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# Attenuation of alignment effect with exocentric encoding of location

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**Abstract.** An object's location is best retrieved from the orientation in which it was learned. Otherwise, retrieval necessitates a mental effort to restore the original perspective. In this case there is a cost to speed and accuracy of location responses known as the alignment effect. We hypothesised that one can attenuate this alignment effect by systematically referring objects in an exocentric frame of reference during learning. Sixteen male students were asked to learn the location of five objects disposed in a totally new environment either by locating the objects in an egocentric or in an exocentric spatial frame of reference. After the learning phase, the participants were asked to imagine orienting themselves to an object in the scene and to point to another object. The analysis of pointing accuracy, orientation, and pointing times showed that the performances of participants engaged in the exocentric condition remained insensitive to the augmentation of the angle between their actual position on the path and the imagined orientation. On the other hand, the participants engaged in egocentric learning were disoriented when the difference between their actual orientation and the imagined orientation was great. We conclude that when an object's location is intentionally referred to in an exocentric reference frame, alignment effect can be significantly reduced.

## 1 Introduction

Having a good sense of direction entails knowing the right direction to get back to places already passed through. This constitutes, while moving, an enviable skill necessitating a clear awareness of the position of things which disappear from vision when one turns away from them or when one moves on. The maintenance of the spatial orientation of things, however, depends on the type of frame of reference used for their localisation (Bard et al 1990; Farrell and Robertson 1998; Jolicoeur and Kosslyn 1983; Paillard 1991; Rieser 1999; Sholl and Nolin 1997). The first frame of reference usually distinguished is an egocentric frame, in which people use their own head/feet, front/back, and left/right axes to code locations and distances of objects. The second is an exocentric frame, in which the distance and the spatial angles separating the objects in the environment are represented in relation to stable or conventional landmarks; hence the goalposts do not change position while the body moves (Péruch and Lapin 1993; Roskos-Ewoldsen et al 1998). In the present study we explore the way the frames of reference may contribute to providing flexible information, thus making things easy to retrieve whatever one's position on a path.

### 1.1 *Alignment effect while moving*

Walking in an environment provides proprioceptive information, which allows people to automatically gear, at the sensory motor level, their changing relation to the surroundings (Presson and Montello 1994; Rieser et al 1986). Indeed, each facing direction of the egocentric frame of reference—or heading (Loomis et al 1999)—is effortlessly updated with respect to the referent direction (Farrell and Robertson 1998; Levine et al 1982). One of the consequences is that each new spatial layout is memorised in a specific perspective (Presson et al 1989), and is therefore best retrieved from the orientation in which it was learned. In this case, one is aligned with the reference direction. Otherwise one is misaligned (Levine et al 1982; Roskos-Ewoldsen et al 1998). In the latter case there is a cost to the speed, accuracy, or both of the location responses (Sholl and Nolin 1997). The time taken for the participants to make decisions increases with the disparity between their own body-centered axes and the imaginary point of view that they had to adopt to make the judgment. For instance, Presson and Montello (1994) asked the participants to memorise the locations of objects in the surroundings. Then, the participants were blindfolded and asked to turn (or imagine turning) their body until facing (or imagining facing) directly towards an object. Once they were actually positioned on the object (or once they imagined being positioned on it), the participants had to locate another object by pointing. The authors demonstrated that the pointing latencies were not influenced by the misalignment of the target relative to the actual heading of the participants, provided that the participants actually rotated their body to the targets. They benefited from an automatic alignment while they moved. However, the response latencies increased with the angular difference between the participants' new position and the imagined orientation. Results were compatible with the idea that in the imagined condition the absence of locomotor proprioception leaves the egocentric reference frame unchanged, thus creating a conflict between the unchanged egocentric reference frame and the demands of the task. In the same vein, Farrell and Robertson (1998) showed that when people have to update their positions relative to the targets during actual movement (rotation), response latencies are only slightly affected by the magnitude of the body rotation. However, in another condition, participants had to imagine that they were still in their initial orientation while ignoring their actual rotation. In this condition, response latencies increased with the angular difference between the participants' new position and their original orientation. Thus the participants had to mentally restore the original orientation which had been changed automatically with the body rotation.

