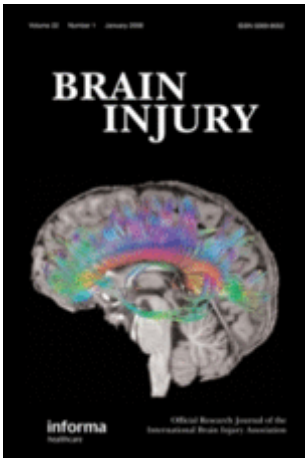

Behavioral Couples Therapy for Brain Injury: Single Case Methodology with Bi-Phasic Design

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ABSTRACT

Objectives: To explore the outcomes of Behavioral Couples Therapy (BCT) for couples with brain injury.

Background: Brain injury can result in communication, emotional and behavioral disturbances, leading to higher levels of depression, anxiety and relationship distress. Currently, no study has explored the outcomes of BCT in couples impacted by brain injury.

***Method*:** Four heterosexual couples living with brain injury were seen at a specialist outpatient service, and attended an average of 13 (range 8 - 25) BCT sessions. Participants with brain injury and their partners completed weekly measures of depression, anxiety, and couple satisfaction throughout baseline, assessment, intervention, and follow-up phases. Data were visually analyzed, and effects examined using reliable change analysis, and between-phase comparison conducted using Tau-U.

Results: Tau-U analysis demonstrated that both the patient and partner groups experienced significant overall improvement in relationship satisfaction and anxiety. Partners also reported significant reduction in depression scores overall. Reliable change analysis indicated improvement for some individual patients and partners, with effects maintained at follow-up in some cases.

***Conclusions*:** The results offer promising results regarding the use of BCT for brain injury in increasing relationship satisfaction and reducing psychological distress. Further investigation is warranted.

Keywords: Behavioral couples therapy, depression, anxiety, brain injury

Introduction

Brain injury is characterized by significant problems with emotional, behavioral and cognitive functions, such as deficits in attention, learning, memory, reasoning, and decision-making. Difficulties in emotional and behavioral functions can lead to rapid and unpredictable mood swings, apathy and impulsivity (1). It is inevitable, therefore, that romantic relationships will be affected for couples living with a brain injury. Increased dependence on partners and a redistribution of roles are typical (2). In studies looking at the impact of brain injury on relationships, poor marital adjustment and greater financial strain have been frequently reported (3, 4). Further challenges to the relationship may include a distancing of previously shared interests, reduced ability to engage in activity together, and sexual issues, amongst others. Difficulties with interpersonal communication post brain injury are common (2).

It is therefore unsurprising that marital dissatisfaction appears to be higher when living with a brain injury condition than for couples with no such condition (5), with estimates of the incidence of marital distress after brain injury ranging from 15-78% (1). Despite this, studies suggest that individuals with brain injury are not at greater risk for divorce, relative to the general population (6). On the contrary, recent findings have found that 66% of married adults who received inpatient rehabilitation for traumatic brain injury remained married to the same individual 10 years later (7). There is limited research, however, on the unique difficulties experienced by couples who stay together, and little support is offered by health services.

Arguello (8) highlights the range of concerns for uninjured spouses in long-term relationships post-traumatic brain injury (TBI). The most common long-term stressors reported by spouses included: cognitive and personality changes related to the brain injury, financial and work concerns, isolation, disconnection from their partner, sex and intimacy concerns, worries about

the future and the responsibilities of the caring role, as well as existential concerns (e.g. “why is this happening to me?”). It is not uncommon to hear statements such as “I just can't relate to my partner anymore”, and “it is like living with a stranger”, as described by Satink et al. (9). Increased levels of stress and burden and reduced emotional well-being, including clinically significant levels of anxiety and depression, have been reported by partners of people with TBI (5). Loss of empathy and sensitivity in the individual with brain injury have been highlighted as factors lowering relationship satisfaction (10). Grief and loss are central to the processes involved in adapting to living with a partner with brain injury. Klonoff (11) suggested that these processes are compounded by the nature of the deficit and the course of recovery. If these issues are not addressed, individuals with brain injury and their partners can experience strain on their relationship.

According to O’Keeffe et al. (3), the research exploring the impact that brain injury has on couple relationships is limited. In their study, they found that in relationships where one partner had a brain injury, there was significant disruption of psychological well-being for both partners. A destabilization of existing relationship dynamics was identified. However, they suggest that brain injury does not inevitably lead to separation or breakdown of relationships. Rather, it was the lack of knowledge about potential changes that negatively impacted relationships and increased levels of psychological distress. O’Keeffe et al. (3) suggest that for some couples, factors such as hope, effort, and knowledge about the impact of brain injury, not just on the brain and the individual, but also on the couple and the family may be therapeutic. Studies have found that the adoption of a problem-solving approach, limited use of avoidance coping strategies and a positive perception of the communication skills of one’s spouse have been associated with positive adjustment and marital satisfaction for individuals with TBI and their spouses (12). Two studies looking at an adapted small group treatment for couples where

one partner has a brain injury found that the couples' dyadic adjustment and communication could be improved. The interventions involved psychoeducation, affect recognition, empathy training, skill building, cognitive-behavioral and dialectical-behavioral strategies, communication skills training, supportive intervention, and Gottman's theoretical framework (13, 14).

