Cognitive Psychology and Neuropsychology

EFFECT OF AGING WHEN PROCESSING LEXICO-SEMANTIC AMBIGUITY

The role of activation/selection and selection/interference in automatic or voluntary tasks

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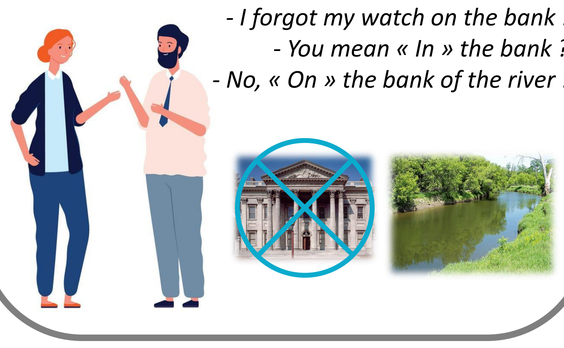
INTRODUCTION

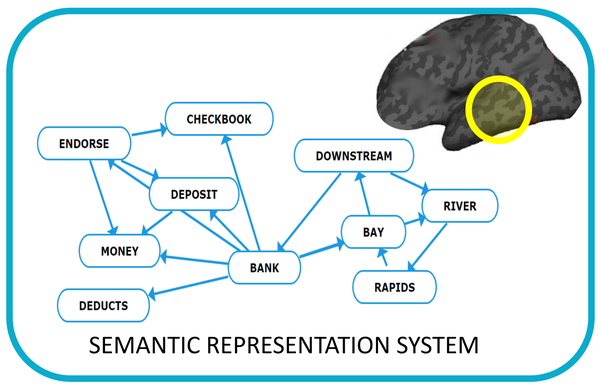
Management of lexico-semantic ambiguity as when homonym words are used, implies a sequence of cognitive processing, diffenrently affected by ageing.



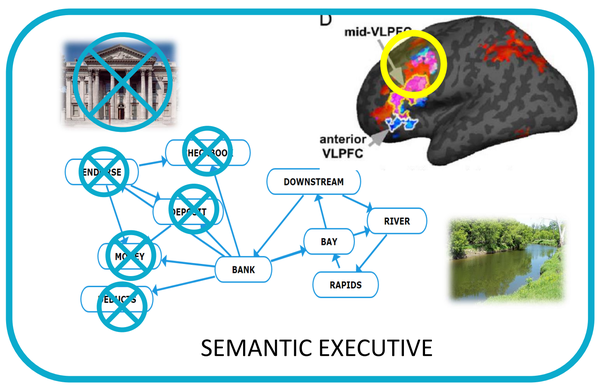
1 **AUTOMATIC SPREADING OF ACTIVATION**, (Collins et Loftus, 1975), relying on middle temporal cortices, and not affected by ageing (Giffard et al., 2001; Laisney et al., 2011).

2.a **ACTIVATION/SELECTION** between concepts, proposed as relying on the middle prefrontal ventrolateral cortex (Badre et al., 2005) and affected by ageing (Hoffman, 2018).

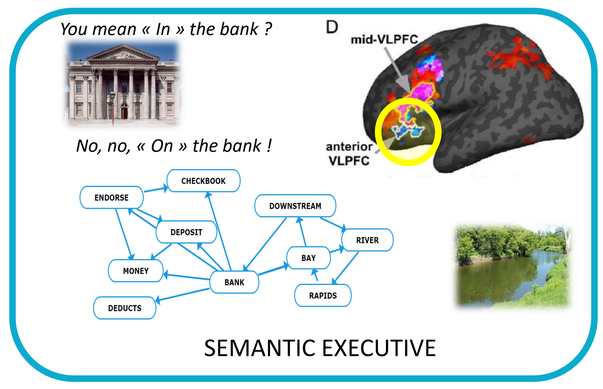
2.b If the unappropriate concept is selected, the **CONTROL RETRIEVAL** of a new meaning by reactivation of semantic system, relying on the anterior prefrontal ventrolateral cortex (Badre et al., 2005), and as unaffected by ageing (Hoffman, 2018)



