). Segalowitz (in press) proposed that individual differences in L2 skill may reflect, among other things, differences in attentional flexibility (AF) relevant to L2 situations. To perform well, L2 users must be able to adjust to changes in the linguistic environment as they occur in real time (new ideas introduced in the text, by the interlocutor, etc.). Hence the need for AF.

This study assessed English speakers' French reading speed, and their AF in French (their L2) and English. AF was tested with linguistic adaptations of the Wisconsin Card Sorting Task. A significant correlation between French-AF and reading speed would indicate that AF underlies individual differences in L2 reading skill; further partialling out English-AF to remove effects of general AF would indicate whether L2-specific components of attentional control underlie differences in reading skill.

Method

Subjects. Subjects were 28 English speakers (21 females) aged 17–43 (M = 24).

On a French reading speed test, their reading rates ranged from 275 to 741 msec/word (M = 382), with minimum comprehension scores of 60% (chance = 33%).

Materials and procedures. Four tests were administered to subjects: an English attention shifting task (E-Shift), a French attention-shifting task (F-Shift), a French control task, and a French reading speed test. Half received the tasks in this order, half with the attention shift tasks reversed.

On each trial of the attention shifting tasks, a target word (e.g., VAST) appeared in centre screen surrounded by 4 potential match words: synonym (LARGE), antonym (TINY), rhyme (FAST), and a semantically/phonologically unrelated word (LOW). Six such sets were constructed in English and 6 in French for the E-Shift and F-Shift tasks respectively. Each task involved 180 uninterrupted trials, comprising 30 blocks formed by cycling randomly through the 6 word sets. Ss pressed one of 4 keys on a keypad corresponding to the screen position of the word they believed matched the target.

Accuracy feedback was provided after each trial. Ss initiated each trial with a key press. Ss had to determine by trial and error the rule determining the correct response (synonym, antonym or rhyming word).

This rule was randomly determined in a counterbalanced manner and was

shifted, randomly, after a run of 4–12 correct responses. Once the rule shifted, Ss had to find the new response rule by trial and error.

The French control task resembled the F-Shift task except that Ss were always informed about the match rule and there were only 12 rhyme, 12 antonym and 12 synonym match trials, in that order. This provided a measure of basic abilities needed for the F-shift task (everyone scored above 94%).

The French reading speed test presented stories from the French language version of Reader's Digest on the computer screen one paragraph at a time, with comprehension tests following each story. Reading times and comprehension were scores recorded.

Results

RTs and perseverative errors (Heaton, 1981), based on performance in Ss' first 6 runs and first 6 searches, provided separate indices of disruption due to the need to shift attention. Here, a run refers to a sequence of trials where S responded correctly until the rule shifted. A search refers to a sequence of trials between runs.

Following Allport et al. (1994), we developed an RT measure of recovery from disruption due to attention shifting. Search costs (slower RTs on search versus run trials) were generally greater in early search trial sequences than later. Improvement rates in search RTs across the 6 search sequences were computed for each S. We assumed that the greater the improvement rate, the greater the initial disruption must have been, and hence the weaker AF was. Corresponding improvement rates were also computed for run RTs, to serve as a baseline for individual differences in tendency to improve in RT with practice and in general skill reading French stimuli. These search measures were then regressed against the corresponding run measures and a residual obtained for each S. These residuals reflected whether improvement in search RT was greater or less than expected for a given improvement level in run RT. Ss' residuals thus served as an index of AF; the greater the residual, the weaker the AF. Residuals were obtained separately from the F-Shift and E-Shift tasks for each S.

The F-Shift measure of AF correlated significantly with French reading speed ($r = .474$, $n = 28$, $p < .01$), indicating that slower readers had greater residuals (less AF). When the E-Shift measure of AF was partialled out, the partial correlation was still significant ($pr = .429$, $n = 28$, $p < .025$).

Similar analyses of perseverative errors did not yield a significant partial correlation ($pr = .131$, $n = 28$, ns).