Beyond populations with brain injury, in 2018, NHS Digital (15) reported that people who had access to couple therapy as part of mental health provision were more likely to recover from symptoms of depression and anxiety than those who did not. The findings showed a higher recovery rate from depression when the couple was treated (56.1% recovery rate) compared to individual treatment (49.3%). These figures demonstrate the extent to which people's relationships are intertwined with their mental health difficulties and long-term health conditions. NHS Digital (15) recommended that people who are experiencing relationship distress in the context of long-term illness should be able to access couple therapy. There is some evidence that couple therapy can reduce carer burden and address unmet needs unique to the uninjured partner (16). This is in keeping with research findings that emphasize the need for support for partners and families to prevent problems in the long term (4).

Treatment model

For people with brain injury, a learning/behavior theory approach to individual psychological intervention can be beneficial (17-20). Behavioral Couples Therapy (BCT)[1] similarly draws upon learning theory, namely the reinforcement principles of operant conditioning (21), as well as social exchange theory (22). Operant conditioning principles suggest that partners will be

[1] "Behavioral Couples Therapy (BCT), termed Cognitive Behavioral Couple Therapy in the USA"

more likely to behave in positive ways towards each other if they receive positive consequences from each other for those actions (23). In line with social exchange theory, Stuart (24) suggests that successful marriages are distinguished from unsuccessful marriages in the rate and frequency of positive reinforcements exchanged by the partners. A scarcity of positive outcomes available for each member, particularly in relation to the frequency of negative outcomes, can consequently lead to distress within the relationship. This approach is consequently highly appropriate for couples living with brain injury, who may be adjusting to a loss of previously experienced positive outcomes and increased negative outcomes associated with changes in functioning.

In BCT, the goal of the therapist is to help couples to better understand their patterns of interaction and teach them relevant skill-based interventions, such as communication and decision-making. Cognitive restructuring is central to BCT work and is applied by therapists delivering the work. Furthermore, behavioral interventions including guided behavior change (i.e. behavioral interventions that do not involve a skilled component, such as "date nights") are employed dependent on the conceptualization of a couple's needs.

BCT has been shown to be effective in helping couples with relationship distress (25). However, to the best of the authors' knowledge, there are currently no UK based studies that have investigated the effectiveness of BCT for people with brain injury in the NHS context where there is limited funding. This would be useful in shaping service design and delivery. Yet the need for support for couples living with brain injury is evident. This case series examines the application of BCT to couples living with an acquired brain injury (ABI) as part of a pilot service initiative.

Methods

Design

A single case methodology with bi-phasic A-B design was used to assess the effectiveness of BCT with a neurological population.

Participants

Couples with brain injury were seen at a specialist neuro-rehabilitation outpatient service. Inclusion criteria were (i) 18 years old and over with no upper limit; (ii) one member of the couple living with an ABI and (iii) participant self-report of relationship distress. The exclusion criteria were (i) insufficient level of English language for engaging in therapy and (ii) a current substance use disorder. A screening of eligibility was conducted prior to participation.

Outcome measures

The primary outcome measure considered was the Couples Satisfaction Index Scale-8 (CSI-8) (26). The CSI-8 is an eight item self-report scale designed to measure each partner's satisfaction with their relationship. Scores can range from 0-41 with higher scores indicating higher levels of relationship satisfaction. Scores below 27.5 indicate notable relationship dissatisfaction. The CSI has demonstrated excellent internal consistency ($\alpha \geq .94$) (26), and has been used previously with couples with brain injury (27, 28).

Secondary outcome measures included the Patient Health Questionnaire-9 items (PHQ-9) (29) and Generalized Anxiety Disorder Assessment-7 items (GAD-7) (30). The PHQ-9 is a multipurpose instrument for screening, diagnosing, monitoring and measuring the severity of depression. It incorporates DSM-IV depression diagnostic criteria along with other leading major depressive symptoms within a brief self-report tool. The GAD-7 is a self-administered

patient questionnaire used as a screening tool and severity measure for generalized anxiety disorder. Both secondary measures have demonstrated good (PHQ-9; $\alpha \geq .86$ (29)) to excellent internal validity (GAD-7; $\alpha \geq .92$ (30)), and have been used previously in research involving individuals with brain injury (31) and their families (32, 33).

Intervention

The current intervention was adapted and delivered by N.B. under the supervision of S.C.. N.B. is a qualified clinical psychologist and neuropsychologist, trained in BCT, and S.C. is a specialist in BCT. The intervention was based on BCT for depression (34), incorporating adaptations for working with patients with brain injury described by Coetzer (35), and N.B.'s experience of working with ABI. The intervention typically entailed up to 14 weekly one-hour sessions (see Table 1 for a summary of the intervention). For one couple, this was extended to 25 sessions due to the patient engaging in rehab during the course of work, and the identification of further issues within the relationship.

Treatment goals were negotiated following discussion of the case conceptualization (see Supplementary information - Table 1). The treatment consisted of the following: (i) behavioral interventions, namely skill-based interventions; (ii) guided behavior change to alter the relationship atmosphere (e.g. for homework, couples were encouraged to establish a regular date night) and (iii) psycho-education about the impact of the brain injury on emotions and behavior to facilitate a shared understanding (36). The couples were given homework to complete between sessions, and the rationale for active practice was fully explained.

