An Actor–Partner Interdependence Model of Acquired Brain Injury Patient Impairments and Caregiver Psychosocial Functioning: A Dyadic-Report, Multinational Study

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Objective: The purpose of this study was to use actor–partner interdependence modeling (APIM) to examine the simultaneous effects of both acquired brain injury (ABI) patient and caregiver ratings of patient impairments on both patient and caregiver ratings of caregiver psychosocial dysfunction. **Method:** A sample of 968 individuals with ABI and their caregivers ($n = 1,936$) from 4 countries completed the European Brain Injury Questionnaire, a measure of ABI impairments and caregiver psychosocial functioning in the context of providing care for the person with ABI. **Results:** An APIM with all adequate or good fit indices found that patient ratings of their own impairments in the domains of social disadaptation and depression were uniquely and positively associated with patient ratings of caregiver psychosocial dysfunction, yet none of the patient ratings of their own impairments were uniquely associated with caregiver ratings of caregiver psychosocial dysfunction. Caregiver ratings of patient impairments across all 3 domains (cognition, social disadaptation, and depression) were uniquely and positively associated with caregiver ratings of caregiver psychosocial dysfunction. Yet only caregiver ratings of patient social disadaptation were uniquely and positively associated with patient ratings of caregiver psychosocial dysfunction. **Conclusions:** These findings suggest that caregivers' views of ABI patients' impairments are likely much more associated with caregiver psychosocial functioning than are patients' views of their own impairments, pointing to caregivers' interpretations of their patients' impairments as a primary target for cognitive behavioral interventions. © 2016 Wiley Periodicals, Inc. J. Clin. Psychol. 00:1–15, 2016.

Introduction

Acquired brain injury (ABI) results from damage to the brain caused by strokes, tumors, anoxia, hypoxia, toxins, and/or other conditions after birth (Ontario Brain Injury Association, n.d.). ABI can result in cognitive, physical, emotional, or behavioral impairments that could lead to

serious permanent or temporary changes in functioning (Anderson & Catroppa, 2006). There is a growing public awareness of deficits in long-term service provision for people disabled by ABI. It represents a major health burden in Western countries, with an annual incidence of up to 1.7 million traumatic brain injuries in the United States alone (Faul, Xu, Wald, & Coronado, 2010). When the brain is injured, a person's life can be negatively affected, often requiring major life adjustments around the individual's condition; making those adjustments is critical for recovery and rehabilitation (Lundqvist, Grundström, Samuelsson, & Rönnberg, 2010; Ragnarsson et al., 1999).

Given these short- and long-term consequences, individuals sustaining an ABI are often unable to lead an independent life. This lack of autonomy requires a certain level of caregiving, a responsibility typically assumed by family members. The caregiving role involves aiding the individual with ABI in daily functioning. Almost 50% of primary caregivers in families with an individual who has suffered a traumatic brain injury report dedicating at least 5 hours a week to his or her needs (Doser & Norup, 2014). As family members become caregivers, they can experience frustration due to decreased personal time (Arango-Lasprilla et al., 2010) and the difficulties associated with daily management of the behavioral issues, physical disabilities, and cognitive deficits present in the individual with ABI (Grant, Glandon, Elliott, Giger, & Weaver, 2004; Saban, Hogan, Hogan, & Pape, 2014). Moreover, family members are often unprepared and/or inexperienced in the caregiving role.

Caregivers of persons with ABI may experience stress, depression, anxiety, poorer communication, and social isolation (Gordon et al., 2006). These adverse effects on caregiver psychosocial functioning have been associated with two main categories of ABI symptoms. The first includes behavioral, emotional, and personality changes (Brooks, Campsie, Symington, & Beattie, 1987; Ergh, Rapport, Coleman, & Hanks, 2002; Marsh, Kersel, Havill, & Sleigh, 2002). Irritability, aggression, anger outbursts, depression, egocentricity, and infantilism are examples of these symptoms. The second includes cognitive impairments, primarily memory, information processing, and executive disorders (Winstanley, Simpson, Tate, & Myles, 2006). ABI's cognitive, emotional, and behavioral problems play a large role in the level of distress experienced by caregivers (Marsh et al., 2002). Although these ABI chronic symptoms constitute a source of daily hassles, the distress of caregivers might not be due to the direct effect of neurobehavioral impairments, as shown by the lack of associations between neuropsychological impairment and family functioning (Gan, Campbell, Gemeinhardt, & McFadden, 2006).

Winstanley and colleagues (2006) found the effect of impairments after ABI on caregivers was mediated by the community participation of person with the injury. Social isolation of the person with ABI plays a role in the experience of subjective burden for primary caregivers (Marsh et al., 2002). Marsh et al. (2002) found that the degree of anxiety and depression in caregivers was stable across the first year after brain damage, but social adjustment worsened. Because many neurobehavioral changes produce inappropriate social behavior, avoidance of social situations by caregivers causes isolation for patients as well.