Discussion

The significant partial correlation (RT data) indicates that, after taking into account general AF as indexed by the E-Shift measure, there remains a significant amount of reading speed variance accounted for by L2 specific

attention shifting ability. Attention shifting here was a conscious response to surprise and therefore implicated central control processes. Our evidence for L2-specificity, however, further suggests that these central control processes interacted with lower level, stimulus guided (hence, domain specific) mechanisms. Shallice's 1988 model, involving Supervisory System modulation of the lower level Contention-scheduling System, accounts for this result. Our study has shown that individual differences in this modulation reflect one's level of domain-specific skill.

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T-20. The Information Associated with Names of Persons: A Clinical Study

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A proper name anomic could retrieve proper names only as a part of an idiosyncratically used association. Besides his problem with proper names he showed difficulties in retrieving any material entertaining an arbitrary link with a given reference. This finding suggests that proper names and any other material that entertains an arbitrary link with its reference are retrieved according to a mechanism that is different from that used for common names. Proper names representations contain only idiosyncratically associated information.

Introduction

It has been claimed (Burton & Bruce, 1992) that patients who have great difficulty in recalling persons' names should also find it difficult to recall other information that is unique to a particular individual. This hypothesis is not supported by observations on anomics (Hanley, 1995) and, specifically,

on anomics for proper names (Semenza & Zettin, 1988, 1989), who are indeed able to retrieve very specific information about the individuals they refer to. This finding supports the view that, in general, names are represented in a store separate from that for semantic information about people. However, some sort of information may yet be part of proper name representation and be automatically retrieved when they are retrieved.

For instance, it has been noted that some names of cities effectively cue the state they belong to (e.g., Denver cues Colorado). Another interesting phenomenon has been found in anomics for proper names. When specifically tested, these anomics have been shown (Semenza & Zettin, 1989; Semenza, Mondini, & Zettin, 1995) to also have difficulties with retrieval of members of arbitrary associations as, for example, the difficult items in paired associate learning tasks.

Since the link of proper names with their reference is held to be arbitrary, this association of symptoms may demonstrate that a retrieving mechanism specific for proper names and other members of arbitrary associations does exist. Thus some of the disturbances that associate with proper names anomia may be explained with a deficit of a single type of retrieving mechanism rather than with a lack of access to a complex representation that includes proper names and related information. These phenomena are further investigated in the present case study.

Case Study

General neuropsychological assessment. O.T. was a 66 y.o. right handed physician, who in June 1996 sought neuropsychological evaluation because of a severe difficulty in finding names of persons. A CT scan showed a moderate cortical atrophy. He was diagnosed with probable Alzheimer disease. He scored 25/30 on MMSE (Folstein et al., 1975) and he was within normal limits on verbal and non verbal intelligence tests. With frontal lobe tasks he scored within normal limits except for a mild deficit with Toulouse Matrices. He had no apparent problems with speech production and speech comprehension. Memory for autobiographical and public events appeared to be preserved but he experienced serious difficulties in learning supraspan lists of words, showing however, both a primacy and a recency effect. Paired associate learning for semantically different pairs proved to be impossible. O.T. was also unable to retrieve such material as personal phone numbers, titles of music pieces, titles of famous books, given the story that he however could easily tell.

Naming. O.T. correctly named 62/64 pictures (two errors determined by visual confusion) from the Snodgrass and Vanderwart collection and never showed any problem in naming objects in the environment. He was very good also with geographical names on a blank map of Europe. Provided with pictures of very famous people he scored 13/22 correct on repeated sessions.

He was unable to recall the names of about half of the real people he knew and he met during his hospitalization. When he failed, he was nonetheless able to provide very specific information about the individuals he could not name (e.g. profession and specific life events). Phonemic cueing was never effective but first names successfully cued retrieval of family names in about 90% of the cases.

In naming on definition O.T. was successful 38/40 times with common names and only 16/33 times for names of famous people. When failing, however, he properly enriched the definition adding further very specific information and thus showing a perfect knowledge of the individuals in all cases. Naming by category in one minute showed some reduction with respect to normals in providing names beginning with F, A, and S but was essentially normal with semantic categories (e.g., fruits). With proper name categories O.T. provided one or two items except for cities and historical characters where he was surprisingly successful.

