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Research report

Meta-analysis of social cognition in amyotrophic lateral sclerosis

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ABSTRACT

Amyotrophic lateral sclerosis (ALS) is associated with executive dysfunction and behavioural impairment. Recent studies suggested that social cognitive deficits might also be a prominent feature of ALS. Current meta-analysis aimed to summarize available evidence for deficits in social cognition including theory of mind (ToM) and emotion recognition in ALS. In this meta-analysis of 15 studies, facial emotion recognition and ToM performances of 389 patients with ALS and 471 healthy controls were compared. ALS was associated with significant impairments with medium effect sizes in ToM (d = .65) and facial emotion recognition (d = .69). Among individual emotions recognition of disgust and surprise were particularly impaired. Deficits in perspective taking (d = .73) aspects of ToM (ToM-PT) was more pronounced in comparison to decoding (d = .28) aspects of ToM (ToM-decoding). The severity of social cognitive impairment was similar to level of executive dysfunction and there was a significant relationship between social cognition and executive dysfunction. Deficits in social cognition are part of the cognitive phenotype of ALS.

1. Introduction

Amyotrophic lateral sclerosis (ALS) is a neurodegenerative disease that primarily affects lower motor neurons in the brainstem and spinal cord, and the upper motor neurons in the motor cortex. ALS had long been conceptualized as a degenerative disorder with isolated motor neuron involvement. However, research over the last few decades suggested that ALS is not a homogenous disease and can affect other neural systems such as basal ganglia, anterior cingulate cortex (ACC) and frontotemporal regions leading to non-motor symptoms (Shen et al., 2016; Swinnen & Robberecht, 2014). Subtle cognitive impairment is a relatively common (30–50%) feature of ALS and a minority of patients with ALS (5–15%) also met criteria for frontotemporal dementia (FTD) (Cui et al., 2015; Montuschi et al., 2015; Murphy et al., 2016; Phukan et al., 2012; Ringholz et al., 2005). A meta-analysis of cognitive deficits found medium effect sizes for executive functions, fluency, language and memory in ALS (Beeldman et al., 2016). Many non-demented patients with ALS have also behavioural impairment (Mioshi et al., 2014; Murphy et al., 2007, 2016; Strong et al., 2009). It has been argued that the non-motor cognitive manifestations of ALS can be considered to reflect a heterogeneous group of 'frontotemporal dysfunction syndromes' that include cognitive impairment (involving a dysexecutive syndrome) (ALSci),

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behavioural impairment (ALSbi) and, in a small proportion, FTD (ALS-FTD) (Strong et al., 2009).

Social cognitive impairment, in addition to dysexecutive syndrome, is one of the hallmark features of frontotemporal dysfunction syndromes (Bertoux, O'Callaghan, Dubois, & Hornberger, 2016; Bora, Velakoulis, & Walterfang, 2016; Bora, Walterfang, & Velakoulis, 2015). Therefore, it might be expected that deficits in social cognition can be a feature of ALS. The recognition of affect from perceptual cues and theory of mind (ToM), the ability to attribute mental states (feelings, beliefs, intentions, and desires) to others and understand and predict others' behaviour based on their mental states, are the most commonly studied domains of social cognition. ToM is a heterogeneous construct including abilities to infer others' mental states perspective taking (ToM-PT) or decoding (ToM-decoding) based on emotional/perceptual cues to infer others' thoughts, beliefs, emotions (Bora & Köse, 2016; Sabbagh, 2004; Sabbagh, Moulson, & Harkness, 2004). A review of studies investigating emotion recognition abilities suggested that results of the studies were mixed but recognition of anger, sadness and disgust might be impaired in ALS (Sedda, 2014). Recently, a number of studies have also investigated ToM in ALS (Burke et al., 2016; Watermeyer et al., 2015). The outcomes of these studies were inconsistent, especially for ToM-decoding. A number of studies have not found significant differences between ALS and control groups in ToM-decoding tasks (Cavallo et al., 2011; Watermeyer et al., 2015). The findings of these studies were also inconsistent regarding whether impaired performance in ToM-PT in ALS reflects specific deficits in social cognition or general cognitive deficits (Cavallo et al., 2011; Gibbons et al., 2007). Currently, it is not known whether recognition of some emotions or different aspects of ToM are differentially impaired in ALS. The severity of social cognitive impairment in comparison to other neuropsychological deficits in ALS is also unclear.