As a consequence, when body alignments during the learning phase and the test are the same, there is no alignment effect. For instance, there is no alignment effect when one imagines oneself in a new location in the environment (ie imagining a translation) provided that one imagines facing in the same direction as one's actual direction (Rieser 1989). On the other hand, when a viewer uses the information in an imagined orientation which is different from the one in which the information was learned, judgments are much more difficult, because heading in the imagined orientation does not correspond to actual heading.

### 1.2 *Attenuation of alignment effect*

However, not all imagined spatial representations are subject to orientation specificity. When spatial information about the environment is obtained from multiple experiences with the world, it provides multiple vantage points which contribute to fusing each sequential representation in a unified representation. This later facilitates the recognition of a location whatever the way of entry into the imagined scene. In addition, when exposed to a sufficient number of perspectives, a collection of orientation-dependent representations would appear to be orientation-independent, because each novel representation—whatever its perspective—would require only minimal transformation of an already existing representation in memory. For instance, crossing a town repeatedly and freely along several paths makes it easier to later use the spatial information in a variety of orientations (Evans and Pezdek 1980; Sholl 1987). This contributes to minimising the alignment effect. More decisively, Presson and Hazelrigg (1984) examined the conditions under which route information is represented in a flexible manner. Participants learned a simple route either by a blindfolded walk, by viewing the route directly, or by viewing a map. After learning the route, participants were placed (while blindfolded) at a location on that route either aligned or contra-aligned with the route as initially learned. If the critical factor determining orientation-specific coding is learning from a single vantage point, then the route condition will be equivalent to the map condition and will show alignment effect. On the other hand, if viewing a route elicits a spatial activity which directly interacts with the immediate surroundings, then no alignment effect should be obtained. The participants, after having viewed the path for 30 s from one side, were asked to make a judgment about that path. While blindfolded, they were wheeled in a meandering path between the learning and testing phases to ensure that they would rely on a memorised representation, and to avoid a direct tracking of their relations to the specific route locations as they moved. The results showed no alignment effect when the route was learned either by viewing or by blindfolded walking. In the latter case, people may have access to knowledge of exocentric relations: the objects of the surrounding environment together with people's own position are perceived in their relative locations. The absence of alignment effect is explained by the fact that people have direct access to spatial knowledge without going through the origin of an egocentric reference system. The information involved is specified in terms of exocentric references. When we recall the information in this way, we imagine a scene within which we are positioned as the other objects (Ittelson 1973; Thorndyke and Hayes-Roth 1982). Presson et al (1989) further showed that orientation-free coding may be obtained in a large display (say, 8 feet in size). Sholl and Nolin (1997) also found orientation-free location when a scene, viewed from the horizontal perspective, has sufficient depth to allow people to imagine navigating and to prevent the self-reference system from automatically tracking the movement trajectory at the sensorimotor level.

## 2 The present research and general method

As mentioned, and in line with the above studies, we attempt here to show that attenuation of alignment effect may be obtained in spatial location when the coding of a spatial layout leads participants to disengage automatic updating and engages them to imagine themselves as a point among others in the spatial layout. More specifically, and given that people may have direct access to exteroceptive relations (Neisser 1987), it is hypothesised that when one is instructed to learn a spatial configuration of objects in an exocentric manner, alignment effect should not be revealed in the accuracy and the speed of location of these objects.