SEMANTIC REPRESENTATION SYSTEM

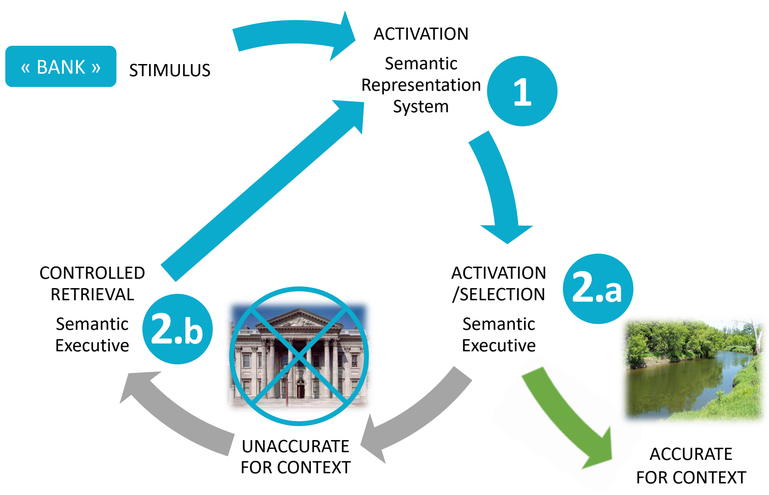


SEMANTIC EXECUTIVE



SEMANTIC EXECUTIVE

THEORETICAL PROPOSITION



1 Automatic activation in semantic representation system is proposed as age-invariant;

2.a Activation/ selection in semantic executive is proposed as negatively affected by ageing;

2.b Controlled retrieval is proposed as age-invariant

EXPERIMENTAL PROTOCOLS

LEXICAL DECISION TASK WITH PRIMING*

In this task design to measure **activation of the semantic representation system** and **activation/selection**, participants face a screen where sequences of prime/blank/target are presented and have to judge for every target if it is a word or not. Four contrebalanced versions of the task were created with 4 conditions of interest (blue lines of the Table 1).

+	PRIME		TARGET
200 ms	500 ms	500 ms	No limitation

Table 1. Metrics of pairs in the lexical decision task: mean (standard deviation)

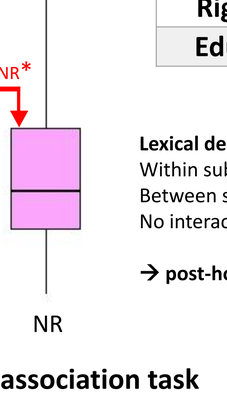
Prime – target relationship	N (task)	N (corpus)	Length	Book frequency	LSA (0 /1)
Homonym/Dominant e.g. Bank/money **(HD)**	**8**	32	6,09 (1,67)	42,74 (36,98)	0,33 (0,20)
Homonym – Subordinated e.g. Bank/river **(HS)**	**8**	32	6,06 (1,81)	34,19 (38,43)	0,14 (0,08)
Word – semantic associate e.g. Desk/screen **(SA)**	**16**	64	6,09 (1,87)	39,52 (39,82)	0,26 (0,14)
Word - non related word e.g. River/money **(NR)**	**32**	32	6,45 (1,91)	34,66 (33,56)	-
Fill-in unrelated pairs	**20**	20			
Word – Non-word	**84**	84			
TOTAL	**168**	264			

Note. *There were no signifcant differences of metrics between conditions, except for LSA (*: strengh of lexico-semantic association)

*inspired by Copland et al. (2007)

CUE TO TARGET ASSOCIATION TASK*

Task designed to enhance the demand for **activation/selection** and **controlled retrieval** in semantic cognition. The instruction was to choose a target corresponding to the clue, or on *Global meaning*, or on a *Common feature*.



2 conditions :

Cue-target relationship (3 levels)

Global **HD**: Homonym – dominant meaning (e.g. BANK – TREASURY)

Global **HS**: Homonym – subordinated meaning (e.g. BANK – SHORE)

Feature : sharing same color or size (e.g. COFFEE – PANTHERA)

Cue-foil relationship (2 levels)

Congruent (e.g. BANK – MONEY)

Incongruent (e.g. SUN – PAPER)

Table 2. Metrics of words in the cue to target association task: mean (standard deviation)