Time was spent educating the couples on the BCT model. The emphasis of this adaptation was to promote understanding of how specific changes to cognition, affect and behavior occur because of brain injury. It appeared that the individuals with brain injury needed to learn not only that their cognitive capacities had changed because of injury, but also how this gave rise to new patterns of thinking that could substantially influence affect and behavior. This was also helpful for their partners to learn. Sessions were made accessible for this client group by including modifications such as (i) the use of repetition; (ii) personalized metaphors; (iii) simplified explanations and (iv) concrete examples. Other adaptations included: (i) the use of memory aids such as written notes during the session, e.g., the mapping of formulations (cognitive strengths and weaknesses and their impact on functioning); (ii) practicing skills in session prior to engaging in them for homework (e.g. relaxation techniques); (iii) applying newly learned techniques to daily activities in the home; (iv) the use of role-play to rehearse target behaviors and (v) longer sessions (90 minutes) to provide time for processing during treatment.

[Insert Table 1 here]

Procedure

Behavioral Couples Therapy is an intervention offered routinely within the service. The present study involved an evaluation of this provision, and as such, approval was obtained from the relevant NHS audit team (reference: AUD100078). Informed consent was obtained from all participants prior to their involvement. Consistent with usual practice, full psychological assessments were conducted following acceptance to the service, including assessment of psychological needs, capacity to consent to treatment, and risk. Potentially eligible participants were introduced to the BCT service by the assessing psychologist (N.B.). All couples who met

the inclusion criteria for receiving the intervention were invited to take part in this study. One couple were invited to participate but did not consider themselves to be in a sufficiently substantial relationship for the intervention. No others declined participation.

Those consenting to participation immediately began the pre-intervention phase, consisting of a wait-list baseline period lasting three weeks, followed by three-to-five hours of interview-based assessment sessions. Assessment sessions were conducted with the couple, together and individually, gathering a general history which would lead to the formulation of their difficulties and a treatment plan. Therapeutic sessions commenced immediately after the pre-intervention phase. Engagement with the treatment was good, non-attendance was infrequent and occurred due to childcare or other social issues only. Outcome measures were completed weekly on paper, independently by participants throughout pre-intervention, treatment and at follow-up, and gathered by the intervention psychologist as well as other junior psychologists in the service.

Therapist log

Single case methodology is vulnerable to the possibility that any changes during the intervention phase are attributable to external factors rather than the intervention (e.g., changes in medication, regression to the mean). To protect against such threats to internal validity, a therapist log was used to sample behavior throughout all phases to identify possible explanations for changes in study variables and these are included in the results section where relevant.

Analytic strategy

All individual CSI-8, PHQ-9 and GAD-7 data were first plotted graphically for visual inspection of treatment effects. Visual analysis was conducted according to Kratochwill and colleagues (37), who recommend consideration of the following six factors: level, trend, variability, overlap, immediacy, and consistency. A visual analysis worksheet (see Supplementary Information - Table 2 (38)) and online tool (https://manolov.shinyapps.io/Overlap/ as described by Manolov (39)) were utilized to assist analysis. In the present study, the intervention was anticipated to have gradual effects, due to the skill-building nature of the therapy. Consequently, immediacy was not considered a key factor. Similarly, due to the fluctuating nature of the impact of brain injury, some variability was anticipated in both pre-intervention and intervention phases. As this evaluation included just two phases (pre-intervention and intervention) it was not possible to evaluate consistency across similar phase changes. As recommended standards (37) require a phase to consist of at least three data points, the follow-up period was not included in visual analysis.

In terms of statistical analysis, individual and overall effect size estimates were calculated using Tau-U (40). Tau-U is a distribution-free, non-parametric statistical approach that quantifies the level of non-overlap between two phases and provides an overall effect size. Tau-U is recommended for single-subject research data as it is less subjective than visual analysis alone and enables small treatment effects to be detected (41). Tau-U can also control for trends in baseline scores, making comparisons more accurate (42). Tau-U values may be considered small (< 0.2), moderate (0.2-0.6), large (0.6-0.8) or very large (> 0.8) (43). A Tau-U score equal or close to one indicates no overlap (41). Tau-U scores, and their associated significance, were calculated using an online calculator (44). Phase 1 included all pre-intervention time points (baseline and assessment), while Phase 2 included all intervention time points.

The data were also analyzed using the reliable change index (RCI). The pre-intervention score (the average of all pre-treatment scores, inclusive of baseline and assessment time points) was compared to post-intervention (final intervention session time point) and six-month follow-up scores. Reliable change (RC) examines whether the magnitude of change per participant is statistically reliable, accounting for expected change due to measurement variability (45). If a participant's change score falls beyond the reliable change criterion of 1.96, it can be concluded with 95% certainty that the change observed is statistically reliable. The RCI was calculated according to the equation below (45):

$$RC = \frac{X_2 - X_1}{S_{diff}}$$

In the equation above, X_1 represents a subject's pre-test score, X_2 represents the subject's post-test score, S_{diff} is the standard error of the difference between the two test scores, calculated from the standard error of measurement (S_E) as follows:

$$S_{diff} = \sqrt{2(S_E)^2}$$

This calculation utilizes measurement of test-re-test reliability from previous literature, such that:

$$S_E = s\sqrt{(1 - r_{xx}}$$

In the equation above, s is the standard deviation of a reference group, and r_{xx} is the reliability of the instrument (Cronbach's alpha). See Table 2 for details of reference data used in this analysis. Where possible, reference groups were identified relevant to the current study (i.e., individuals with ABI).