Some of the inconsistent findings of studies investigating social cognition in ALS might be related to low statistical power of individuals studies as most of the available studies have small sample sizes. A meta-analysis can be helpful to increase statistical power and estimate the effect size for different aspects of social cognitive deficits in ALS. There has been only one attempt to summarize social cognitive deficits in ALS using meta-analytical methods, the meta-analysis of Beeldman et al. (2016) included a preliminary analysis of a small number of studies ($k = 5$) including social cognitive measures. Also, the social cognition measure in the meta-analysis of Beeldman et al. (2016) included a combination of facial emotion recognition, prosody and ToM. The primary goal of this meta-analysis was to quantify the magnitude of social cognitive deficits, to examine if some aspects of emotion recognition and ToM are relatively more impaired in ALS than others, and to explore the relationship between social cognitive impairment and other variables in ALS.

2. Methods

2.1. Study selection

We followed PRISMA guidelines in conducting this meta-analysis (Moher, Liberati, Tetzlaff, Altman, & Group PRISMA, 2009). A literature search was conducted using the databases Pubmed, PsycINFO, ProQuest and Scopus to identify the relevant studies (January 1990–July 2016) using the combination of keywords as follows: (ToM or emotion recognition or social cognition) and "amyotrophic lateral sclerosis". Reference lists of published reports were also reviewed for additional studies. Inclusion criteria were studies that: (1) Compared ToM or facial emotion recognition performances of nondemented ALS and healthy controls; (2) reported sufficient data to calculate the effect size and standard error of the social cognition measure. Studies investigating emotion recognition abilities with methods other than facial recognition were excluded as only a few studies investigated ALS using such methods (i.e., vocal). Two studies were excluded as they included a mixed sample of patients with and without dementia (Table 1s in supplement). Savage et al. (2014) included pure ALS and FTD-ALS groups, FTD-ALS sample of this study was excluded from the current meta-analysis.

2.2. Social cognition measures

Studies have investigated facial emotion recognition with a variety of methods (different sets of images of faces to label: most commonly Ekman) (Ekman & Friesen, 1976). Different ToM tasks have been utilized across studies, most commonly Reading the Mind in the Eyes Task (RMET); other tasks have included faux pas recognition (the task involves recognizing faux pas in series of short stories), judgement of preference test (JPT), Happe cartoons and stories, and The Awareness of Social Inference Test (TASIT) sarcasm (Baron-Cohen, Campbell, Karmiloff-Smith, Grant, & Walker, 1995; Baron-Cohen, Wheelwright, Hill, Raste, & Plumb, 2001). In RMET, individuals are instructed to look at a series of photographs of just the eye region of the face, and picking which of four words best describe what the person in the photo is thinking or feeling. RMET was the only measure for ToM-decoding (Baron-Cohen et al., 2001; Sabbagh et al., 2004). All other ToM tasks were measuring ToM-PT (also called mental state reasoning (Sabbagh, 2004)).

2.3. Statistical analyses

For studies that reported more than one ToM task, pooled effect sizes (Cohen *d*) and standard error values were calculated. A pooled effect size of social cognition based on ToM and/or total emotion recognition score was calculated for each study. Individual tasks analyses for RMET (ToM-decoding) were also possible. A pooled effect size of ToM-PT was also calculated by averaging effect size of ToM tasks other than RMET. In addition to the total emotion labelling score, separate effect sizes for six basic emotions (anger, fear, disgust, sadness, happiness, surprise) were also calculated. In 10 studies that co-administered cognitive assessments along with social cognitive tasks, a pooled effect size for executive dysfunction was calculated for each study. As a measure of executive of functions, these studies included one or several of Brixton Spatial Anticipation test, Hayling Sentence completion test, Stroop interference, trail making B test, verbal fluency tests and frontal assessment battery. Five studies reported correlational coefficient for the relationship between