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C – Statistical Analysis
D – Data Interpretation
E – Manuscript Preparation
F – Literature Search
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EXTINCTION: POSSIBLE INTERFERENCE OF TOP-DOWN INFORMATION. A CASE STUDY

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SUMMARY

Background:

Brain-damaged patients showing extinction are able to process stimuli presented on either hemispace, but fail to report contralesional stimuli when simultaneously presented with an ipsilesional stimulus. Extinction may occur between stimuli of the same modality or between stimuli of different modalities (such as visual and tactile). This phenomenon has been interpreted as supramodal imbalance in stimulus competition for attention selection. However, recent studies have reported the existence of a complex interaction of competition-facilitation between visual and tactile information.

Case study:

We describe a patient (RP) who suffered from a brain damage on the right occipito-temporal cortical area. RP showed severe visual neglect associated with a rare case of extinction. He performed at ceiling on tactile extinction tasks when his eyes were closed, but showed dramatic tactile extinction when he looked directly at the hand being touched.

Conclusions:

The results as reflecting the existence of top-down mechanisms whereby the “absence” of visual information caused by visual neglect might have exacerbated underlying latent attentional biases.

Keywords: tactile extinction, neglect, attention, supramodal, double stimulation

INTRODUCTION

Brain-damaged patients showing extinction fail to report a contralesional stimulus when simultaneously presented with an ipsilesional stimulus. This phenomenon has been interpreted as the result of a competition of spatial attention where the ipsilesional stimulus has a disproportionate advantage (e.g., Driver, Mattingley, Rorden, & Davis, 1997). Extinction has been observed not only with stimuli presented within the same sensory modality but also with stimuli presented in different modalities (crossmodal extinction; e.g., Brozzoli, Demattè, Pavani, Frassinetti, & Farnè, 2006). These findings have opened a debate on whether the proposed advantage for one modality occurs at a supramodal level through shift of spatial attention (Chamber, Stokes, & Mattingley, 2004) or convergence of multi-modal information may start in the early stages of the encoding process (Macaluso, Frith, & Driver, 2000; Pachalska, Góral-Pótróla, Brown & MacQueen 2015).

Recently, some authors (e.g., Sambo et al., 2012) have observed a more complex interaction of competition-facilitation between visual and tactile information. For example, Sambo and colleagues (2012) assessed tactile extinction in a group of right brain damaged neglect patients while they kept their eyes opened. Unlike neurologically healthy controls, neglect patients were faster in responding to tactile stimuli delivered on their left hand when the hand was visible and placed in the right ipsilesional hemifield, compared to when the hand was placed in the contralesional (neglected) side. These findings suggested that vision can enhance the processing of tactile stimuli when these stimuli are placed where attention is pathologically directed. It follows that attentional deficits, such as neglect, may interfere significantly with the interaction of different modalities.

In this paper, we report the case of a patient who showed an intriguing phenomenon of crossmodal-like extinction, whereby the ‘meaningful absence’ of visual information associated to a tactile stimulus may have led to its ‘extinction’.

CASE STUDY

RP, a 62-year old right-handed man with five years of formal education, was admitted to hospital following a vascular accident. The CT scan, performed three days later, showed a lesion in the right occipito-temporal cortical area. Neurological examination revealed left hemiplegia with hypoaesthesia for touch and proprioceptive stimulations and homonymous hemianopia. After three months, RP underwent a formal neuropsychological assessment, where he showed a selective impairment in visuo-spatial tasks associated with severe neglect on a wide range of tests (see Table 1 and Figure 1).

On the standard clinical visual confrontation tests and on a computerised version, RP detected all right stimuli, whereas he missed all unilateral and bilateral left stimuli.

