

ABSTRACT

HOW VOLUNTARY IS 'VOLUNTARY' ORIENTING OF ATTENTION?

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INTRODUCTION

Attention can be directed to an object in space either in a relatively reflexive way (e.g., when a honking car attracts the attention of a pedestrian), or in a more controlled mode (e.g., when the pedestrian monitors the traffic light waiting for the 'go' signal to appear). These two processes are often referred to as, respectively, exogenous and endogenous orienting. It is traditionally maintained that endogenous orienting, among other characteristics, is voluntary and requires conscious awareness, whereas exogenous orienting is more automatic in nature (Posner and Snyder, 1975; Jonides, 1981). Exogenous and endogenous orienting can be studied in relative isolation from one another by using the Posner response time (RT) paradigm (Posner, 1980). Participants are presented with three horizontally arranged boxes. They fixate the central box and respond by pressing a key to a target (an asterisk) appearing in one of two lateral boxes. The target is preceded by a cue. Cues can be central (an arrow presented at fixation pointing toward one lateral box) or peripheral (a brief brightening of the contour of one lateral box). *Valid* cues correctly predict the location of the impending target, whereas *invalid* cues indicate the box on the opposite side. Cues can be either *informative*, when targets usually (e.g., 80% of the time) appear in the cued box, or *non-informative*, when targets can appear with equal probabilities in the cued or in the uncued location. Peripheral non-informative cues attract attention automatically, or exogenously (Jonides, 1981; Müller and Rabbitt, 1989). This exogenous attentional shift, revealed by faster RTs for cued than for uncued trials, is typically observed only for short stimulus onset asynchronies (SOAs) between cue and target. For SOAs longer than ~300 ms, uncued targets evoke faster responses than cued targets (Posner and Cohen, 1984), a phenomenon known as inhibition of return (IOR; Posner et al., 1985). With peripheral informative cues, the cue validity effect persists even at longer SOAs, thus suggesting that the initial exogenous shift is later replaced by a more controlled, endogenous shift toward the same location (Müller and Findlay, 1988). This endogenous shift would be motivated by strategic considerations, because subjects know that targets will appear with high probability at the cued location.

In a study devoted to the exploration of exogenous and endogenous orienting in left unilateral neglect (Bartolomeo et al., 2001), we varied the level of predictiveness of peripheral cues in a Posner RT paradigm. With non-informative cues, neglect

patients showed a disproportionate cost for left targets preceded by right (invalid) cues; this cost was maximal at the shortest SOA, consistent with the idea of a biased exogenous orienting in neglect. With 20% predictive cues (a situation in which the best response strategy was to endogenously orient attention towards the box opposite to the cued one), neglect patients achieved their fastest RTs to left targets preceded by invalid right cues. With long SOA (1000-ms), RTs to left targets were actually in the range of RTs to right targets. Thus, in this condition neglect patients were surprisingly able to nullify their spatial bias. We concluded that leftward endogenous orienting is relatively spared, if slowed, in unilateral neglect, consistent with other abundant evidence (reviewed in Bartolomeo and Chokron, 2002).

The present study originated from a casual remark that some of our normal participants made after performing the experiments. Despite having been informed of the level of cue predictiveness, they claimed not to have paid attention to the cues; instead, they just tried to respond as fast as possible to the targets. And yet, these participants' performance showed the typical effects of cue predictiveness; not only effects related to exogenous orienting, like IOR with non-informative cues, but also durable advantage for cued locations with 80% valid cues and an advantage larger than IOR for uncued locations with 20% valid cues. Since these last effects are usually taken as resulting from endogenous orienting, we wondered whether this form of orienting is really based on volitional strategies, as is usually maintained (Posner and Snyder, 1975; Jonides, 1981), or whether it can result from more implicit processes.

EXPERIMENT 1

Methods

Nineteen undergraduates from the Paris 5 University took part in the experiment (mean age 26, range 21-34). They performed a Posner-type cued detection paradigm with peripheral cues (see Bartolomeo et al., 2001, for details of stimulus display). The target followed the cue at 600, 800, or 1000-ms SOA. Unknown to the participants, two blocks of trials followed one another without interruption. In the first block, consisting of 24 trials, cues were not informative about the future location of the target. In the second block, made of 90 trials, 80% of cues correctly predicted the target location. In 12 additional catch trials, interspersed within the second block, only cues were presented and participants had to refrain from responding. Participants were not informed of the cue-target relationship; they were just invited to respond to the targets as fast as possible. Immediately after the experiment, participants completed a questionnaire (inspired by Lambert et al., 1999) asking whether participants noticed any cue-target relationship, and, if yes, whether cues predicted most often the target location or the wrong location.