Cue-target relationship in GLOBAL MEANING instruction (N=28)		
Cue = Homonym word	Target = Dominant meaning	= Subordinated meaning
word length	8,69 (10,08)	5,93 (1,52)
book frequency	22,42 (26,85)	27,88 (31,83)
cue-target LSA	0,26 (0,18)	0,11 (0,08)
cue-foil LSA	0,12 (0,09)	0,17 (0,19)
Cue – foil relationship for ALL TRIALS (N=60)		
	Congruent	Incongruent
word length	7,46 (7,04)	6,67 (1,93)
book frequency	18,2 (21,7)	17,89 (24,12)
cue-target LSA	0,12 (0,09)	0,14 (0,14)
cue-foil LSA	0,23 (0,20)	0,11 (0,15)

Note. *There were no signifcant differences of metrics between conditions, except for LSA*

*inspired by Badre et al. (2007) and Hoffman (2018)

HYPOTHESIS

1 In a **Lexical decision task with priming**, younger and elderly healthy adults will respond faster when the relationship between prime and target is HD compared to HS;

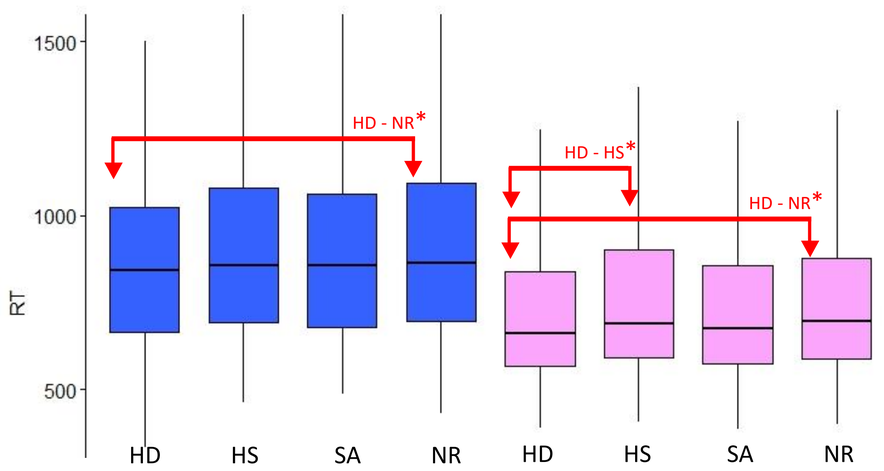
2.a In a **Lexical decision task with priming**, elderly healthy adults will respond significantly slower than younger adults when the relationship between prime and target is HS;

2.a In a **Cue to target association task** elderly healthy adults will respond significantly slower and make more mistakes than younger adults when the relationship between cue and target is HS;

2.b In a **Cue to target association task** elderly healthy adults will respond significantly slower and make more mistakes than younger adults when the relationship between foil and target is congruent.

RESULTS

Figure 1. Boxplot of reaction time (ms) at the Lexical decision task



PARTICIPANTS	ELDERLY	YOUNGER
N	58	60
Age	66.34 (4.2)	28.86 (5.9)
Women (%)	27 (46%)	31 (51%)
Right-handed (%)	42 (72.4%)	44 (73.3%)
Education (1 to 4)	3.55 (0.7)	3.83 (0.4)

