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A technology-assisted learning setup as assessment supplement for three persons with a diagnosis of post-coma vegetative state and pervasive motor impairment

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ABSTRACT

Post-coma persons in an apparent condition of vegetative state and pervasive motor impairment pose serious problems in terms of assessment and intervention options. A technology-based learning assessment procedure might serve for them as a diagnostic supplement with possible implications for rehabilitation intervention. The learning assessment procedure adopted in this study relied on hand-closure and eye-blinking responses and on microswitch technology to detect such responses and to present stimuli. Three participants were involved in the study. The technology consisted of a touch/pressure sensor fixed on the hand or an optic sensor mounted on an eyeglasses' frame, which were combined with a control system linked to stimulus sources. The study adopted an ABABCB sequence, in which A represented baseline periods, B intervention periods with stimuli contingent on the responses, and C a control condition with stimuli presented non-contingently. Data showed that the level of responding during the B phases was significantly higher than the levels observed during the A phases as well as the C phase for two of the three

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participants (i.e., indicating clear signs of learning by them). Learning might be deemed to represent basic levels of knowledge/ consciousness. Thus, detecting signs of learning might help one revise a previous diagnosis of vegetative state with wide implications for rehabilitation perspectives.

1. Introduction

Post-coma persons in an apparent condition of vegetative state and pervasive motor impairment pose serious problems in terms of assessment (with the need for new assessment strategies to supplement those available) and intervention options (Avesani, Gambini, & Albertini, 2006; Bekinschtein et al., 2005; Bernat, 2006; Bernat & Rottenberg, 2007; Giacino & Kalmar, 2005; Giacino & Trott, 2004; Laureys & Boly, 2007; Wilson & Gill-Thwaites, 2000). Among the assessment strategies now available, behavioral tests such as the Coma Recovery Scale-Revised and the Rancho Los Amigos Cognitive Scale-Revised (Hagen, 1998; Kalmar & Giacino, 2005; Lombardi, Gatta, Sacco, Muratori, & Carolei, 2007) might be seen as critically reliant on the participants' motor expressions and, as a consequence, insufficiently sensitive for cases with minimal motor behavior (Lancioni, Singh, et al., 2007; Owen & Coleman, 2008). The use of event-related brain potentials (e.g., P300 and mismatch negativity), which constitutes an obvious and largely practiced complement to the behavioral assessment, might not necessarily provide a diagnostic solution. In fact, those potentials may not be reliably observable in a number of persons; their presence, moreover, may represent a weak and incomplete evidence of awareness/consciousness if not corroborated by any behavioral indicators (Kotchoubey et al., 2006; Lancioni, Singh, et al., 2007; Perrin et al., 2006). Functional magnetic resonance imaging (fMRI) is a technique of great potential (Coleman et al., 2007; Owen et al., 2006, 2007). Yet, reservations are also cast about its applicability on a large scale and its reliability in providing actual evidence of individual consciousness (Bernat, 2006; Bernat & Rottenberg, 2007; Greenberg, 2007; Parashkev & Masud, 2007).

Recently, a technology-based learning assessment procedure has been suggested as an additional and potentially relevant approach in the diagnosis of these persons (Lancioni, Olivetti Belardinelli, Chiapparino, et al., 2008; Lancioni, Singh, et al., 2007; Lancioni et al., 2009). The procedure relies on a learning setup involving a participant's simple response (e.g., small forehead skin movements) and positive environmental stimuli presented contingent on the response through microswitch technology (cf. Lancioni, O'Reilly, et al., 2005; Lancioni, Singh, et al., 2005; Naudé & Hughes, 2005; Ptak, Gutbrod, & Schnider, 1998). The procedure determines the participant's ability to associate the response selected with the environmental stimuli, and, thus to increase the frequency of such response to obtain those stimuli. This increase (together with response declines in the absence of the stimuli and the non-contingent use of them) can be considered a sign of learning (Catania, 2007; Pear, 2001). Such learning might be viewed as representative of forms of concrete knowledge and presumably basic levels of consciousness (Grossberg, 1999; Grossberg & Versace, 2008; Schanks, 2005; Sun, Merrill, & Peterson, 2001; Sun, Slusarz, & Terry, 2005; Sun, Zhang, Slusarz, & Mathews, 2007).

Detecting signs of learning (i.e., acquisition of the link between response and environmental stimuli) might (a) bring about a change of diagnostic label from vegetative state to "minimally conscious state" for the persons involved, (b) emphasize the usability of minimal responses and microswitch technology as means for helping these persons establish contact with the outside world, (c) provide a ready-made intervention basis (i.e., the response, microswitch technology, and stimuli used in the learning setup) for developing a rehabilitation program, and (d) encourage an extension of the learning process with new responses, technology and stimuli to increase the person's overall level of activity and provide basic choice opportunities (Boyle & Greer, 1983; Davis & Gimenez, 2003; Giacino, 2004; Lancioni, Olivetti Belardinelli, Oliva, et al., 2008).

Lancioni, Olivetti Belardinelli, Chiapparino, et al. (2008) and Lancioni, Singh, et al. (2007) and Lancioni et al. (2009) used the aforementioned technology-based learning setup with five participants