ABI is considered a stressor that changes caregiver psychosocial functioning (Perlesz, Kinsella, & Crowe, 2000). Higher distress and lower life satisfaction of caregivers are associated with low long-term functional outcomes of persons with ABI, even after accounting for injury severity and cognitive functioning of care recipients (Vangel, Rapport, & Hanks, 2011). As the person with ABI and his or her caregiver belong to the same family system, both are influenced and influential agents (Vangel et al., 2011). Because relationships between neurobehavioral symptoms and caregiver psychosocial functioning are not unidirectional, it is necessary to address the combined effects of the dyad. However, few studies provide explanatory models of the influence that people with ABI and their caregivers exert on one another (Lehan, Arango-Lasprilla, de los Reyes Aragón, Quijano, & Godwin, 2012).

Caregiver psychosocial functioning is associated with caregiver appraisal (Chronister & Chan, 2006; Marsh et al., 2002) and patient self-awareness (Gan et al., 2006; Hickey, O'Boyle, McGee, & McDonald, 1997; Wells, Dywan, & Dumas, 2005). Therefore, caregivers' self-reports might be influenced by caregivers' mental status and cognitive appraisal of patient impairments. Conversely, patients' lack of awareness of their own difficulties may mask the possible correlation

with poor psychosocial functioning of the caregiver. Neurobehavioral predictors of caregiver dysfunction could be better determined by taking into account simultaneously the perception of injured person status and their effects on caregiver functioning by both agents.

Very little research has collected data from both ABI patients and caregivers simultaneously and tried to determine which member of the dyad's ratings are more predictive of which outcomes. Such an approach would simultaneously reduce and highlight potential problems that can emerge with common method bias (CMB), whereby spurious—or overinflated—connections between variables may emerge because one participant is providing information about multiple constructs (in this case about ABI patient impairments and about caregiver psychosocial functioning). Actor–partner interdependence modeling (APIM; Cook & Kenny, 2005) is a unique statistical approach that minimizes CMB when data are collected from two members of a dyad and looks at which member's ratings are more predictive of outcomes. Actor and partner effects can differ in their susceptibility to CMB; only by using self-reports and other-reports, as in the present study, can CMB be reduced (Orth, 2013). As a result, the purpose of the current study was to use APIM to examine the simultaneous effects of both patient and caregiver ratings of patient impairments on both patient and caregiver ratings of caregiver psychosocial dysfunction.

Method

Participants

Participants were 968 dyads of individuals with ABI and their family caregivers. The dyads came from four different European countries: Denmark ($n = 485$ dyads), Spain ($n = 66$), France ($n = 151$), and United Kingdom ($n = 266$). All ABI participants had a moderate or severe ABI documented by an initial Glasgow Coma Scale score less than 13; posttraumatic amnesia greater than 24 hours; or a period of unconsciousness longer than 6 hours. Half of the participants had a traumatic brain injury, about 40% had a stroke, and the remainders had other nontraumatic brain injuries. The majority of the individuals with ABI were male (64.3%); the mean age was 38.4 ($SD = 14.9$). The mean number of months between the ABI and the follow-up assessment was 26.3 months ($SD = 37.4$). Most dyads were parent–child or spousal dyads, and although family members did not have to be primary caregivers necessarily, they all provided some level of informal care to the individuals with ABI.

Procedure

Participants were recruited from rehabilitation hospitals and centers, and all centers were public facilities and referral centers providing rehabilitation after ABI. For the current study, four separate samples were combined into a database from previous data collections. The U.K. sample was recruited from 1996 to 2011 at Oliver Zangwill Centre, and the Spanish sample was recruited from 2002 to 2011 at Virgen de las Nieves Hospital. In both cases, the samples were from consecutive referrals, with both forms of the questionnaire answered by the patient–caregiver dyad, and all met inclusion criteria for a previous study (Caracuel, Bateman, Teasdale, Verdejo-García, & Pérez-García, 2011). To form the French sample, patients without language problems were selected in 1994–1995 among a large sample of 465 dyads recruited for previous studies (Deloche, Dellatolas, & Christensen, 2000). The Danish sample was recruited from the Clinic og Neurorehabilitation, TBI unit, Rigshospitalet, and the Center for Brain Injury Rehabilitation, where the questionnaire was used as a standard assessment in rehabilitation between the years 1996 and 2008. All participants had given informed consent to use their data for research purposes under ethics committee approval at each site.

It should be noted that the different countries followed a somewhat different protocol with regard to participants receiving assistance in completing the questionnaire if needed. In the United Kingdom, if help was needed with regard to reading, concentration, or writing, a staff member was nearby. In Denmark, participants were able to complete the measures on their own, but they also had the option of having the questionnaire mailed to them if they preferred. In Spain, all participants completed the questionnaire on their own in the presence of

a clinician who was on call to clarify any questions. Finally, in France, caregivers completed the questionnaire on their own, but patients did so with the assistance of a clinician to ensure understanding.

Measures

Demographic data were collected about gender, age, etiology, and time since injury as a standard part of rehabilitation.