[Insert Table 2 here]

Results

Patient characteristics

Four individuals with ABI (stroke n = 3, or traumatic brain injury (TBI) n = 1), and their partners, were recruited. For all couples, the index patient was male, and their partner female. Participants (patients and partners) ranged in age from 41 to 71 years (M = 54.9 years, SD = 14.5 years). Most patients had no history of mental health difficulties, except one who reported a history of anxiety (patient A1). For further patient characteristics, see Table 3.

[Insert Table 3 here]

Changes in relationship satisfaction during and after BCT

Pre-intervention, all participants reported low level relationship satisfaction (scoring below 27.5; see Table 4). Visual inspection of individual CSI-8 data (see Figure 1) indicated a slight improving trend during baseline for patients A2 and A3 and partners B2 and B3. There was a trend of improvement during the intervention phase for patients A1, A2 and A4, as well as partners B1, B3 and B4. However, data were variable for patients A3 and A4, and partner B2, decreasing confidence in level change. While intervention phase data were often somewhat overlapping of pre-intervention, this typically improved over time, as predicted a priori. In contrast, for patient A4, an immediate change was observed between phases.

Tau-U scores, comparing the pre-intervention phase to intervention phase, demonstrate a significant overall effect of BCT for both patients and partners (moderate effect size; see Table 4). A statistically significant improvement in relationship satisfaction was observed for all partners individually (moderate to large effect sizes), and for one patient (patient A2; very large effect size). Further to this, all partners and all but one patient met criteria for reliable change

between the mean pre-intervention phase score, and the final intervention session. These effects were maintained at six-month follow-up for two patients (A1 and A3), and two partners (B1 and B4).

[Insert Table 4 here]

[Insert Figure 1 here]

Changes in depression during and after BCT

During the pre-intervention phase, participants typically reported low level depression scores in the 'none' to 'mild' ranges (see Table 5). A visual inspection of plots indicated an improving baseline trend for patient A3 and partners B3 and B4 (see Figure 2). An improving trend during the intervention phase was observed for patients A2 and A3, and partner B4. Scores typically at floor level for patient A1, and partners B1 and B2, as well as high variability in scores across almost all participants, made confidence in change in level from visual analysis more challenging.

Tau-U analysis demonstrated an overall significant intervention effect on depression for partners (moderate effect size) but the overall effect size for patients was not significant ($p > .2$; see Table 5). Individually, one patient (A3; very large effect) and one partner (B4; very large effect) demonstrated significant improvement during the intervention phase. A further patient (A4) showed high variability in scores, and Tau-U analysis indicated an overall worsening that was significant (moderate effect). One partner (B4) met criteria for reliable change between the mean pre-intervention phase score and post-intervention, which was maintained at six-month follow-up. Furthermore, one patient (A2) reported a reliable deterioration in symptoms at six-month follow-up, relative to pre-intervention.

[Insert Table 5 here]

[Insert Figure 2 here]

Changes in anxiety during and after BCT

Patient scores were typically suggestive of very low level anxiety pre-intervention, whereas partners reported anxiety ranging from none to moderate (see Table 6). Visual analysis indicated an improving baseline trend for partner B4. During the intervention, an improving trend was demonstrated for patient A1, and partners B3 and B4. While scores for patient A4 were highly variable, an improvement in level between pre-intervention and intervention was observed (see Figure 3). The visual plots show patients A2 and A3 remained fairly consistently low (floor level) in anxiety, with high overlap throughout most of the pre-intervention and treatment process. Visual inspection of the data for partners B3 and B4 suggested improvement in level from assessment to treatment. In contrast, due to high variability and overlap in scores for partners B1 and B2, confidence in change was impeded.

Tau-U analysis demonstrated the improvement was significant for both patients A1 and A4 (very large effect size) and met criteria for reliable change at the end of treatment and follow-up (see Table 6). Tau-U analysis demonstrated that the overall intervention effect on anxiety was significant for the patient group ($p < .001$; moderate effect size). At follow-up, patients A2 and A3 experienced a deterioration in anxiety which met criteria for reliable change. Tau-U analysis showed significant change for both partners B3 and B4 (large and very large effects respectively). The criterion for reliable change was met for B4 and maintained at follow-up. Scores were more variable for partners B1 and B2 and change was non-significant ($p < .2$). The

overall effect of BCT on anxiety for partners was significant ($p < .001$; moderate effect size). One partner (B2) experienced a reliable deterioration in anxiety at follow-up.

[Insert Table 6 here]

[Insert Figure 3 here]

Discussion

It is widely documented that the deficits experienced after brain injury can lead to difficulties such as poor marital adjustment, greater financial strain, distancing of previously shared interests, reduced ability to engage in activity together and sexual issues, all of which can contribute to marital dissatisfaction (6). Furthermore, the first year post injury has been found to be the most unstable (7). The implementation of interventions such as BCT is one potential avenue for addressing such issues. BCT can serve to increase understanding between couples and facilitate communication using core components such as education and skill-based interventions, including communication and decision-making. These are in keeping with other couple based interventions which have been found to demonstrate promising results using psychoeducation, affect recognition, empathy training, skill building, cognitive-behavioral and dialectical-behavioral strategies, communication skills training and supportive intervention (13, 14).