The paradigm we used is based on the fact that instructions play a major role in determining the spatial frame of reference used by participants (Amorim et al 1997; Presson et al 1989; Taylor and Tversky 1996). Amorim et al (1997) compared two processing modes used in updating the location of an object disposed in an L-shaped path after a guided walk without vision on that path. In one condition the participants were asked to track the object continuously, or to estimate the object's perspective only at the terminal vantage point, depending on the trajectory they walked. In addition, the participants had to verbalise continuously the output of their computation in order to make sure that they allocated attention towards the relevant spatial information for each processing mode. The results showed the effects of the processing mode engaged in the updating of the object's location, thus giving support to the idea that attentional resources may be allocated to different spatial processings which give rise to different spatial representations. In the present study, we asked the participants to walk through a path comprising five objects, and to learn their positions either within exocentric or within egocentric references. In order to ensure that the participants focused their attention on an egocentric representation, participants were asked to be concerned only with the proprioceptive cues from their walk and to state aloud to which position each encountered object pointed in their egocentric references. In the exocentric condition, the participants also had to verbalise continuously the output of their computation, which consisted, however, in localising each object relative to extracorporal landmarks.

Thereafter, all the participants had to imagine standing at an object and facing a second object. Then from this imagined position they had to point to a third object.

As it has already been shown that alignment effects increase with the angular difference between the participants' actual direction and the imagined orientation that the participants had to adopt (Easton and Sholl 1995; Presson and Montello 1994; Rieser 1989), we chose four imagined orientations. The first imagined orientation corresponded to the participant's alignment (0°) and the three others necessitated imagined rotations of 60°, 120°, and 180°. We expected that the latency and the accuracy of the location would be subject to alignment effect only after egocentric learning.

## 2.1 *Method*

2.1.1 *Participants.* Participants were sixteen male students (mean age, 21.8 years) at the Université René Descartes. They all reported normal vision and were naïve as to the purpose of the experiment. Informed consent was obtained from the participants and confidentiality ensured. They were randomly allocated to the two experimental groups: the exocentric learning group and the egocentric learning group.

2.1.2 *Materials.* We created a path which could be explored in specific ways in order to have optimal control over the spatial experience of the participants. Indeed, the discrepancy of the findings in spatial mental representations has been explained by the absence of control over the number of orientations that the participants experienced before performing spatial judgments (Roskos-Ewoldsen et al 1998). The path consisted of five shapes each drawn on a 40 cm × 40 cm piece of wood: a triangle, a moon, a circle, a square, and a diamond disposed on the ground (see figure 1). The shapes