The European Brain Injury Questionnaire (EBIQ). The EBIQ is a 63-item self-report and relative-report measure of the subjective experience of cognitive, emotional, and social difficulties experienced by people with brain injury (Teasdale et al., 1997). Patients completed the "self" form of the questionnaire, in which they were asked to indicate how much they had experienced any of the problems in question within the last month. Participants rated each of the items on a 3-point Likert-type scale ranging from 1 (*not at all*) to 3 (*a lot*). At the same time, close relatives were asked to complete the "carer" form of the questionnaire, in which they provided their perceptions of the person with brain injury.

Both "self" and "carer" forms of the EBIQ contain the same items, just phrased differently to be patient- or caregiver-report, and therefore all subscales calculated across the two forms in the current study were the same and tapped the same construct from either the patient or caregiver point of view. At the end of both versions of the questionnaire, participants responded (using "not at all," "a little," or "a lot") to three questions about their views on the psychosocial consequences (psychosocial dysfunction) of the ABI on the family member or caregiver (Teasdale et al., 1997). These three items assess whether the caregiver's life has changed after the injury, whether the caregiver is having problems due to the injury, and whether the caregiver's mood has changed due to the injury.

All factor analyses on the patient and the family EBIQ forms agree on the existence of three subscales indexing Cognition (13 items), Depression (10 items), and Social Disadaptation (11 items) symptoms (Bateman, Teasdale, & Willmes, 2009; Björkdahl, Lundgren Nilsson, & Stibrant Sunnerhagen, 2004; Caracuel et al., 2011; Deloche et al., 2000). EBIQ versions were designed in the original study of the questionnaire, conducted by an international team of researchers who especially avoided questions with specific cultural content and expressions that might be difficult to adapt from one culture to another (Teasdale et al., 1997). However, because Rasch analysis can detect even the slightest cultural differences, differential item functioning has been shown in seven items among the U.K., French, and Spanish versions (Caracuel et al., 2011). This differential item functioning has not been taken into account in the current study because the goal was to detect relationships between the responses of the patient–caregiver dyads belonging to the same country.

Generally speaking, the EBIQ has been shown to be a clinically reliable measure to determine the subjective well-being of people with brain injury and to assess change of subjective concerns over time (Sopena, Dewar, Nannery, Teasdale, & Wilson, 2007).

Statistical Analyses

A correlation matrix was calculated among all primary predictor and outcome variables in the current study, and the sample was characterized according to degree of patient impairment. Then an APIM, using structural equation modeling (SEM) techniques and fit calculations, was conducted with AMOS 22. The purpose of an SEM is to test the fit of a hypothesized pattern of relationships among observed (manifest) variables and hidden (latent) variables. In particular, an APIM is used for dyadic data (in this case, data from ABI patients and caregivers) in which both members of the dyad complete the same measures. In the current study, both ABI patients and caregivers completed the EBIQ, which assessed patient impairments and caregiver psychosocial dysfunction relative to those impairments.

In comparison to nondyadic analyses, APIM allowed us to examine the simultaneous effects of both patient and caregiver ratings of patient impairments on both patient and caregiver
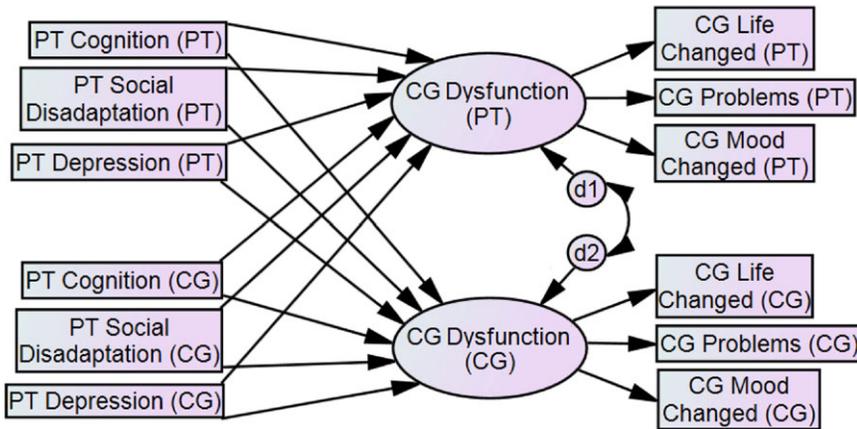
Figure 1. Actor-partner interdependence model without loadings.
Note. PT = patient; CG = caregiver; (PT) = patient-report; (CG) = caregiver-report; d1–2 = disturbance term 1–2.

ratings of caregiver psychosocial dysfunction. It is worth noting that the traditional purpose of an APIM is to model relationships among variables across a dyad when those variables tap the same construct differentially for the two members of the dyad (e.g., each partner in a romantic relationship may have differing levels of relationship satisfaction).

The current approach extends the traditional purpose now to simultaneously reduce and highlight potential problems that can emerge with common method bias in ABI caregiving research when caregivers report only their own psychosocial dysfunction, a construct that can be profoundly influenced by their own view of the patient's impairments.