Partners of people with TBI have reported increased levels of stress and reduced emotional well-being (5). The loss of empathy and sensitivity in the individual with brain injury have been highlighted to lower relationship satisfaction (10). In line with the primary focus of this intervention, the findings of this small-scale pilot study show some promise that BCT may improve relationship satisfaction, although further research will be required to demonstrate the

efficacy of this intervention. An association between spousal satisfaction, depression, and anxiety symptomatology was less evident in the current study due to the low pre-intervention secondary outcome scores. Determining the association between spousal satisfaction and improved depression and anxiety would require further exploration in a larger scale study. Moreover, symptomatic changes within the normal range are not a compelling indicator of change and so must be interpreted with considerable caution.

Health and social care costs following brain injury are high, with total estimates in the United Kingdom between £3billion and £7billion per year (46, 47). The investment in clinical interventions such as BCT could potentially reduce these care costs. As couples achieve improved communication, develop greater understanding of the role of brain injury in their relationship, and the mentalization process is promoted for the brain injured partner, relationship satisfaction improves and the likelihood of separation is reduced. Furthermore, this study's findings are in keeping with the recommendations from NHS Digital (15), that people who access couple therapy as part of service provision are more likely to recover from symptoms of depression and anxiety (4). Psychological factors, such as depression and anxiety, are predictive of therapeutic response to neuro-rehabilitative interventions (48). Effective intervention through BCT may therefore lead to wider benefits than the target outcomes investigated, and consequent further reduction in care costs.

The statistical analysis utilized in this study allowed for control of any significant baseline trend, which can reduce the accuracy of baseline and intervention comparison (42). However, for this sample, the baseline trend was rarely significant. This provides further indication of the need for intervention, such as BCT, to improve outcomes for brain injured individuals and their partners, as difficulties are likely to persist without such input.

Although improvement in depression scores overall were observed for partners, this study did not result in the reduction of depression overall for the brain injured individuals. The current study highlights that low mood can be maintained despite changes in the perceived relationship satisfaction demonstrating the challenges of living with brain injury. It is important that this process is normalized, and that accessible information about this process should be given to couples and families. Similarly, anxiety was maintained for some of the partners at follow-up; this was due to the ongoing challenges of living with the consequences of brain injury on their spouse. Further research should explore ways in which relevant information could be made available to couples and families post brain injury. Using models from grief literature, for example, has been suggested for explaining the challenges of living with brain injury to couples (11).

Participants in this study were followed up at two- and six-month intervals following treatment completion. It was observed that several participants, both patients and partners, experienced a deterioration in anxiety and depression symptoms at six months. This may indicate the utility of offering short-term 'booster' sessions to facilitate maintenance of improvements. It is also possible that the worsening of depression and anxiety symptoms were unrelated to issues in the couple dynamic and benefit may instead come from further individual psychological support at that stage. This pattern was not observed for relationship satisfaction, for which half of patients and partners maintained reliable improvement to follow-up and none deteriorated relative to the pre-intervention score. However, despite reliable improvements in couple satisfaction for almost all individuals, all patients and partners continued to score below threshold on the CSI-8, indicating continued notable dissatisfaction. This may be a reflection of the very low pre-intervention satisfaction reported, which was substantially reduced in the

current sample relative to similar populations observed in prior research (27, 28). It is therefore possible that a longer treatment duration is required for patients and their partners who are so dissatisfied, given the ongoing impact of brain injury on quality of life. However, this was a heterogenous clinical group, further research may be useful in exploring the impact of length of treatment on different brain injury presentations.

Limitations

This study presents a small sample audit of routine treatment, and as such does have limitations. Due to the sample size and preliminary nature of this pilot study, further research with a larger number of participants will be required to determine the efficacy of this intervention. Other limitations include the fact that there was no inter-rater reliability or blinding of patients and therapist. Furthermore, individuals were not randomly allocated to the intervention but were instead opportunistically recruited from existing service users who were eligible and expressed interest in participation. Consequently, the sample was not diverse; most patients with brain injury who were recruited were white men, and all were in heterosexual relationships. It would be important for future research to replicate and expand on these findings with a wider, more diverse clinical sample, who face these challenges but have additional unique experiences. Furthermore, it would be useful to explore if women with brain injury and their partners experience similar trends as those seen in this study.

As a preliminary investigation, this study required eligible participants to have the ability to communicate, meaning that individuals with severe communication difficulties were excluded. Further research would benefit from investigating the adaptations needed to accommodate individual needs differences resulting from varying types of brain injury. Nonetheless, the type of stroke did vary and there were differences in age across the participants. The differences in

brain injury presentations and date of onset may have impacted the severity of behavioral, cognitive, and emotional deficits, and therefore differences in subsequent relationship difficulties. This perceived relationship distress could have also been impacted by the length of the marital relationship.

As an audit of routine treatment, outcome measures reported were completed as part of routine service. Future investigations may benefit from inclusion of further measures, for example of empathy and communication difficulties, to provide further understanding of mechanisms of change. A further limitation of the study was that outcome measures were gathered by the clinician delivering the intervention, as well as junior psychologists in the service. It is therefore possible that this may have biased the results.

Conclusion

This study set out to explore the outcomes of BCT for couples with brain injury. The results offer a preliminary indication that BCT may increase relationship satisfaction and reduce psychological distress. However, modification from the standard protocol of between 10-20 sessions (34), such as increasing number of sessions, was necessary. Further investigation is needed to establish which couples are most likely to benefit from BCT and the nature of the adaptations needed to accommodate different forms of brain injury.

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[Removed from manuscript for review]

Declarations of Interest

The authors report no conflict of interest

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Table 1

Summary of planned intervention content.