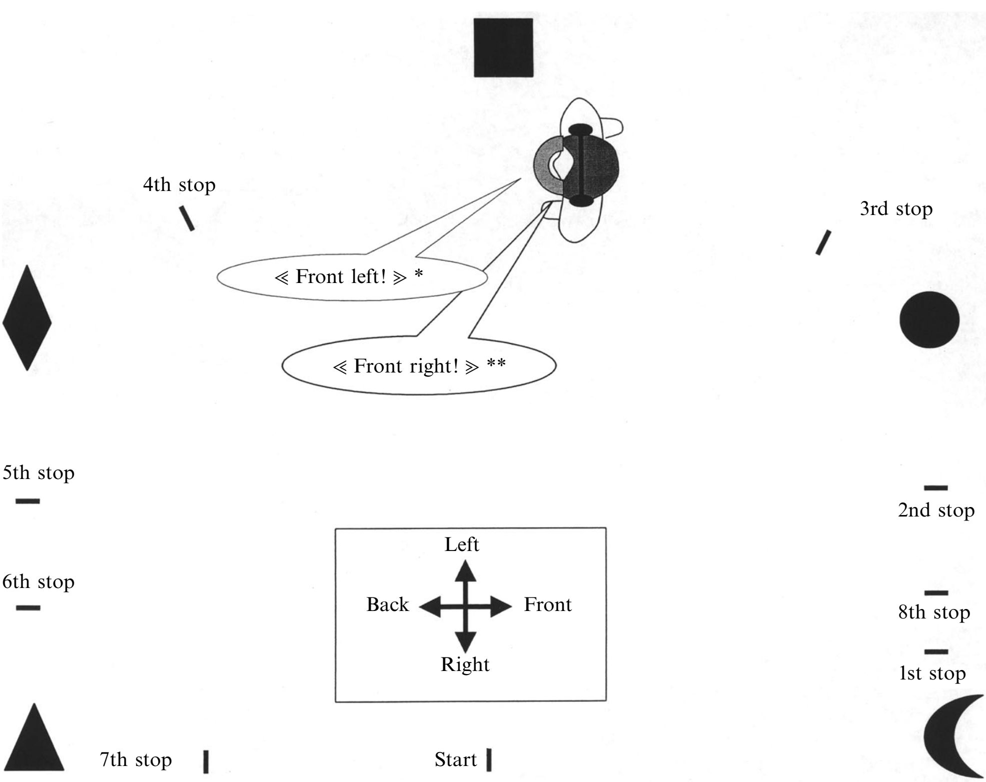


**Figure 1.** Schematic presentation of the experimental layout with the five objects. The participant, seen from above, is locating the square in the exocentric manner (*). The egocentric manner is also presented (**). The exocentric framework is presented in its actual position: the five objects are presented in their actual positions relative to the four quadrants.

were separated from each other in the given order by a distance of 10, 5, 6, 6, and 5 m, respectively. The participants wore helmets with Plexiglas opaque visors restricting their vision of the objects to one metre. The participants were also equipped with a headphone emitting a white noise, which was loud enough to mask any background sounds that could have acted as location cues but which still allowed the experimenter to be heard when giving instructions. A framework (figure 1, bottom) constructed of wood was set at the start of the path. It indicated the exocentric spatial references separating the spatial path in four quadrants in which the encountered objects had to be located. Each trial of each phase of the experiment was recorded by an experimenter with a JVC GR-60S video camera equipped with a JVC CG-P50S timer functioning at the rate of 40 ms. As Middlebrooks and Green (1991) showed that sighted participants could achieve high accuracy (ie with an error of only 2°) in a location task by pointing, the participants of our study were asked to point with their arm and index finger when they had to locate the objects. The accuracy of the location was measured by a second experimenter in the following manner: once the participant indicated that he had terminated his pointing, the experimenter placed a plumb line under the pointing finger and a wooden peg on the ground at the point of contact between the plumb and the floor. Thus the angle between the direction of pointing and the true direction of the object could be measured relative to the stop mark.

2.1.3 *Procedure.* The participants were first told that they would view sequentially a series of five objects and that once they had learned their names and their locations they would be asked to make a judgment from memory about the location of some of them. There were two phases in the experiment: the first was a self-paced learning phase during which the participants had to memorise the place of the objects in the exocentric frame of reference or in their egocentric frame of reference. The second phase was a location phase during which the participants had first to imagine an orientation and then to point as accurately and as quickly as possible to the memorised location of the objects. The participants performed the experiment individually and the session lasted 20 min.

### 2.2 *Learning phase*

In the exocentric condition, the participants had first to look at the exocentric framework set at the start of the path and memorise the specific directions. Then, the participants had to enter the path following the direction indicated by an arrow 10 cm long (not represented in figure 1 and removed during the location phase) which was set on the floor at the start and after each object in order to guide them to the following object. In order to locate each encountered object which he could see from underneath the visor, the participant had to indicate aloud which position it occupied relative to one of the four exocentric locations of the framework. In the egocentric condition the participant had to follow the same path, encountering the same objects, and locate them in his egocentric frame of reference. To illustrate this phase, figure 1 presents a participant learning the location of a square. In the exocentric mode, the participant had to locate the square in the 'front left' quadrant of the exocentric framework, and, having passed it, had to continue to locate it in the same quadrant. In the egocentric condition, the participant located the square in his 'front right' quadrant. Once the square was passed, the participant had to locate it again but in his 'back right' quadrant.

Whatever the condition, the second experimenter corrected the location verbally as soon as the participant began to indicate erroneous locations. If necessary, the participant was asked not to stop stating aloud the position of each passed object until he encountered another. In addition, if the participant began to deviate substantially from the path, the experimenter touched the participant's arm lightly to correct the direction of his walk. The learning phase was repeated three times. Then, the second experimenter asked the participant to indicate if the name and the location of the objects were, to his mind, well memorised. Otherwise, the participant had to perform other learning trials. No participant, however, asked for a further learning trial.