An APIM using SEM with latent variables was chosen over one with only manifest variables or simple bivariate correlations for the following reasons: (a) An SEM calculates latent variables that are more accurate indices of constructs and contain less measurement error; (b) an SEM allows us to create a comprehensive and simultaneous assessment of the associations of patients' and caregivers' ratings of patient impairments with caregiver psychosocial dysfunction; and (c) an SEM provides fit indices for the overall model, indexing how well the data fit the model. The manifest predictor variables in the APIM, pictured in boxes on the left side of Figure 1, are patients' and caregivers' three subscale scores for their ratings of patient impairments on the EBIQ (cognition, social disadaptation, and depression).

On the far right side of the figure are patients' and caregivers' scores on the three items assessing their ratings of caregiver psychosocial dysfunction on the EBIQ. These three items were specified as manifest variables, pictured in boxes, to load onto the two latent factors, pictured in ovals, of patient- and caregiver-reported caregiver psychosocial dysfunction. The patient impairment subscales were treated as three separate manifest variables to construct a regression-based path analysis to determine which specific aspects of patient impairments uniquely predicted caregiver psychosocial dysfunction, especially in terms of cross-dyad prediction. Caregiver psychosocial dysfunction was treated as a single latent variable to have a more accurate and holistic indicator of the construct, as well as contributing to parsimony in the model.

Before running the structural model pictured in Figure 1, a measurement model was run to independently assess the fit of the latent constructs in the model before adding the structural components. The measurement model therefore included only the two correlated latent variables of patient-reported and caregiver-reported caregiver psychosocial dysfunction, which were each calculated from their respective manifest variables of the three items assessing caregiver psychosocial dysfunction on the EBIQ.

In the structural model, uniqueness terms were calculated for all endogenous manifest variables in the model and correlations were specified between all predictors on the left side of the model so that the predictors would not be forced to be orthogonal; for simplicity, these

uniqueness terms and correlations were left off of Figure 1. However, the disturbance terms (d1-2) on the two latent variables are shown and were allowed to correlate. Full information maximum likelihood estimation (FIML) was used for missing data; FIML uses all available data for parameter estimation rather than using listwise deletion of each case with missing data.

The following criteria were used to assess goodness of fit in the structural equation models (Kenny, 2014). The normed fit index (NFI), incremental fit index (IFI), and Tucker-Lewis index (TLI) are relative fit indices, such that they compare the chi-square for the tested model to that from the null model, which specifies that the measured variables are orthogonal. We used a conventional cutoff of .90 for establishing adequate fit (Byrne, 1994; Hu & Bentler, 1999).

Some authors have argued that a chi-square to degrees of freedom ratio lower than 2.0 is an index of good fit (Tabachnick & Fidell, 2001), but this ratio is influenced by sample size, and as a result other authors have therefore recommended using 5.0 as a cutoff (Wheaton, Muthen, Alwin, & Summers, 1977). Because of the large sample size in the current study, the more liberal 5.0 cutoff was used.

Other indices used to assess fit included a comparative fit index (CFI; Bentler, 1990) greater than .90 (ideally greater than .95; Hu & Bentler, 1999) and a root mean squared error of approximation (RMSEA) of .10 or lower (RMSEA uses errors of prediction and measurement to assess the match between hypothesized and "true" models; Meyers, Gamst, & Guarino, 2013).

A series of exploratory analyses were performed including paired samples *t*-tests to examine whether there were significant differences in patient and caregiver ratings on the various constructs. And finally, to obtain a more comprehensive estimate of the effects of patient and caregiver ratings on caregiver psychosocial dysfunction, a single second-order "caregiver [CG] dysfunction" factor was calculated from the first-order factors of patient and caregiver ratings of caregiver psychosocial dysfunction. An SEM was used to examine whether patient or caregiver ratings of patient impairments were stronger predictors of this latent composite. The same fit index cutoffs listed above were used to determine fit.

Results

Correlation Matrix and Descriptives

In the correlation matrix (Table 1), all patient ratings of patient impairments were positively correlated with each other ($rs = .560–.677$), as were all caregiver ratings of patient impairments ($rs = .464–.523$). Similarly, all patient ratings of caregiver psychosocial dysfunction were positively associated ($rs = .261–.538$), as were all caregiver ratings of caregiver psychosocial dysfunction ($rs = .461–.515$). Generally, patients' and caregivers' ratings of patient impairments were in agreement ($rs = .332–.632$), and so were their ratings of caregiver psychosocial dysfunction ($rs = .136–.431$), although somewhat less so. The correlation between caregiver ratings of patient impairments and patient ratings of caregiver psychosocial dysfunction was higher ($rs = .234–.359$) than the correlation between patient ratings of patient impairments and caregiver ratings of caregiver psychosocial dysfunction ($rs = .090–.241$), and some in the latter group of correlations were not statistically significant.

Means and standard deviations published by Teasdale et al. (1997) were applied to estimate the degree of patient impairment based on caregiver ratings (also see Table 1). According to the cutoff scheme established by Heaton, Grant, and Matthews (1991), caregivers rated that 63.8% of patients had cognitive impairment (16.7% mild, 22.7% moderate, and 24.4% severe), 50.2% depression symptoms (22.4% mild, 12.2% moderate, and 15.6% severe), and 32.9% problems in the social area (20.1% mild, 10.3% moderate, and 2.5% severe).