Table 1. RP' performance on psychometric tests

Test (range)	RS score	Cut-off	Performance
Memory			
Bisyllabic word span (0-10)	4#	3	Normal
Verbal learning (0-30)	17#	7.5	Normal
Language			
Token test (0-36)	32.5#	26.5	Normal
Naming from verbal description (0-38)	35.75#	33.5	Normal
Executive functions			
Weigl test	5.5#	4.5	Normal
Verbal abstract reasoning (0-60)	53#	32	Normal
Apraxias			
Ideomotor apraxia (right upper limb; 0-72)	56#	20	Normal
Construal apraxia (0-20)	1.5#	7.75	Neglect-like errors
Semantic memory			
Colour-figure matching (0-16)	14#	11	Normal
Mental imagery			
Colour (0-25)	19	22.7	Impaired
Animal's tails (0-20)	18	14.8	Normal
Size (0-16)	16	16	Normal
Neglect			
Line cancellation	R-L= 12	< 1	Neglect
Star cancellation	R-L= 17	< 2	Neglect
Verbal description of a complex scene	Only right side described		Neglect
Reading of words (letters on each side= 46 centre=5)	L= 21; R= 46; C= 5		Neglect
Reading of sentences (letters read on each side: L=121; R= 115)	L=24; R=104		Neglect
Clock hands position task	Both L= 5/5; Both R =4/5^; L & R = 3/6^^		Neglect
Visual and auditory extinction			
Visual extinction (clinical task) (0-10 per each condition)	UL= 0; UR= 10; BL= N/A		Hemianopia/neglect
Visual extinction (computerised task) (0-10 per each condition)	UL= 0; UR= 10; BL= N/A		Hemianopia/neglect
Auditory extinction (0-10 per each condition)	UL= 10; UR= 10; BL= 1 (9/10 only right stimulus reported)		Auditory extinction

L=left; R=right; C= centre; UL= unilateral left; UR= unilateral right; BL= bilateral left

Where appropriate, RP's scores were compared with Italian standardised tests.

score corrected by age and gender

^ RP' response "Right and left"; ^^ omission of right stimuli

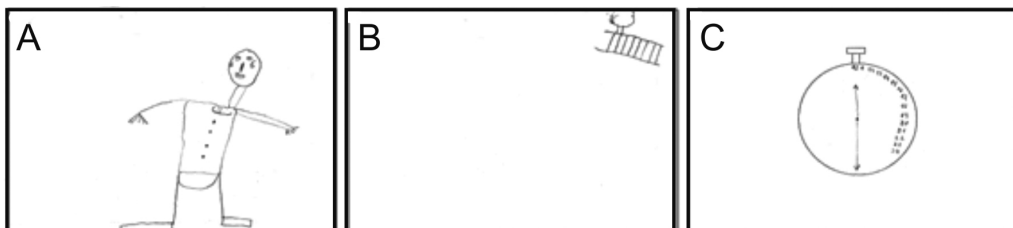


Figure 1. RP's drawings from memory: A) a person; B) landscape; C) clock (central circle provided)

Because of RP's left hemiplegia, tactile extinction was assessed on this right hand, only. The hand was positioned on the table with the palm faced down and in line with his body midline. The tactile stimuli consisted of brief pressure of the examiner's index fingers on the dorsal surface of the patient's hand (e.g., Di Pellegrino et al., 1997). Each test consisted of 30 stimuli (10 for each condition: left unilateral, right unilateral and bilateral) in random order. RP performed the extinction task under two conditions: with eyes closed and with eyes opened, looking at his right hand where the tactile stimuli were applied. In the unilateral condition, both examiner's fingers were 'visibly' moving but only one finger touched the patient's hand. The tactile extinction test was repeated eight times (for a total of 240 stimuli, 80 for each unilateral and bilateral stimulation) across two different days, leaving ten days between test and re-test. Two blocks of trials were given for each condition (eyes opened or closed) using an ABBA design. Before starting each 30-series test of the eyes opened condition, RP was informed that he had to report how many touches he felt and on which side of his hand (left, right or both). When he was reminded to pay attention to the touches not what he was seeing, he showed signs of irritation stating that this was exactly what he was doing.

RP's results on tactile extinction tasks are shown in Table 2. In the eyes closed condition, RP did not show clear tactile extinction (Vallar, Rusconi, Bignamini, Geminiani, & Perani, 1994), despite missing a few left stimuli. In the eyes opened condition, RP's performance was almost at ceiling with unilateral stimulation but he consistently omitted the left stimulus in at least half of the bilateral trials in both test and retest sessions. The difference between eyes opened (42.5%) and eyes closed (80%) performance in detecting the left stimulus on bilateral stimulation was significant (chi-square= 4.59; df=1; p<.05).