Lexical decision task : Repeated Measures Anova

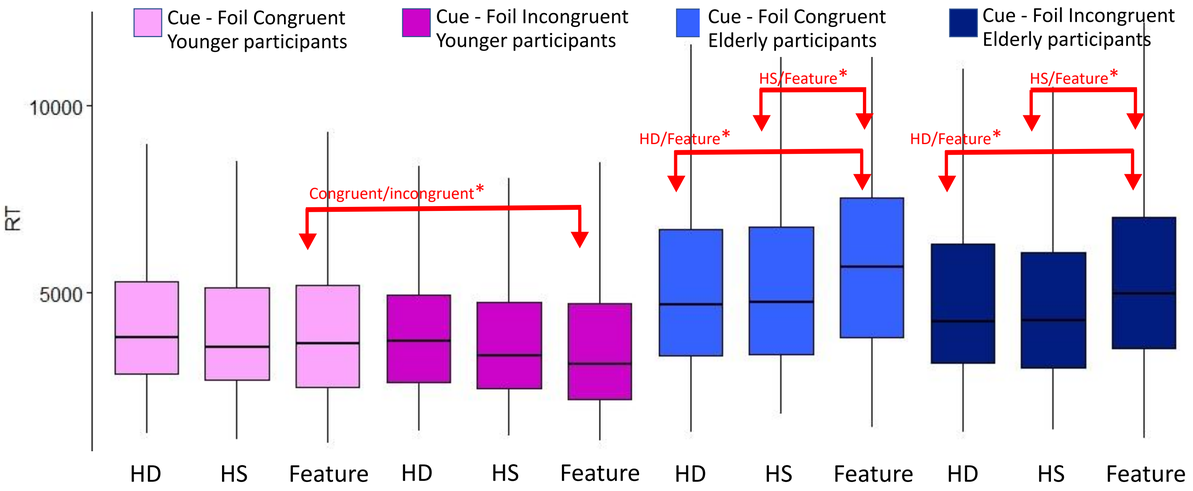
Within subject effect (prime/target) : $F_{(1,3)}$= 12.46, p<.001, η^2=.006

Between subjects effects (group): $F_{(1)}$= 17.93, p<.001, η^2=.126

No interaction effect between prime-target condition and group

→ **post-hoc :** see significance in Figure 1 (*p<.05)

Figure 2. Boxplot of reaction time (ms) at the Cue to target association task



Cue to target association task
Repeated Measures Anova

Within subject effects

Cue/target: $F_{(1,2)}$= 4.13, p=.01, η^2=.003

Cue/foil: $F_{(1)}$= 50.05, p<.001, η^2=.009

Between subjects effects of group

$F_{(1)}$= 20.64, p<.001, η^2=.124

Interaction effects

Cue/target*group:

$F_{(1,2)}$= 16.43, p<.001, η^2=.013

Cue/foil*group: *Not significant*

Cue/target*Cue/foil : *Not significant*

Cue/target*Cue/foil*group : *Not significant*

→ **post-hoc :** see significance in Figure 2 (*p<.05)

DISCUSSION

In this research, pairs of homonyms associated to their dominant or subordinated meaning were used in two tasks. First a lexical decision task with priming relying on two automatic processes; the **activation of semantic representation system** (in HD condition) and the selection of activated concepts "**activation/selection**" (in HS condition). Second a Cue to target association task relying on **activation/selection** (when cue-target were HS) and on **controlled retrieval** (when cue-foil were congruent).

Age did not affect the reaction time difference between HD and NR conditions in the lexical decision task, and no differences were found between the HD/HS cue-target conditions between groups in the cue to target association task, indicating an **activation/selection process age-invariant**.

The presence of a congruent foil in the cue to target association task shows a tendency to deeply impact the reaction times for the elderly group, but the difference was not statistically significant. This support the hypothesis of the absence of age-effect on the **controlled retrieval** process involved in management of a congruent foil to inhibit (according to Hoffman, 2018).

References (in order of appearance) : Collins, A. M., & Loftus, E. F. (1975). A spreading-activation theory of semantic processing. *Psychological review*, *82*(6), 407.; **Giffard, B., Desgranges, B., & Eustache, F. (2001).** Le vieillissement de la mémoire : vieillissement normal et pathologique. *Gérontologie et société*, *24 / 97*(2), 33-47; **Laisney, M., Giffard, B., Belliard, S., de la Sayette, V., Desgranges, B., & Eustache, F. (2011).** When the zebra loses its stripes: Semantic priming in early Alzheimer's disease and semantic dementia. *Cortex*, *47*(1), 35-46; **Badre, D., Poldrack, R. A., Paré-Blagoev, E. J., Insler, R. Z., & Wagner, A. D. (2005).** Dissociable controlled retrieval and generalized selection mechanisms in ventrolateral prefrontal cortex. *Neuron*, *47*(6), 907-918.; **Hoffman, P. (2018).** An individual differences approach to semantic cognition: Divergent effects of age on representation, retrieval and selection. *Sci Rep*, *8*(1), 8145; **Copland, D. A., de Zubicaray, G. I., McMahon, K., & Eastburn, M. (2007).** Neural correlates of semantic priming for ambiguous words: an event-related fMRI study. *Brain Res*, *1131*(1), 163-172.