O.T. was further tested with definition of medical conditions some of which rather unfrequent but he was perfectly able to provide their names (26/26 correct) when the name was not an eponym. When specifically asked for eponyms (e.g. Parkinson) he was almost never successful. Further proper names testing was performed by asking O.T. to retrieve members of famous pairs like Castor and Pollux. Give one member O.T. was able to retrieve the other only if the one provided was that coming first in the order in which they are most frequently mentioned. Giving the second member was effective in only 50% of the cases. Other testing included cueing with proverbial, idiosyncratic information.

Thus, the name Damocles was cued with the sword of . . . . O.T. was perfect at this testing (27/27 correct). Also proper names in the context of titles of famous books were remembered better than in the context of the book's plot (9/13 vs 1/13).

Conclusion

This study demonstrates that proper name representations contain only the information that is frequently and idiosyncratically associated with proper name. Proper name anomics also cannot retrieve other information in the context of arbitrary semantic links.

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T-21. Problem-Solving Deficits in Patients with Dementia of the Alzheimer's Type on a Tower of London Task

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The behavioral manifestations of patients with dementia of the Alzheimer type (DAT) are varied. A growing number of studies suggest deterioration in problem solving capacity, but there is still little research on this subject. The goal of this study was to examine problem solving deficits of DAT, and to identify the nature of the deficiencies with a new, simplified version of Shallice's (1982) Tower of London test.

Method

Nineteen DAT patients, conforming to the diagnostic criteria of NINCDS-ADRDA group, and 19 healthy seniors, matched for age, sex, and education, were exposed to a modified version of the Tower of London test. The protocol included 15 problems, segmented into 3 series of different levels of complexity. Problems were presented in order of increasing difficulty, from one to 5 movements. The protocol followed a hierarchical design; simpler problems were embedded in more complex, subsequent problems.

Results

The basic finding is that controls performed significantly better (M = 29,37, S. D. = 4.21) than DAT subjects. Performance analysis was done for controls and DAT subjects for each of the 3 series A, B, and C. The main effects of subjects and series were both significant [$F(1, 36) = 79.41$, $p < .001$ and $F(2, 72) = 11.83$, $p < .001$, respectively], but the interaction was not [$F(2, 72) = 79.41$, $p = .08$]. Qualitative analysis reveals that control and DAT subjects made a total of 31 and 100 rule violations, respectively. Results show that DAT subjects have a planning deficit, which is compatible with several existing accounts of frontal lobe dysfunction generally assumed in the neuropsychological literature.

T-22. Effects of Normal Aging on the Recognition of Gestures

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Little is known about the effect of aging on the recognition of gestures. The present study was designed to answer this question. Three groups of adults were assessed: (a) 30 subjects aged from 20 to 36 years; (b) 30 subjects aged from 40 to 55 years; (c) 54 subjects aged from 60 to 75 years. The protocol tested 5 tasks: (1) gesture decision; (2) recognition of correct gestures; (3) similarity judgment; (4) gesture designation; (5) gesture naming. Significant differences were found in tasks 3 and 5. These results were interpreted as difficulties located in the gesture lexicon or the semantic system.

Although complex, gesture function can generally be divided into production and recognition processes. An effect of age on the production of pantomimes has been demonstrated in a few studies (i.e., Ska & Nespoulous, 1987; Duffy & Duffy, 1989). In these studies, the errors produced by older adults appeared to be related to problems of semantic representation of the actions, particularly with the structural attributes of the tools to be represented. In contrast to production, the effect of age on the recognition of gestures is unknown. This knowledge is important because apraxic impairments appear with the evolution of neurological diseases during aging. For example, Kempler (1988) has shown that subjects with dementia of the Alzheimer's type had problems with the recognition of gestures. Thus, the difference between normal and pathological manifestations during aging has to be established for this behavior. The goal of the present study was to assess the effect of normal aging on the recognition of gestures by comparing the performance of younger and older adults on various recognition tasks. Given the errors found in the area of production, the hypothesis was that normal aged subjects would have problems when the semantic system is requested to resolve the task.