Measurement Model

The initial measurement model was meant to assess the fit of the latent constructs in the model before adding the structural components. In the measurement model, the two latent variables of patient-reported and caregiver-reported caregiver psychosocial dysfunction were significantly correlated, $r = .61$, $p < .001$. All manifest variables of the three items assessing caregiver

Table 1
Correlations, Means (M), Standard Deviations (SD), and Cronbach's Alphas

Variable	1	2	3	4	5	6	7	8	9	10	11	M	SD	α
1. PT Cognition (PT)												23.36	5.69	.83
2. PT Depression (PT)	.677											16.99	4.89	.85
3. PT Social Disadaptation (PT)	.566	.560										19.17	4.93	.83
4. PT Cognition (CG)	.581	.448	.332									24.19	5.97	.84
5. PT Depression (CG)	.445	.632	.371	.642								17.21	5.16	.87
6. PT Social Disadaptation (CG)	.354	.354	.602	.464	.523							20.09	5.41	.86
7. CG Life Changed (PT)	.259	.266	.253	.261	.234	.247						2.09	.73	—
8. CG Problems (PT)	.284	.340	.359	.258	.296	.359	.538					2.03	.75	—
9. CG Mood Changed (PT)	.303	.330	.321	.240	.274	.303	.261	.280				1.69	.75	—
10. CG Life Changed (CG)	.182	.183	.090	.402	.380	.265	.431	.270	.136			2.07	.76	—
11. CG Problems (CG)	.213	.241	.209	.378	.398	.368	.334	.418	.185	.515		2.11	.74	—
12. CG Mood Changed (CG)	.098	.115	.223	.262	.377	.397	.233	.285	.386	.462	.461	1.97	.78	—

Note. PT = patient; CG = caregiver; (PT) = patient-report; (CG) = caregiver-report. Due to the large sample size, statistical significance in the table was not flagged. However, for reference, all correlation coefficients above.120 were significant at *p* < .05. Cronbach's alpha coefficients are not reported for the caregiver variables because each is comprised of only one item.
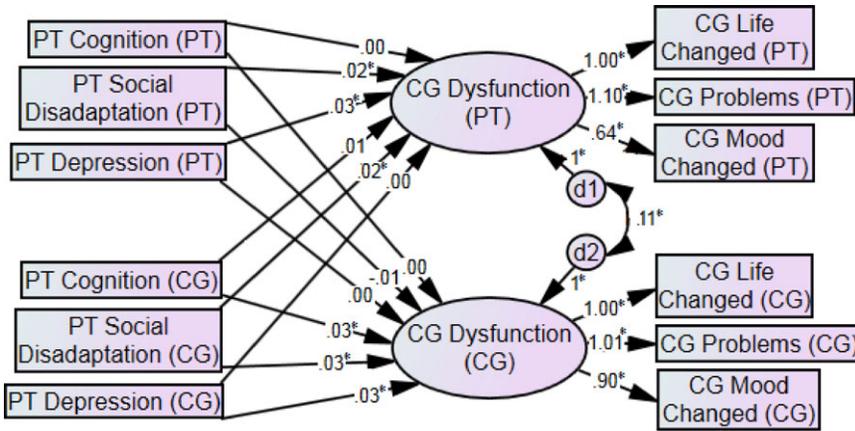
Figure 2. Actor-partner interdependence model with unstandardized path loadings.
Note. * = $p < .01$; PT = patient; CG = caregiver; (PT) = patient-report; (CG) = caregiver-report; d1–2 = disturbance terms 1–2.

psychosocial dysfunction on the EBIQ loaded significantly (all $ps < .001$) onto their respective latent constructs. The χ^2 goodness-of-fit test was statistically significant, $\chi^2 (8) = 22.83$, $p = .004$, but the ratio of the χ^2 statistic to the degrees of freedom in the model was below the cutoff of 5.0 for establishing adequate fit.

The NFI, IFI, TLI, and CFI were .95, .96, .90, and .96, respectively, where values of .90 or higher indicate adequate or good fit. The root mean square error of approximation (RMSEA) was .09, where an RMSEA of .10 or lower indicates a reasonable error of approximation and adequate fit. Overall, these goodness-of-fit indices suggested that the measurement fit adequately or well with the data, and that running a structural model was appropriate as a next step.

APIM Unstandardized Path Loadings and Correlations

The structural APIM with unstandardized path loadings appears in Figure 2 (uniqueness terms and correlations among manifest predictors are not shown). Additionally, for reference Table 2 presents all unstandardized path loadings, along with their standard errors, extended to three numbers after the decimal. All manifest variables specified to load onto a latent factor (patient and caregiver ratings of caregiver psychosocial dysfunction) had statistically significant standardized path loadings (all $ps < .001$). The correlation between the disturbance terms (d1-2) was statistically significant, suggesting that the latent factors indexing patient and caregiver ratings of caregiver psychosocial dysfunction were positively correlated.