### 2.3 *Location phase*

Following the learning phase, the participant had to enter the path once again and was stopped at a particular location indicated by a mark drawn perpendicular to the path (see the stop marks in figure 1). If necessary, and in order to reach perfect positioning, the experimenter could place his hand on the participant's shoulders for the participant to align the extremities of his shoes with the mark. The participant was questioned by the second experimenter following one of the eight conditions presented in table 1.

**Table 1.** The eight stops and the corresponding imagined orientations and pointing directions.

| Stop | Imagined orientation | | Angle/° | Pointing direction | Angle/° |
|---|---|---|---|---|---|
| | standing at the ... | facing the ... | | | |
| 1 | moon | circle | 0 | triangle | 90 |
| 2 | circle | moon | 180 | diamond | 90 |
| 3 | square | diamond | 60 | triangle | 30 |
| 4 | diamond | triangle | 60 | circle | 90 |
| 5 | triangle | diamond | 180 | square | 30 |
| 6 | triangle | circle | 120 | square | 30 |
| 7 | triangle | moon | 0 | circle | 30 |
| 8 | square | diamond | 120 | moon | 90 |

*Orientation.* Once correctly positioned, the participant was asked to imagine as quickly and as precisely as possible standing at an object (eg the moon) and facing a second object (eg the circle). The participant had to indicate out loud with a 'stop' signal the moment when he imagined being accurately positioned.

*Pointing.* The experimenter then asked the participant to point to a third object (eg the triangle) as accurately and as quickly as possible. The participant also had to indicate with a 'stop' signal when he was sure that his pointing was accurate. For example, given the location at the second stop presented in table 1, the circle – moon – diamond triad represents an imagined orientation of 180° and a pointing angle of 90°.

The participants did not receive any feedback on their pointing accuracy.

2.3.1 *Data.* As suggested by Roskos-Ewoldsen et al (1998), pointing latency and orienting time were recorded separately because pointing latency, which can reflect time to retrieve the target object's location once heading has been adopted, may not be as sensitive as orientation to the angular distance. The second experimenter indicated by a distinguishable signal (a 'cutting' gesture effected with the index and middle fingers) the end of each orienting and pointing instruction and the moment of the participant's "stop" responses. Thus, the analyses of the video recordings allowed the computation of the duration of (a) each learning trial, (b) each orientation, and (c) each location. The angular deviations of the pointing performances were recorded in degrees relative to the exact location. To indicate the direction of the errors (ie the overestimation or underestimation of the pointing), the constant errors (CE) were calculated. Absolute errors (AE) were also collected in order to evaluate the overall pointing accuracy.

### 2.4 *Learning time*

The performances of the two groups were analysed with a 2 × 3 (learning × trial) analysis of variance: learning condition (exocentric versus egocentric) as between-participants factor, trial (1st, 2nd, and 3rd) as within-participants factors. The analysis revealed only a significant effect for trial, $F_{2,28} = 37.12$, $p < 0.05$. Mean learning times (with standard deviations in parentheses) performed by the egocentric group and the exocentric group and averaged on the three learning phases were 80.7 s (10.8 s) and 87 s (14.9 s), respectively.

### 2.5 *Pointing accuracy*

The performances in CE and AE of the two groups were analysed with a $2 \times 4 \times 2$ (learning × orienting × pointing) analysis of variance: learning condition (exocentric versus egocentric) as between-participants factor, orienting (0° versus 60° versus 120° versus 180°) and pointing (30° versus 90°) as within-participants factor.

For CE, there was an effect for orientation ($F_{3,42} = 4.02$, $p < 0.05$) and a significant two-way interaction (learning × orientation) effect ($F_{3,42} = 2.97$, $p < 0.05$). Visual inspection of the results presented in figure 2 shows that the errors of the exocentric group increased for an imagined orientation of 180°. It looks as though the differential changes from an orientation of 120° to an orientation of 180° are responsible for this interaction. Indeed, analysis contrasting the performances of the egocentric group with the performances of the exocentric group for the 120° orientation relative to the 180° orientation was significant ($F_{1,14} = 5.77$, $p < 0.05$).