Results

The first 12 trials of block 1 and the first 18 trials of block 2 were discarded as practice. Based on the results of the post-experiment questionnaire,

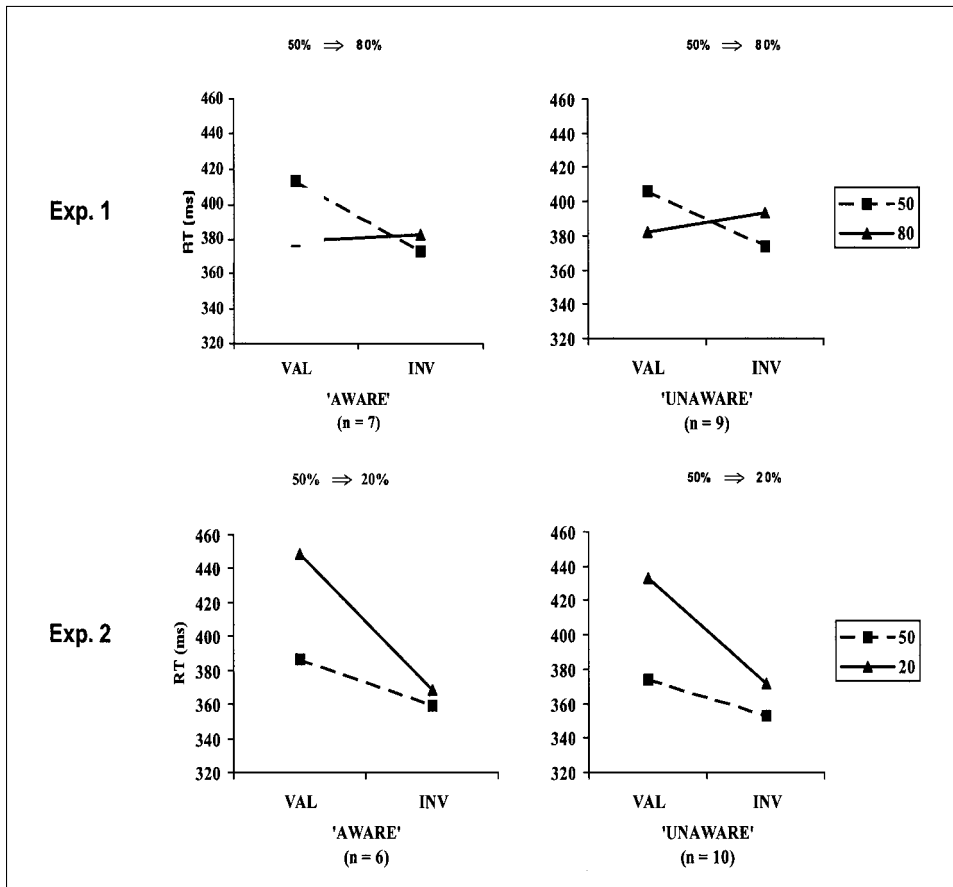


Fig. 1 – Performance of ‘aware’ and ‘unaware’ participants for the two consecutive blocks (50% valid cues and 80% or 20% valid cues) in the two experiments.

participants were divided into two groups: the ‘aware’ group ($N = 7$) and the ‘unaware’ group ($N = 9$) (the three remaining participants were discarded because of incoherent responses to the questionnaire). RTs were entered in an ANOVA with group (aware, unaware) as between-subjects factor and block (first, second), cue validity and SOA as within-subjects factors. There was no effect of group ($F < 1$), but an interaction emerged between block and validity, $F(1, 14) = 21.52$, $p < 0.0005$ (Fig. 1).

In the block with non-informative cues, RTs were faster for invalid trials (373 ms) than for valid trials (409 ms), consistent with the phenomenon of IOR. In the 80% validity block, instead, there was a small, nonsignificant advantage for valid trials (380 ms) over invalid trials (387 ms), as if an endogenous facilitation for validly cued targets masked IOR. The block/validity interaction was statistically reliable for both the ‘aware’ and the ‘unaware’ group, thus suggesting that endogenous processes may be unavailable to verbal report.

EXPERIMENT 2

Methods

Seventeen undergraduates from the Paris 5 University (mean age 27, range 20-30), none of whom had participated in Exp. 1, performed an RT task identical to Exp. 1, with the exception that now the second block consisted of a majority (80%) of invalid trials.