Patient ratings of their own impairments in the domains of social disadaptation and depression were uniquely and positively associated with patient ratings of caregiver psychosocial dysfunction, yet none of the patient ratings of their own impairments were uniquely associated with caregiver ratings of caregiver psychosocial dysfunction. This suggests strong actor effects of patient ratings of patient impairments on patient ratings of caregiver psychosocial dysfunction, but no partner effects of patient ratings of patient impairments on caregiver ratings of caregiver psychosocial dysfunction.

Conversely in the APIM, caregiver ratings of patient impairments across all three domains (cognition, social disadaptation, and depression) were uniquely and positively associated with caregiver ratings of caregiver psychosocial dysfunction. However, only caregiver ratings of patient social disadaptation were uniquely and positively associated with patient ratings of caregiver psychosocial dysfunction. Similarly, this suggests strong actor effects of caregiver ratings of patient impairments on caregiver ratings of caregiver psychosocial dysfunction, but limited partner effects of caregiver ratings of patient impairments on patient ratings of caregiver psychosocial dysfunction.

Table 2
Unstandardized Path Loadings and Standard Errors (SEs)

Predictor	Criterion	Path Loading	SE
Actor-partner interdependence model			
PT Cognition (PT)	CG Dysfunction (CG)	−.002	.006
PT Social Disadaptation (PT)	CG Dysfunction (CG)	−.009	.007
PT Depression (PT)	CG Dysfunction (CG)	−.001	.008
PT Cognition (PT)	CG Dysfunction (PT)	.004	.006
PT Social Disadaptation (PT)	CG Dysfunction (PT)	.017	.007
PT Depression (PT)	CG Dysfunction (PT)	.030	.008
PT Cognition (CG)	CG Dysfunction (PT)	.008	.005
PT Social Disadaptation (CG)	CG Dysfunction (PT)	.024	.006
PT Depression (CG)	CG Dysfunction (PT)	−.001	.007
PT Cognition (CG)	CG Dysfunction (CG)	.027	.006
PT Social Disadaptation (CG)	CG Dysfunction (CG)	.026	.006
PT Depression (CG)	CG Dysfunction (CG)	.034	.007
CG Dysfunction (CG)	CG Mood Changed (CG)	.896	.091
CG Dysfunction (CG)	CG Life Changed (CG)	1.000	–
CG Dysfunction (CG)	CG Problems (CG)	1.011	.073
CG Dysfunction (PT)	CG Mood Changed (PT)	.638	.073
CG Dysfunction (PT)	CG Life Changed (PT)	1.000	–
CG Dysfunction (PT)	CG Problems (PT)	1.096	.080
Exploratory Model			
PT Cognition (PT)	CG Dysfunction	.000	.004
PT Depression (CG)	CG Dysfunction	.019	.005
PT Social Disadaptation (CG)	CG Dysfunction	.022	.005
PT Cognition (CG)	CG Dysfunction	.017	.004
PT Social Disadaptation (PT)	CG Dysfunction	.000	.005
PT Depression (PT)	CG Dysfunction	.009	.006
CG Dysfunction	CG Dysfunction (PT)	1.000	–
CG Dysfunction	CG Dysfunction (CG)	1.205	.141
CG Dysfunction (CG)	CG Mood Changed (CG)	.926	.097
CG Dysfunction (CG)	CG Life Changed (CG)	1.000	–
CG Dysfunction (CG)	CG Problems (CG)	1.076	.081
CG Dysfunction (PT)	CG Mood Changed (PT)	.586	.073
CG Dysfunction (PT)	CG Life Changed (PT)	1.000	–
CG Dysfunction (PT)	CG Problems (PT)	1.074	.085

Note. PT = patient; CG = caregiver; (PT) = patient-report; (CG) = caregiver-report.

APIM Fit Indices

The χ^2 goodness-of-fit test was statistically significant, $\chi^2(32) = 145.69$, $p < .001$, but the ratio of the χ^2 statistic to the degrees of freedom in the model was 4.55 and below the liberal critical ratio cutoff of 5.0. The NFI, IFI, TLI, and CFI were .97, .97, .93, and .97, respectively. Similarly, the RMSEA was .061. Overall, these goodness-of-fit indices suggest that the structural APIM fit adequately or well with the data.