Treatment phase	Summary of content
Phase 1, session 1-4	Brain injury psychoeducation; Introduction to skill-based interventions
Phase 2, session 5-9	Skill-based intervention techniques are established, the couple are encouraged to use these outside sessions independently; Brain injury education continues.
Phase 3, session 10-14	Alongside the continued focus on skill-based training, the couple are supported to reflect on obstacles to intervention; Therapy blueprints are developed to help the couple remember the work.

Table 3

Patient and partner characteristics.

Patient							Partner			
Patient ID	Ethnicity	Gender	Age group	Diagnosis; years since onset; severity	Key deficits	Relationship duration (years)	Partner ID	Ethnicity	Gender	Age
A1	Other white background	Male	40s	Traumatic Brain Injury; 7yrs; Moderate, GCS = 13[a]	Cognitive impairment: Behavioral changes: Increased irritability and impulsivity	14	B1	Other white background	Female	40s
A2	Other black background	Male	40s	Right-sided hemorrhagic stroke; 4yrs; mRS = 3	Left-sided weakness; Impaired mobility; Left-sided visual neglect; Cognitive impairment: memory, attention, executive functioning (initiation, planning, problem-solving, inhibition, self-monitoring, emotional lability)	8	B2	Other white background	Female	40s
A3	White British	Male	60s	Stroke; 1yr; mRS = 4	Left-sided weakness; Impaired mobility; Cognitive impairment: memory, attention, executive functioning (initiation, planning, inertia, disinhibition, emotional lability, behavioral: increased irritability)	20	B3	White British	Female	60s
A4	White British	Male	70s	Stroke-Right basal ganglia; 2yrs;	Aphasia, left sided foot drop, cognitive impairment: Attention, dysexecutive function (problem-solving, planning and organizing).	50	B4	White British	Female	70s

mRS = 3	

Note. [a] score on arrival to hospital.
GCS = Glasgow Coma Scale (49); mRS = Modified Rankin Scale (50)

Table 3

Data utilized from previous literature for calculation of reliable change indices.

Measure	Reliability: Cronbach's α (Reference)	Mean SD (Reference)
CSI-8	0.94[a] (26)	Not available[b]
PHQ-9	0.89 (29)	TBI population[c]: M = 5.07 SD = 5.35 (51) Stroke population: M = 5.1 SD = 5.3 (52)
GAD-7	0.92 (30)	TBI population: M = 3.63 SD = 4.54 (51) Stroke population: M = 5.5 SD = 5.4 (53)

Note. CSI = Couples Satisfaction Index; PHQ = Patient Health Questionnaire; GAD = Generalized Anxiety Disorder

[a] Cronbach's alpha not available for eight-item measure; scores of 0.94 reported for four-item measure, and 0.98 for 16- and 32-item measures. Therefore 0.94 was selected as a conservative estimate. [b] Where reference group data were not available, the SD of the current sample pre-test scores was utilized. [c] Due to the current study's mixed sample, research involving individuals who had experienced either a stroke or traumatic brain injury (TBI) were considered, and the larger standard deviation reported was utilized in statistical analysis.

Table 4
Effect of BCT on Patient and Partner CSI-8 scores

	Patient							Partner						
	Pre[a]	Post[b]		6-month follow-up		Intervention effect		Pre[a]	Post[b]		6-month follow-up		Intervention effect	
Couple	Score	Score	Reliable change	Score	Reliable change	Tau-*U*[c] (90% CI)	*p*	Score	Score	Reliable change	Score	Reliable change	Tau-*U*[c] (90% CI)	*p*
1	11.83	25.00	✓	24.00	✓	0.58 (0.05 to 1.00)	.071	11.33	19.00	✓	19.00	✓	0.69 (0.14 to 1.00)	**.038**
2	15.75	21.00	✓	18.00	×	0.89 (0.41 to 1.00)	**.002**	22.25	28.00	✓	22.00	×	-0.58[d] (-1.00 to -0.11)	**.041**
3	22.38	27.00	✓	26.00	✓	0.25 (-0.21 to 0.71)	.374	18.13	23.00	✓	21.00	×	0.64 (0.18 to 1.00)	**.024**
4	10.67	10.00	×	13.00	×	-0.46 (-0.88 to -0.04)	.075	1.83	8.00	✓	14.00	✓	0.77 (0.35 to 1.00)	**.003**
Overall						0.29 (0.05 to 0.52)	**.048**						0.38 (0.14 to 0.62)	**.009**

Note. BCT = Behavioral Couples Therapy, CI = Confidence interval, CSI = Couples Satisfaction Index. [a] Pre-intervention score is mean score across baseline phase, inclusive of baseline timepoints and assessment sessions. [b] Post-intervention score is score at final intervention session. [c] Tau *U* is calculated across whole baseline phase and intervention phase. [d] corrected for baseline trend