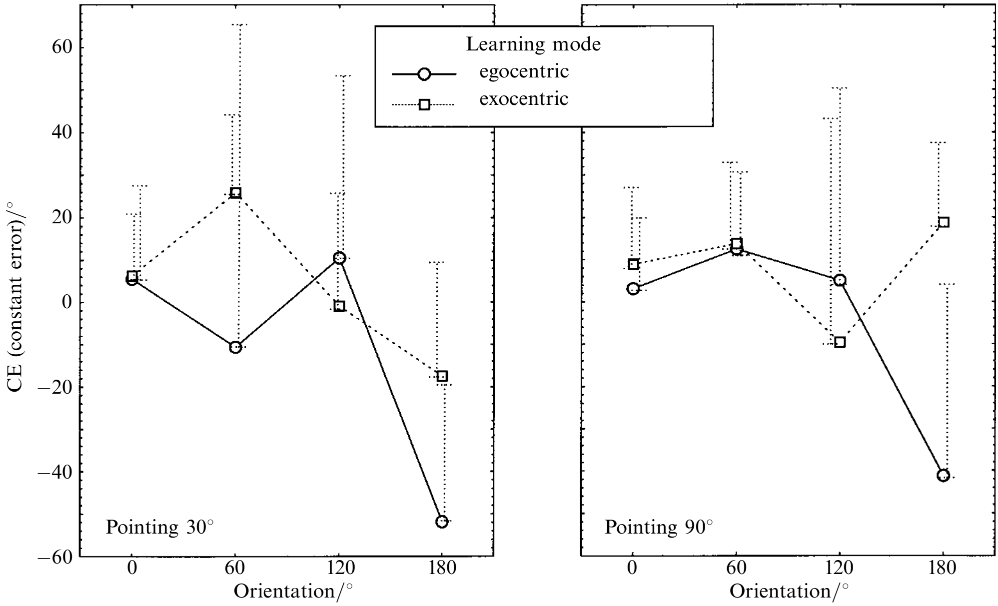


**Figure 2.** Mean error in CE as a function of learning condition, orienting amplitude, and pointing angle. Vertical lines depict one standard error of the mean.

For the performances in AE, the analysis showed a significant effect for orientation ($F_{3,42} = 6.82$, $p < 0.05$) and for learning ($F_{1,14} = 16.79$, $p < 0.05$). More importantly, there was a two-way interaction (learning × orientation) effect ($F_{3,42} = 3.6$, $p < 0.05$). The results presented in figure 3 showed that, relative to the performances of the exocentric group, the errors of the egocentric group increased markedly for the 120° and the 180° orientations whatever the pointing direction. Indeed, the interaction may be explained by the significant changes in AE from the 0° and 60° orientations to the 120° and 180° orientations in the egocentric group relative to the exocentric group ($F_{1,,14} = 7.36$, $p < 0.05$). Trend analysis shows a significant linear relation between the four orientations and the EA for the egocentric group ($F_{1,14} = 28.62$, $p < 0.05$), but not for the exocentric group ($F < 1$).