Exploratory Analyses

Six paired-samples *t*-tests were conducted to determine whether patients and caregivers reported differing levels of the three aspects of patient impairments and the three aspects of caregiver psychosocial dysfunction (means and standard deviations presented in Table 1). These comparisons suggested that caregivers rated patients higher (i.e., having more impairment) on the cognition ($p < .001$; Cohen's $d = .14$) and social disadaptation ($p < .001$; Cohen's $d = .18$) subscales. Similarly, caregivers rated themselves higher (i.e., having more psychosocial dysfunction) on the
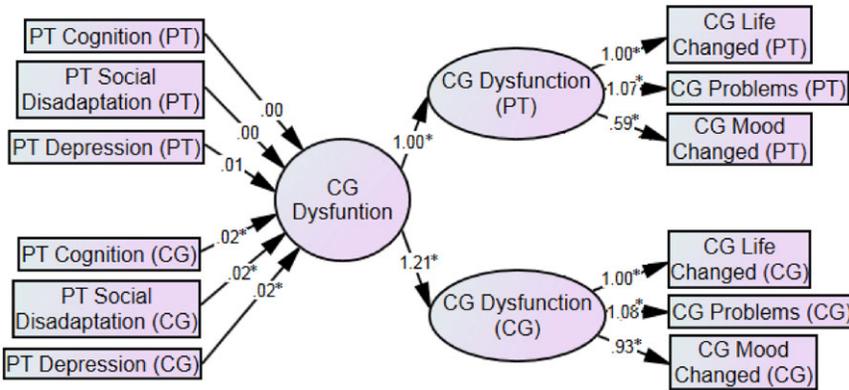
Figure 3. Exploratory model with unstandardized path loadings.
Note. * = $p < .01$; PT = patient; CG = caregiver; (PT) = patient-report; (CG) = caregiver-report.

problems ($p = .003$; Cohen's $d = .13$) and mood changed ($p = .001$; Cohen's $d = .24$) items. It should be noted that only the final comparison for mood changed reached a Cohen's d threshold of a small-sized effect ($d \geq .20$).

The final SEM that calculated a single second-order "CG dysfunction" factor from the first-order factors of patient and caregiver ratings of caregiver dysfunction, with unstandardized path estimates, is pictured in Figure 3. (Again, additionally see Table 2 for all unstandardized path loadings, along with their standard errors, extended to three numbers after the decimal.) This SEM examined in an exploratory fashion whether patient or caregiver ratings of patient impairments were stronger predictors of this latent composite of caregiver dysfunction. As before, all manifest variables loading onto a latent factor had statistically significant standardized path loadings, as did the two latent factors loading onto the second-order factor of caregiver psychosocial dysfunction (all $ps < .001$). None of the patient ratings of their own impairments was uniquely associated with the latent composite of caregiver dysfunction (all $ps \geq .142$); however, all three caregiver ratings of patient impairments were uniquely and positively associated with caregiver dysfunction (all $ps < .001$).

The χ^2 goodness-of-fit test was again statistically significant, χ^2 (37) = 226.74, $p < .001$, and the ratio of χ^2 to degrees of freedom was 6.13 and above even the liberal critical ratio cutoff of 5.0. The NFI, IFI, TLI, and CFI were .95, .96, .90, and .95, respectively. The RMSEA was .073. These goodness-of-fit indices, though generally in the adequate range, were slightly worse than those in the original structural model, suggesting the retention of that model over the exploratory one.

Discussion

The purpose of the current study was to use APIM to examine the simultaneous effects of both ABI patient and caregiver ratings of patient impairments on both patient and caregiver ratings of caregiver psychosocial dysfunction. The study's findings generally suggested that caregivers' beliefs about ABI patients' impairments are much more likely associated with caregiver psychosocial functioning than are patients' beliefs about their own impairments. The results of this study are novel; no study before has used APIM to investigate the effect of dyadic ratings on caregiver psychosocial function. So far, only a few studies in the literature have looked at the relationship between patients' difficulties and the psychosocial functioning of caregivers using APIM or other models that account for dependence of data, despite the fact that this relationship is of utmost importance in the process of neurorehabilitation.

Most studies have focused on patient-related characteristics, such as level of function and consciousness (Norup, Petersen, & Mortensen, 2015), neurobehavioral difficulties (Ergh et al., 2002), cognitive problems (Ponsford, Olver, Ponsford, & Nelms, 2003), and personality changes

(Norup & Mortensen, 2015), and have assessed how these influence the emotional well-being of caregivers. These studies have illuminated how the characteristics of patients affect the emotional well-being or psychosocial functioning of caregivers, a highly important topic as caregivers fulfill a critical and irreplaceable role.

Another category of studies has used different assessment methods such as the EBIQ, in which both the individual with the brain injury and their caregiver provide information about the perceived difficulties. These studies have looked at the concordance or discrepancy between patient and caregiver ratings. In the current study, patients and caregiver ratings were positively correlated with each other, indicating a similar perception of patients' impairments. This is in contrast to previous studies that have revealed a discrepancy between patients' and relatives' view of difficulties (Holm, Schonberger, Poulsen, & Caetano, 2009; Teasdale et al., 1997). However, the present study was conducted with a mean time since injury of 26 months, and the time interval since injury is very likely to affect both patients' and relatives' perception of difficulties. As time goes by, patients and caregivers will have experienced the acquired difficulties in everyday life, and not just in a hospital setting. In many cases, individuals with moderate to severe injuries will sometimes not be fully aware of their difficulties, and consequently the report of a significant other is needed to obtain a complete picture of patient difficulties.

