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My foot? Motor imagery-evoked pain, alternative strategies and implications for laterality recognition tasks

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Conflict of interest statement

The authors report no conflict of interest

Dear Editor

Asking patients to determine the laterality (i.e. left or right) of images depicting parts of the body has been an intriguing development within the management of patients with Complex Regional Pain Syndrome (CRPS). Such Laterality Recognition Tasks (LRTs) are known to involve the mental rotation of one's own limbs (1-3), activating areas of the brain involved in the execution of related limb movements (4, 5) and subsequently considered to have a potential role in the assessment and treatment of patients with CRPS and other conditions (6-8).

As part of routine testing in our clinic, a 35 year old female with CRPS Type II affecting the right foot completed a Foot Laterality Recognition Task in April 2013. Accordingly, she was presented with a series of 48 images on a computer screen, each depicting a foot differing in laterality (left or right), view (dorsum, sole, big toe or heel) or rotation (0, 60, 120, 180, 240 or 300 degrees); images courtesy of Parsons (9). She performed well, responding correctly to each image (accuracy = 100%). Median response times (RTs) were similar for images of left (2314ms) and right (2521ms) feet. On completing the task, the patient revealed that her approach had been to imagine another person's feet (3rd person strategy) rather than her own. She was subsequently asked to complete the task again, imagining her own feet (1st person strategy). She was able to do this but reported that her pain level increased as a result; increased pain while performing LRTs has previously been reported in a patient with CRPS (10). The resulting LRT data again showed accuracy to be good though reduced for images of right feet (left = 100%, right = 84%). However RT differences were more pronounced with a marked slowing in accurate responses to images of right feet (left = 2183ms, right = 3910ms).

Following the first session, the patient practiced LRTs at home using 'flash cards' on a daily basis. We subsequently repeated the tests on two occasions (May and August 2013) and while responses became faster overall, the same pattern of data remained (see Table 1); the patient was slower to recognise images of right feet than left feet when using her non-preferred '1st person' strategy, while response times were comparable when she used a '3rd person' strategy.

Table 1 about here

A relative slowness to recognise images corresponding with an affected vs. an unaffected limb has been reported previously in patients with CRPS (11, 12) but this is not a consistent finding (13). Our patient was able to articulate two distinct strategies, with the preferred and spontaneously selected strategy ('other' or '3rd person') showing no difference in LRT performance for left and right feet. Typically, individuals undertaking LRTs are not asked to imagine limb movements and may not be aware of how they have determined their related judgments when performing the task. Consequently, LRTs are normally considered a good method of *implicitly* facilitating motor imagery, and have been used as part of larger programs of motor imagery, preceding the explicit imagination of movements as they are considered less threatening for patients (7). However, the potential for patients to use alternative strategies, as was the case here, appears to threaten the therapeutic rationale for the task and may therefore threaten their value.

How sure can we be that the 1st vs 3rd person strategies used by this patient are mechanistically distinct? A characteristic of LRTs is the tendency for RTs to adhere to biomechanical constraints, with slower responses to images reflecting awkward postures compared with natural postures, independent of the degree of rotation required (2, 3). Related analyses are often used in studies to confirm the use of a motor strategy (14-16). While such an approach is more challenging for pictures of feet than hands, it is possible to clearly draw a distinction between natural and awkward images for the *sole* and *big toe* views(3). We therefore conducted a related analysis on the available data, collapsing across the individual sessions. As can be seen in Figure 1, biomechanical constraints appeared to have a marked effect when the patient used a 1st person strategy, with slower RTs for awkward postures, with RT differences most striking for images of a right foot. No such effects were evident when the patient used her preferred 3rd person strategy. These findings appear to confirm the patient's description of two relatively distinct strategies.

Figure 1 about here

Although LRTs in unimpaired individuals have been found to consistently induce motor imagery, the rather more mixed data emerging from patient-based studies suggests alternative strategies may arise in some cases (17, 18), and it is suggested that these may be "implicitly triggered or prompted at will" (15, p.878). In the case presented here, alternative strategies only became apparent following discussion with the patient. Her preferred and spontaneously selected '3rd person' strategy (adopted because a 1st person approach caused her pain) resulted in superior performance but did not appear to engage motor processes, indicated by the absence of biomechanical constraints from the resulting data. Discussion with the patient was able to facilitate a '1st person' approach consistent with a motor strategy, the resulting data supporting the change, both in terms of the generally slower RTs to images corresponding with the affected right foot and also the more general biomechanical constraints that became evident for this approach. However, encouraging a strategy in this way precludes the resulting motor imagery being implicit, an issue that is normally seen as being an important strength of LRTs.

The case presented here demonstrates that it is possible for an individual to perform at a high level on LRTs without using motor imagery. This is important as clinics appear to be increasingly embracing the use of LRTs in the assessment and treatment of patients with CRPS, assuming that a motor strategy is being used. It is important that practitioners establish processes when using LRTs, including the careful selection of images and an ability to analyse for the presence or absence of biomechanical constraints. This will enable practitioners to determine with greater confidence whether individual patients are engaging in a motor strategy or not. Widely available tools such as online LRTs and flash cards do not currently allow such control of the task or the ability to perform these analyses. Adopting such processes should allow practitioners to use this potentially powerful tool optimally. Additionally, given the issues raised here, further research examining alternative strategies when individuals perform LRTs are merited.

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Table 1 Mean accuracy and median response times (in milliseconds) on the Foot Laterality Recognition Task across the three sessions (L = left, R = right); see text for details. Pain reported at each session measured via a Visual Analogue Scale (VAS).

		Mean Accuracy (%)				Median Response Time (ms)			
	Reported Pain **(VAS)**	*1st Person*		*3rd Person*		*1st Person*		*3rd Person*	
		L	**R**	**L**	**R**	**L**	**R**	**L**	**R**
Session 1	7/10	100	84	100	100	2183	3910	2314	2521
Session 2	7/10	100	83	100	100	1732	3599	2146	2059
Session 3	7/10	100	96	100	100	1538	2248	1116	1408

Figure 1 Median response times (in milliseconds) based on an analysis of the biomechanical constraints, when the patient used a 1st or 3rd person strategy.