Methods

Three groups of adults were assessed: (a) 30 subjects aged from 20 to 36 years; (b) 30 subjects aged from 40 to 55 years; (c) 54 subjects aged from 60 to 75 years. Ninety subjects were assessed in Lyon by Magnouloux and Rivier (1995) and 24 subjects were assessed in Montreal by Charbonneau (1995). All subjects were healthy, autonomous in daily life and without previous history of neurological or psychiatric problems. Five tasks were used: (1) gesture decision; (2) recognition of correct gestures; (3) similarity judgment of actions; (4) action designation; (5) gesture naming.

All the gestures were modeled on a video in order to reproduce the dynamic aspect of the gestures. The scoring consisted in assigning one point for each correct response.

Results

Preliminary analyses were carried out to compare the group differences in the 5 tasks. Subsequent analyses compared the three groups for the scores of the meaningless and the meaningful gestures in the gesture decision task (task 1).

Significant differences were found in task 3—similarity judgment—($F(2, 111) = 3.36$, $p < .05$) and in task 5—naming—($F(2, 111) = 5.25$, $p < .01$).

In the task of similarity judgment, the older subjects had more difficulties than the younger ones in recognizing that two different gestures represent the same action. There are at least two explanations.

The older subjects have problems when they had to categorize actions. They seem to have difficulties in dealing with the structural attributes of the gestures. Another possibility is that the older subjects may have had problems with instructions and may have interpreted that they had to identify the same gestures instead of the same actions.

In the task of naming, the older subjects made more errors than the younger subjects. The errors were semantic (e.g., to read a book instead of to open a newspaper) or visual (to type instead of to play piano). The older subjects seemed to have problems with the weighting and combination of visual cues, and this led to confusion between semantically related actions.

The interaction between age and types of gestures was significant ($F(1, 111) = 5.67$, $p < .01$) for task 1 (gesture decision). A simple effect was found between the older subjects and the types of gestures ($F(1, 111) = 20.49$, $p < .001$). The older adults, more often than the younger subjects, interpreted the meaningless gestures as having meaning. Again, these results may indicate that the older adults have problems with the semantic aspects of gestures. In this case, they seemed to overuse the semantic system. A similar problem was observed in a word repetition task in which the older adults transformed pseudo-words into words. It is as if a set of movements or a set of sounds not found in the corresponding lexicon is relayed to the semantic system more often than it is rejected.

Discussion

One conclusion is that normal aging has an effect on the recognition of gestures. Another conclusion is that the semantic system may be involved.

Indeed, when the results of the older adults differ from those of the younger adults, a semantic aspect is always present. In task 3, the subjects

had to judge if two gestures represented the same action. In this task, a unique categorical concept must be identified despite the presence of different structural attributes. In task 5, the subjects had to identify the actions. The observed errors seemed to be related to the processing of the information by the semantic system. In task 1, the subjects have to decide if a gesture is meaningful. Errors are due to a semantic treatment of the stimuli. Further studies are needed to explore which precise modifications in the semantic system are responsible for this effect of age on the recognition of gestures.

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T-23. A Semantic Proximity Effect on Object Recognition in Visual Agnosia for Biological Kinds

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Category specific visual agnosia (CSVA) for biological objects appears to be caused by a deficit in retreiving stuctural knowledge. We investigated the case of IL, a patient who suffers from CSVA, in order to examine the relation between structural and semantic knowledge. Two experiments involving synthetic shapes were conducted with IL: a visual discrimination task, which showed no perceptual encoding deficit; and a name-shape association task, which revealed a clear effect of semantic proximity on visual recognition performance. The category specificity of CSVA is explained by the greater semantic proximity between visually similar biological objects compared to artefacts.