Table 5
Effect of BCT on Patient and Partner PHQ-9 scores

	Patient							Partner						
	Pre[a]	Post[b]		6-month follow-up		Intervention effect		Pre[a]	Post[b]		6-month follow-up		Intervention effect	
Couple	Score	Score	Reliable change	Score	Reliable change	Tau-*U*[c] (90% CI)	*p*	Score	Score	Reliable change	Score	Reliable change	Tau-*U*[c] (90% CI)	*p*
1	2.00	0.00	× [e]	0.00	× [e]	0.19 (-0.34 to 0.72)	.561	1.17	0.00	× [e]	0.00	× [e]	-0.08 (-0.61 to 0.45)	.796
2	3.00	0.00	× [e]	11.00	✓[d]	-0.49 (-0.95 to -0.03)	.083	1.25	0.00	× [e]	5.00	× [e]	-0.04 (-0.50 to 0.43)	.894
3	5.75	3.00	×	4.00	×	-1.00 (-1.00 to -0.54)	**<.001**	5.88	5.00	×	7.00	×	-0.46 (-0.93 to 0.00)	.100
4	2.83	3.00	× [e]	2.00	× [e]	0.55 (0.12 to 0.97)	**.034**	5.83	0.00	✓	0.00	✓	-0.86 (-1.00 to -0.43)	**<.001**
Overall						-0.18 (-0.42 to 0.05)	.201						-0.38 (-0.62 to -0.14)	**.008**

Note. BCT = Behavioral Couples Therapy, CI = Confidence interval. [a] Pre score is mean score across pre-intervention phase, inclusive of baseline timepoints and assessment sessions. [b] Post-intervention score is score at final intervention session. [c] Tau *U* is calculated across whole pre-intervention phase and intervention phase. [d] deterioration. [e] No change indicates absence of deterioration in context of sub-clinical pre-intervention score.

Table 6
Effect of BCT on Patient and Partner GAD-7 scores

	Patient							Partner						
	Pre[a]	Post[b]		6-month follow-up		Intervention effect		Pre[a]	Post[b]		6-month follow-up		Intervention effect	
Couple	Score	Score	Reliable change	Score	Reliable change	Tau-U[c] (90% CI)	p	Score	Score	Reliable change	Score	Reliable change	Tau-U[c] (90% CI)	p
1	6.50	1.00	✓	0.00	✓	-0.83 (-1.00 to -0.30)	**<.001**	3.50	3.00	✗[e]	1.00	✗[e]	-0.38 (-0.91 to 0.16)	.245
2	0.00	0.00	✗[e]	8.00	✓[d]	0.00 (-0.46 to 0.46)	1.00	0.63	0.00	✗[e]	7.00	✓[d]	0.19 (-0.28 to 0.65)	.505
3	0.75	0.00	✗[e]	5.00	✓[d]	-0.50 (-0.96 to -0.04)	.076	10.50	7.00	✗	10.00	✗	-0.71 (-1.00 to -0.25)	**.011**
4	7.67	3.00	✓	3.00	✓	-0.83 (-1.00 to -0.41)	**.001**	12.67	1.00	✓	3.00	✓	-1.00 (-1.00 to -0.57)	**<.001**
Overall						-0.54 (-0.77 to -0.30)	**<.001**						-0.49 (-0.73 to -0.25)	**<.001**

Note. BCT = Behavioral Couples Therapy, CI = Confidence interval. [a] Pre score is mean score across pre-intervention phase, inclusive of baseline timepoints and assessment sessions. [b] Post-intervention score is score at final intervention session. [c] Tau U is calculated across whole pre-intervention phase and intervention phase. [d] deterioration. [e] No change indicates absence of deterioration in context of sub-clinical pre-intervention score.

[Figure 1]

Figure 1: Effect of BCT on patient (A) and partner (B) CSI-8 scores. In all cases, x-axis represents time point, and y-axis represents CSI-8 score. Data demonstrates pre-intervention and intervention phases.

[Figure 2]

Figure 2: Effect of BCT on patient (A) and partner (B) PHQ-9 scores. In all cases, x-axis represents time point, and y-axis represents PHQ-9 score. Data demonstrates pre-intervention and intervention phases.

[Figure 3]

Figure 3: Effect of BCT on patient (A) and partner (B) GAD-7 scores. In all cases, x-axis represents time point, and y-axis represents GAD-7 score. Data demonstrates pre-intervention and intervention phases.

Supplementary information - Table 1

Treatment characteristics for each couple

Couple	Goals identified	Intervention details	Treatment sessions attended
A1 – B1	Better communication; learning to recognize the things that 'push buttons' – in order to reduce frequency of anger; improved understanding of personality change; better ability to see others' perspectives and to empathize; better management of mood swings and emotional lability	1. Sharing thoughts and feelings a) Communication b) Parenting 2. Guided behavior change- date nights 3. Brain injury education 4. Individual therapy for patient on adjustment to brain injury and strategies for emotional regulation.	8
A2 – B2	Better communication; adjustment to living with stroke	1. Sharing thoughts and feelings (around four key topic areas which were graded in terms of what felt safest to start with a) Communication and b) parenting; 2. Guided behavior change-caring days, date nights; and 3. Psycho-education re: stroke	9
A3 – B3	Better communication; improved empathy towards partner; reduction in impact of bluntened affect on relationship	1. Sharing thoughts and feelings (around four key topic areas which were graded in terms of what felt safest to start with a) Communication b) Sexual intimacy c) Finances d) Parenting. 2. Guided behavior change-caring days, date nights 3. Decision making about parenting their children.	10
A4 – B4	Better communication Adjustment to living with stroke	1. Sharing thoughts and feelings (around four key topic areas which	25

	were graded in terms of what felt safest to start with a) Communication b) increasing intimacy 2. Guided behavior change-caring days, date nights 3. Psycho-education re: stroke