Results

After excluding one participant because of incoherent responses at the post-experiment questionnaire, six participants were considered as 'aware' and ten as 'unaware'. Again, an interaction occurred between block and validity, $F(1, 14) = 14.36$, $p < 0.005$ (see Fig. 1), in the absence of any effect of group ($F < 1$). As in Exp. 1, IOR was present in the first block (valid: 373 ms; invalid: 353 ms). In the second block, this inverse validity effect was larger in magnitude (valid: 431 ms; invalid: 372 ms), as if an endogenous process, driven by the fact that most trials were invalid, added to IOR in determining an extra cost for valid trials. Once again, the block/validity interaction was statistically reliable in both the 'aware' and the 'unaware' subgroups.

DISCUSSION

Results of both experiments suggest that phenomena related to endogenous orienting of attention may result from processes that (1) can be learned without explicit instructions and (2) may not be accessible to subsequent verbal report.

Lambert et al. (1999) showed that people can implicitly learn contingencies relating the position of the upcoming target with the identity of bilateral letter cues presented near the position expectancy boxes (e.g., W and S predicted a right-sided target). Although most participants did not answer appropriately to the post-experiment questionnaire, they showed an early facilitation for cued locations, followed by a cost for these same locations reminiscent of IOR. The characteristics of these attentional effects differed from both exogenous orienting, because Lambert et al.'s results implied a learned association between cue identity and target location, and endogenous orienting, because when participants were made aware of the cue-target relationships, the late cost for cued targets reversed to a facilitation (Lambert et al., 1999, Exp. 4). Our present findings differ by those of Lambert et al., because here we show that even processes usually labeled as endogenous (late facilitation for cued targets with 80% valid cues, or increased inhibition for cued targets with 20% valid cues) can be learned without explicit instructions and be nevertheless impervious to subsequent verbal description.

The lack of appropriate verbal report does not necessarily mean that the relevant processes be unconscious (Merleau-Ponty, 1942; Holender, 1986). However, verbalization of subjective conscious experience remains an important

criterion of awareness in psychological research (Merikle et al., 2001). Having not observed any qualitative differences between explicit (see Bartolomeo et al., 2001) and implicit processes of endogenous orienting, our future research will try to investigate possible quantitative differences between these aspects, and to explore the implications of the present findings for the pathophysiology of unilateral neglect.

REFERENCES

- BARTOLOMEO P and CHOKRON S. Orienting of attention in left unilateral neglect. *Neuroscience and Biobehavioral Reviews*, 26: 217-234, 2002.
- BARTOLOMEO P, SIÉROFF E, DECAIX C and CHOKRON S. Modulating the attentional bias in unilateral neglect: The effects of the strategic set. *Experimental Brain Research*, 137: 424-431, 2001.
- HOLENDER D. Semantic activation without conscious identification in dichotic listening, parafoveal vision, and visual masking. *Behavioral and Brain Sciences*, 9: 1-23, 1986.
- JONIDES J. Voluntary versus automatic control over the mind's eye's movement. In J Long and A Baddeley (Eds), *Attention and Performance XI*. Hillsdale, NJ: Lawrence Erlbaum, 1981, pp. 187-283.
- LAMBERT A, NAIKAR N, MCLAHAN K and AITKEN V. A new component of visual orienting: Implicit effects of peripheral information and subthreshold cues on covert attention. *Journal of Experimental Psychology: Human Perception and Performance*, 25: 321-340, 1999.
- MERIKLE PM, SMILEK D and EASTWOOD JD. Perception without awareness: Perspectives from cognitive psychology. *Cognition*, 79: 115-134, 2001.
- MERLEAU-PONTY M. *La structure du comportement*. Paris: Presses Universitaires de France, 1942.
- MÜLLER HJ and FINDLAY JM. The effect of visual attention on peripheral discrimination thresholds in single and multiple element displays. *Acta Psychologica*, 69: 129-155, 1988.
- MÜLLER HJ and RABBITT PM. Reflexive and voluntary orienting of visual attention: Time course of activation and resistance to interruption. *Journal of Experimental Psychology: Human Perception and Performance*, 15: 315-330, 1989.
- POSNER MI. Orienting of attention. *The Quarterly Journal of Experimental Psychology*, 32: 3-25, 1980.
- POSNER MI and COHEN Y. Components of visual orienting. In H Bouma and D Bouwhuis (Eds), *Attention and Performance X*. London: Lawrence Erlbaum, 1984, pp. 531-556.
- POSNER MI, RAFAL RD, CHOATE LS and VAUGHAN J. Inhibition of return: Neural basis and function. *Cognitive Neuropsychology*, 2: 211-228, 1985.
- POSNER MI and SNYDER CRR. Attention and cognitive control. In R Solso (Ed), *Information processing and cognition: The Loyola Symposium*. Hillsdale, NJ: Lawrence Erlbaum, 1975, pp. 55-85.