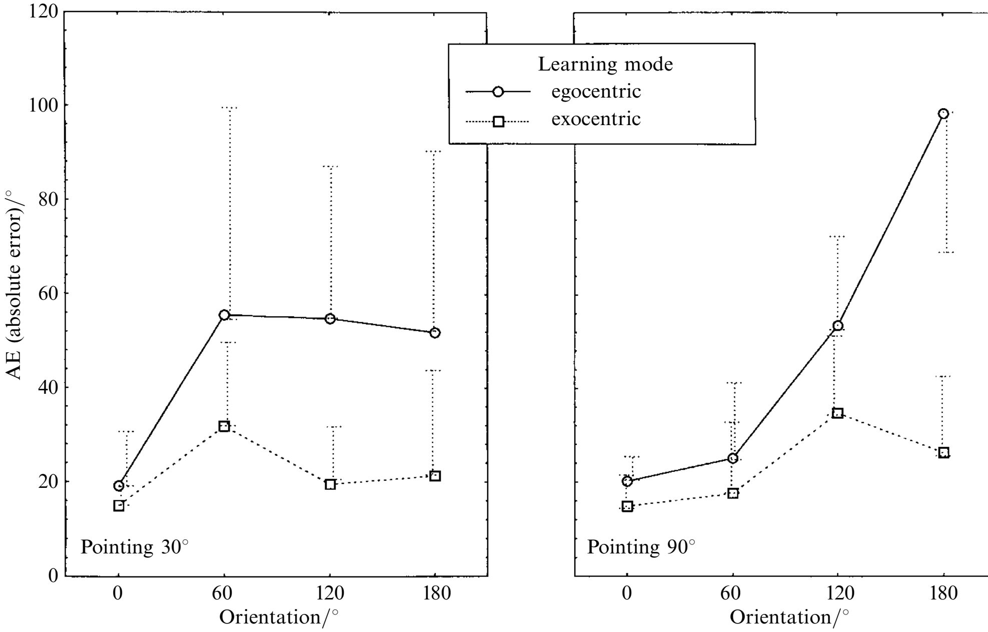


**Figure 3.** Mean error in AE as a function of learning condition, orienting amplitude, and pointing angle. Vertical lines depict one standard error of the mean.

The results showed no effect of the pointing angle on pointing accuracy. More importantly, the headings of the exocentric group seemed to have not been sensitive to alignment effect, as the performances of the exocentric group remained stable whatever the imagined orientations and pointing angles. To illustrate this, mean AEs for the 0° to the 180° imagined orientations were 14.8°, 24.6°, 29.4°, and 23.7°, respectively.

### 2.6 *Orienting time*

The performance of the two groups were analysed with a $2 \times 4$ (learning $\times$ orienting) analysis of variance: learning condition (exocentric versus egocentric) as between-participants factor and orienting (0° versus 60° versus 120° versus 180°) as within-participants factors. These data are plotted in the first two lines of table 2, and they show that the participants in the exocentric group performed their imagined orientation more rapidly than the participants in the egocentric group. The statistical tests confirmed this: there was a significant effect for learning ($F_{1,14} = 8.11$, $p < 0.05$). There was also a significant effect for orientation ($F_{3,42} = 8.03$, $p < 0.05$). There was no interaction effect.

**Table 2.** Mean times (M) with standard deviations (SD) of the four imagined orientations and the eight pointing directions as a function of the two learning conditions.

| Imagined orientation/° | Egocentric | | Exocentric | | Pointing direction/° | Egocentric | | Exocentric | |
|---|---|---|---|---|---|---|---|---|---|
| | M/s | SD/s | M/s | SD/s | | M/s | SD/s | M/s | SD/s |
| 0 | 3.9 | 2.1 | 2.8 | 1.5 | 0 + 30 | 11.5 | 2.8 | 12.2 | 3.1 |
| 60 | 6.2 | 3.1 | 3.8 | 1.2 | 0 + 90 | 13.4 | 4.6 | 10.3 | 2.2 |
| 120 | 4.5 | 1.7 | 3.1 | 1.8 | 60 + 30 | 14.1 | 4.1 | 15.6 | 2.4 |
| 180 | 8.4 | 2.5 | 5.5 | 3.4 | 60 + 90 | 17.2 | 4.4 | 14.8 | 2.8 |
| | | | | | 120 + 30 | 12.8 | 3.2 | 9.4 | 3.1 |
| | | | | | 120 + 90 | 13.6 | 3.7 | 10.8 | 2.9 |
| | | | | | 180 + 30 | 14.6 | 2.1 | 9.3 | 1.5 |
| | | | | | 180 + 90 | 20.9 | 4.8 | 13.5 | 2.7 |

### 2.7 *Pointing time alone*

The performances of the two groups were analysed with a $2 \times 2$ (learning $\times$ pointing) analysis of variance: learning condition (exocentric versus egocentric) as between-participants factor and orienting (30° versus 90°) as within-participants factor. There was no significant effect for learning or pointing ($F < 1$, respectively). To illustrate this result, the mean pointing times for the egocentric group for 30° and 90° were 8.1 and 10.1 s, respectively. For the egocentric group, the mean times were 7.9 and 8.4 s for 30° and 90°, respectively.