Introduction

Category specific visual agnosia (CSVA) for biological objects is a rare disorder which usually results from left or bilateral inferior-temporal brain damage (for a review, see Saffran & Schawtz, 1995). Typically, patients with this form of CSVA have difficulties visually recognizing most biological objects, despite their preserved ability to recognize most man-made objects (common exceptions are musical instruments and makes of car). Although researchers generally agree that this deficit is caused by a problem in the retrieval of stored structural (i.e., visual) knowledge, recent findings suggest that the deficit may be also modulated by semantic knowledge (Arguin, Bub & Dudek, 1996; Dixon, Bub & Arguin, 1996). In the present study, we examined the CSVA patient IL in an attempt to further investigate how this modulation process takes place.

Methods and Results

Subject. IL is a 75 year-old francophone man who contracted herpes encephalitis in July 1995. Initially, IL complained of memory and visual recognition problems. Testing revealed a full-scale IQ of 81 and deficits in long term memory, executive functions and spatio-temporal orientation. Tests also showed that he suffered from prosopagnosia and visual object agnosia. However, his linguistic, visual discrimination (matching geometric shapes or faces), auditory recognition, reasoning, and short-term memory capacities were all spared. All tests reported below were conducted in December 1995.

Visual object naming. IL was asked to name line drawings of biological objects ($n = 75$) and artefacts ($n = 75$) matched pairwise on visual complexity, familiarity and name frequency. Error rates were 65% for biological objects and 20% for artefacts.

Reality decision. The patient was asked to decide whether pictorially represented objects were real or not. Half of the images represented existing objects and half non-existing objects (contructed by exchanging parts of real objects). The categories tested were animals, fruits and vegetables, and artefacts. Error rates were 46% for animals, 48% for fruits and vegetables, and 28% for artefacts.

Visual matching of target by pointing. Five sets of four synthetic shapes were generated by transforming an ellipsoid. Shapes varied according to the dimensions of tapering, curvature or elongation. Two types of shape sets were constructed: (a) single dimension sets in which each shape possessed a unique feature; and (b) conjunction sets in which each shape shared features with other objects of its set. The irrelevant dimensions remained constant across all items within each set. Thus, while the matching of any single dimension set shape could be made on the basis of a single dimension, the matching of any conjunction set shape required the processing of two

dimensions. The patient was asked to match each target by pointing to its identical shape from among a set of four stimuli presented simultaneously. IL's performance was very good, with an overall error rate of 4%. Error rates were similar for the single dimension (6%) and conjunction (1%) dimension sets.

Name-shape association task. Again, single dimension and conjunction sets of shapes were used in this experiment. The single dimension shapes varied according to elongation and the conjunction set shapes varied according to tapering and elongation. The shapes were selected such that each could depict either a familiar artefact or a familiar fruit or vegetable. Each shape set was tested separately under conditions where the patient had to identify the items, presented one at a time, as biological objects or as artefacts. Reference to the stimuli as biological or artefacts was done in separate sessions.

IL's overall naming error rate was 39% (chance level performance = 75%). Error rates did not differ between the single dimension (38%) and conjunction (40%) sets [$X^2(1) = 0.16$; ns]. By contrast, performance was significantly worse for items labeled with biological terms (55%) than for those labeled with artefact terms (22%) [$X^2(1) = 8.7$; $p < 0.01$]. The semantic category effect was significant for both the single dimension and conjunction sets.

Discussion

IL exhibits a visual object recognition disorder that may be explained in terms of an impaired access to stored structural knowledge. This access problem appears to be markedly more severe for biological objects than for artefacts (cf. visual object naming and reality decision). Since the patient's performance is very good for visual matching tasks, the problem does not appear to be one of perceptual encoding.

The shape-name association task involving synthetic shapes showed a clear effect of semantic knowledge on visual recognition performance. IL's performance was markedly better with shapes labeled as artefacts than with shapes labeled as fruits and vegetables, even though the shapes used in both conditions were the same. Semantically, fruits and vegetables are related objects whereas the artefacts used here are semantically distant from one another. Our results suggest that semantic distance prevents confusions between structurally related objects in CSVA. Therefore the disorder is conceived as a retrieval impairement for structural knowledge modulated by semantic proximity. This interpretation is congruent with Humphreys, Riddoch and Quilan's (1988) cascade model which postulates that visual recognition difficulties are more often observed for categories with high structural similarity, such as biological kinds.

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