Table 2. RP performance (%) on tactile extinction tests

Test/ Re-test	Unilateral	Unilateral	Bilateral	
	Left	Right	Left	Right
Eye closed				
Test	100	100	70	100
	100	100	80	100
Re-test	100	100	80	100
	100	100	90	100
Total Mean (SD)	100	100	80 (8.2)	100
Eye opened				
Test	90*	70*	40	100
	90*	90*	30	100
Re-test	100	70*	50	100
	100	100	50	100
Total Mean (SD)	95 (5.8)	82.5 (15.0)	42.5 (9.6)	100

* Errors consisted in responses as 'bilateral' to unilateral stimuli
Significant differences are highlighted in bold

At the end of the last re-test session, RP's ability to visually detect the examiner's finger movements in the same task was assessed. He was informed that no touches were going to occur. He failed to detect all movements of the examiner's finger occurring on the left side of his hand in both unilateral and bilateral conditions.

CONCLUSIONS

RP did not show evident signs of tactile extinction when his eyes were closed, suggesting that possible attentional competition within the same modality was not significantly biased toward the ipsilesional stimulus. On the other hand, when the patient could look at his hand, he consistently missed the left tactile stimulus during bilateral stimulation.

In our eyes open condition, stimuli provided both visual (i.e., seeing the movement of the finger) and tactile (i.e., feeling the touch) information (Sambo et al., 2012). It is possible that the visual stimulus on the right may have "extinguished" the left tactile stimulus when RP's eyes were opened. If this were the case, we would have also observed extinction of the tactile stimulus in the unilateral eyes open condition, as both fingers moved in this condition as well. It seems also unlikely that a general visual background of the right side could have attracted RP's attention towards the ipsilesional hemifield, inducing a form of neglect for any event occurring on the left side. In this case, indeed, we should have expected a poor performance also for left unilateral stimuli. Moreover, the literature seems to suggest that contralesional tactile stimuli are not extinguished only by a passive visual background (e.g., Mattingley et al., 1997) or by visual stimuli not adjacent to the hand (Di Pellegrino et al., 1997). On the contrary, vision of the body part stimulated can ameliorate performance on tactile discrimination tasks on patients with reduced somatosensory sensitivity (Serino et al., 2007).

It is possible that the binding of two events on the right (i.e., movement of finger and touch) might have captured a considerable amount of attention resources resulting in extinction during the bilateral condition. However, this interpretation does not explain why RP responded "bilateral" to about 18% of the right unilateral stimuli in the condition with eyes opened. This is a further interesting observation *per se*, suggesting a tendency to respond "bilateral" to right unilateral stimuli in case of doubt (lax criterion). If this interpretation is correct, the extinction phenomenon in the eyes open condition may be even more profound than reported.

An alternative interpretation of tactile extinction when RP kept his eyes opened suggests that the left tactile information may have been extinguished by the meaningful and **subjective absence** (due to neglect) of visual information on the left, combined with a latent form of tactile extinction. When he was looking at his hand, the movement of the examiner's finger delivering the left tactile stimulus was hardly 'noticed' due to neglect. As such, the failure to detect the left visual stimulus may have been "interpreted", though not intentionally, as the left stimulus not occurring at all and it may have exacerbated a mild form of unimodal extinction.

The novelty of our case is that RP's extinction, and more generally crossmodal extinction, may be modulated by top-down mechanisms that would exacerbate underlying latent attentional biases. In the bilateral trials, the combined effect of right tactile stimulus competition, not strong enough to extinguish the left tactile stimulus alone, and the expectation based on lack of visual information (top-down process), may have led to extinction of tactile information coming from the left side. This phenomenon would be in line with previous studies reporting that top-down processes, such as expectation of being touched, can interfere significantly on multisensory coding (Góral-Pórola, Pórola, Mirski, Herman-Sucharska & Pachalska 2016) even in healthy volunteers (e.g., Carlsson, Petrovic, Skare, Petersson, & Ingvar, 2000).

In conclusion, while our findings await further systematic investigation, this patient posits a question about the extent of interference that higher-order attentional competition involving top-down mechanisms may play in the distribution of attentional resources across different modalities.

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