## 3 Discussion

The experiment was devised to test the hypothesis that the learning of the spatial position of things in the surroundings within an exocentric frame of reference may contribute to minimising alignment effect, thus making things easy to retrieve whatever one's position in the surroundings. The results seem to verify the hypothesis.

Indeed, for pointing accuracy in CE and AE, the participants engaged in exocentric learning (whatever the pointing angle) remained as accurate as when they were aligned (ie having to imagine a 0° orientation), and even after having imagined a 180° orientation. On the other hand, the participants engaged in egocentric learning were largely subject to alignment effect as they greatly underestimated (with a mean CE of −40°) the location of the objects for a 180° orientation whatever the pointing angle. This is confirmed by the constant increase of AE (19°, 45°, 54°, and 75°) as a function of the increase of the orienting angle and regardless of the pointing angles.

Chronometric analyses of the performances showed several important results. First, there was no difference in the learning time during the learning phase. This result did not confirm the findings of Amorim et al (1997) because these authors found that, with respect to the trajectory-centred task, the object-centred processing mode induced a slowdown of the participants self-paced locomotion velocity. The absence of learning-time differences indicated that the differences in the accuracy and the latency of location were not due to a learning phase which would have lasted longer (and thus have been more informative) for one learning mode relative to the other. Examination of the orienting latencies gave some further consistency to our results because they showed that the participants were not implicated in a speed–accuracy trade-off. The attenuation of alignment effect for the exocentric learning was confirmed by the speed with which the participants engaged in this condition imagined their headings. They outperformed the participants of the egocentric group. Taken together, these results attest that pointing situations induce real alignment effects to which the participants in exocentric learning, however, remain insensitive.

Our results suggest that the participants engaged in egocentric learning had to orient themselves by a mental rotation and that the exocentric learning group had not. This is consistent with studies which have shown that location may be equally easy from any orientation (Evans and Pezdek 1980; Thorndyke and Hayes-Roth 1982). However, this consistency is only partial because we also demonstrated that this flexibility is not only obtained after extensive navigation but also after sequential and very confined views of a new layout. In addition, some experiments which have demonstrated the absence of alignment effect used a disorientation method (a meandering path between the learning and testing phases), and this type of path has been criticised. Indeed, for Roskos-Ewoldsen et al (1988), the method used by Presson and Hazelrigg (1984) and Presson et al (1989) may not have prevented the participants from updating their mental representation during their movement in space. The method we used seemed to contribute better to controlling the orientations experienced by the participants.

The results indicate that the accuracy and latencies of the pointing judgments of the participants in the exocentric group remained insensitive to the misalignment of the objects relative to the participants' headings. This runs counter to the idea that imagined headings are easy only when they are aligned with studied orientations (Shelton and McNamara 1997), and it also runs counter to the idea that all spatial knowledge is necessarily stored in orientation-specific ways. Indeed, different studies have shown no alignment effect but only when the participants were permitted to observe and memorise the entire layout. For instance Sholl and Nolin (1997) permitted the participants to study the path for 30 s before having them blindfolded. Thus, as described by Presson and Hazelrigg (1984), the participants may have developed route knowledge that was not linked to the specific orientation presented. In our study, the participants seem to have developed a spatial representation allowing direct access to spatial knowledge without going through the egocentric reference system. Recalling information in this way leads to imagining a scene within which we are positioned as the other objects. Our results further support the existence of a particular way of encoding spatial information. The information is specified in terms of an environmental, object-to-object frame of reference in which "the alignment relative to the information does not affect significantly the accuracy of later judgements" (Presson et al 1989, page 896) and not in terms of a self-as-viewer frame of reference.

In conclusion, our key finding is that flexibility in orientation is not only obtained by repeatedly experiencing the environment; it may also be obtained more 'directly' by voluntarily locating new spatial cues in extracorporal frames. In addition, this result may help to better understand how to find one's way in a new environment.

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