The current study also found a lesser extent of agreement in relation to rating of caregiver psychosocial dysfunction. To the authors' knowledge, no other studies have investigated patients' and caregiver's agreement in relation to caregiver psychosocial functioning. But it is very likely that the lower agreement in relation to caregiver psychosocial functioning may in part be caused by patients' lack of insight into the emotional life of others. The patient may be aware of his or her own difficulties, at least to some extent, but may not be receptive for others' emotional life, even close family members. It is well known that individuals with ABI can lack awareness and insight into the effect of their behavior on personal relationships, which consequently will affect caregiver psychosocial well-being (Williams & Wood, 2013). Indeed, the current exploratory analyses found that in comparison to caregivers, patients underestimated their own impairments as well as the psychosocial dysfunction of their caregivers.

As demonstrated above, the level of physical, cognitive, and neurobehavioral impairments is associated with the well-being of caregivers, and this is an increasing topic of interest. But the relationship between the neurobehavioral symptoms and caregivers' psychosocial functioning may be reciprocal, not unidirectional, and consequently it is necessary to address the combined effects of the dyad. But only a few studies have tried to provide explanatory models of the influence that people with ABI and their caregivers exert on one another (Lehan et al., 2012; Stevens et al., 2013), and such models need a complex statistical framework (Norup et al., 2015).

The current study provided such a framework demonstrating how caregivers' view of patients' impairments are likely much more associated with caregiver psychosocial functioning than are patients' own views of their impairments. This emphasizes how caregivers' views of difficulties predict their own psychosocial functioning, and not the patient's views of difficulties. In other words, the actual situation is of importance, but more important is how the situation is handled and interpreted by the caregiver. This has direct implications for future intervention programs in rehabilitation.

Clinical Implications

These findings suggest that caregivers' views about ABI patient impairments are much more likely associated with caregiver psychosocial functioning than are patients' views about their own impairments, pointing to caregivers' interpretations as a primary target for cognitive behavioral interventions. Indeed, when considering the results of the exploratory SEM in the current study, a case could be made that caregiver reports of patient impairments and their own psychosocial dysfunction should be treated as the standard for caregiver evaluation. ABI rehabilitation programs should include interventions to enhance caregiver functioning and outcomes for persons with ABI. "The ability to predict which caregivers will experience adjustment difficulties is crucial to developing effective interventions" (Davis et al., 2009, p. 145). Understanding that caregivers' beliefs are associated with their own functioning can guide the development of

cognitive-behavioral interventions to correct cognitive distortions that they may have about ABI impairments, psychoeducation to inform them about ABI myths, and cognitive restructuring for meaning making (Swift & Wilson, 2001). Rehabilitation programs could also focus on caregivers' coping strategies. Changing maladaptive coping strategies to more functional types will be of benefit to the primary caregiver.

The functioning of caregivers is associated with their ability and willingness to care (Vangel et al., 2011). Informal care systems are critical in reducing long-term disability of people with ABI. Thus, family intervention is a key component to successful rehabilitation to carry out effectively the family-centered interventions being advocated by others (Backhaus, Ibarra, Klyce, Trexler, & Malec, 2010; Dausch & Saliman, 2009; Kreutzer et al., 2009; Stejskal, 2012).

Limitations and Future Directions

The results of the present study should be interpreted with the following caveats, which present directions for future research. First, the study included only four European countries, and the conclusions cannot be generalized to all of Europe or to all global regions. Having participants from four separate countries in the study does beg a question about whether cross-cultural differences were present in participants' EBIQ ratings. But because four separate databases were combined for the current study, there was unfortunately not enough parallel information about ABI patients and their family members to control for the most obvious confounds that would invalidate comparisons and create dubious internal validity for the study. Example confounds include that the data were collected in four unique cultural contexts, in hospitals of different sizes, across different data collection periods, with patients at potentially differing levels of injury severity, with altogether different rehabilitation procedures and resources. So, if exploratory analyses were to find cross-cultural differences, it would be impossible with the current limited data to determine why those differences were present. As a result, cross-cultural comparisons were omitted from the current study, but this would be an extremely ripe area for future research.

Second, the cross-sectional nature of the study does not allow determination of causation. It is not known if the relationships between patient self-perception and caregiver perception of the patient are stable or change over time. Future studies using cross-lagged panel designs would help tease out causation between patient impairments and caregiver psychosocial functioning. Third, many patients with ABI present anosognosia, which was not measured in the present study, and it is possible this factor may be influencing the patient's perception of deficits.

Fourth, it is possible that additional variables that were not measured may be affecting the results, for instance, patient perceived social support; patient functional independence levels, optimism, and resilience; perceived family dynamics, cohesion, and communication; coping skills, including problem solving; and self-esteem, self-confidence, and/or self-efficacy problems. Finally, because all patients in the sample had moderate to severe ABI, these results cannot be extended to patients with less severe injury. Future studies overcoming these limitations and building upon the findings from the current study will be important for interventions aimed at improving the quality of life of individuals with ABI and their caregivers.

Conclusion

The findings of this study demonstrated that caregivers' views of ABI patients' impairments are likely much more associated with caregiver psychosocial functioning than are patients' views of their own impairments, suggesting that caregivers' interpretations of patient impairments may be an important target for cognitive behavioral interventions.

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