Supplementary information - Table 2

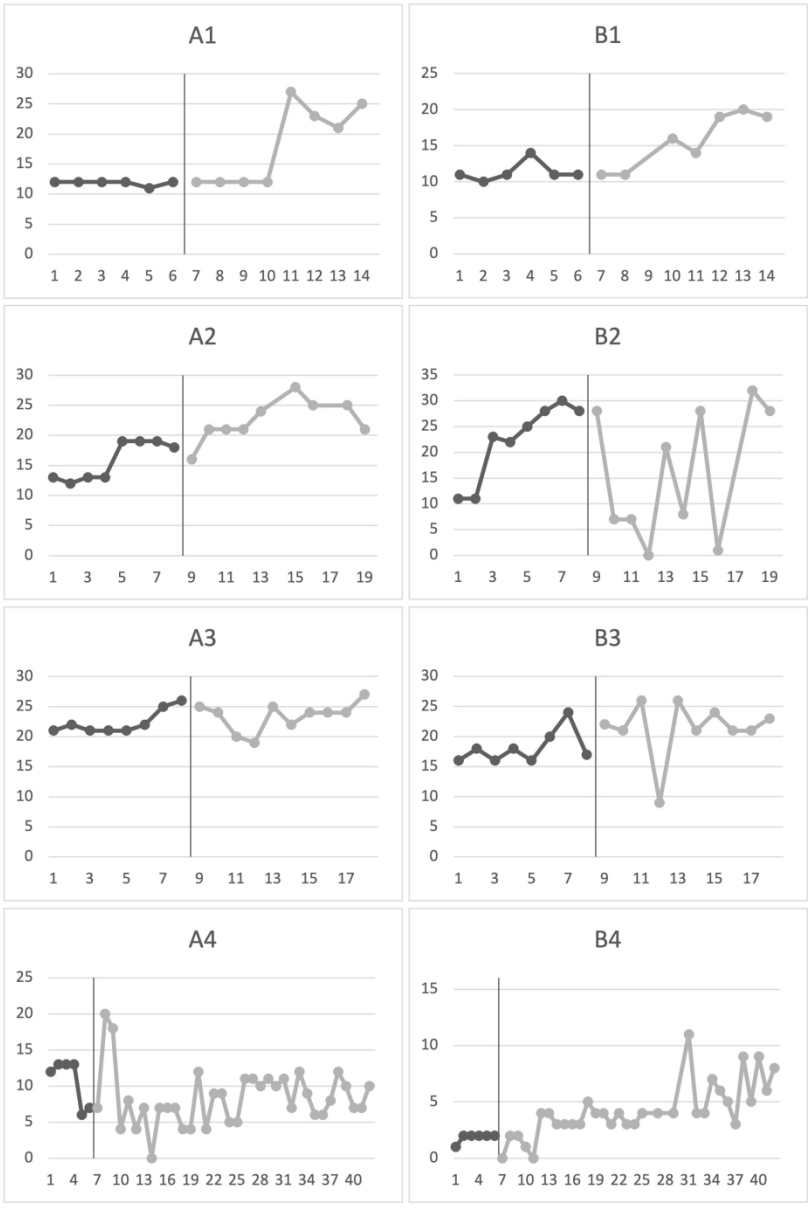
Visual analysis of data (38)

Characteristic	Question	PHQ-9								GAD-7								CSI-8							
		A1	A2	A3	A4	B1	B2	B3	B4	A1	A2	A3	A4	B1	B2	B3	B4	A1	A2	A3	A4	B1	B2	B3	B4
Level	Is a consistent level established in each condition prior to condition change?	✓	✓	×	✓	✓	✓	×	×	✓	✓	×	✓	×	✓	×	×	✓	×	×	×	✓	×	×	✓
	Is there a consistent level change between conditions, in the expected direction?	×	✓	✓	×	×	×	×	✓	✓	×	×	✓	×	×	✓	✓	✓	✓	✓	×	✓	×	✓	✓
Trend	Are unexpected trends present that make determination of behavior change difficult?	×	×	✓	×	×	×	✓	✓	×	×	×	×	✓	×	×	✓	×	✓	✓	×	×	✓	✓	×
	Is there a consistent change in trend across conditions, in the expected condition?	✓	✓	×	×	×	×	×	×	✓	×	✓	×	×	×	✓	×	✓	×	×	✓	✓	×	×	✓
Variability	Does unexpected variability exist in one or more conditions?	✓	×	✓	✓	✓	✓	✓	✓	×	×	✓	✓	✓	✓	×	✓	✓	×	✓	✓	×	✓	×	✓
	Does within-condition variability impede determinations about level changes between conditions?	✓	×	✓	✓	✓	✓	✓	×	×	×	✓	✓	✓	✓	×	×	×	×	✓	✓	×	✓	×	×

Consistency	Are data within conditions and changes between conditions consistent?	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	If changes are inconsistent with regard to level, trend, or variability, was that expected?	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Does inconsistency impede confidence in a functional relation?	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Overlap	Are data highly overlapping between conditions? (e.g. are there many points in the intervention condition that are not improved relative to baseline?)	✓	✓	×	✓	✓	✓	✓	✓	×	✓	✓	×	✓	✓	×	×	✓	×	✓	✓	×	✓	×	✓
	If overlapping, does the degree of overlap improve over time? (e.g., initial intervention data points are overlapping, but later ones are not)	×	✓	N/a	×	×	×	✓	✓	✓	×	×	✓	×	×	✓	✓	✓	✓	×	×	✓	×	N/a	✓
	Is overlap consistent across comparisons (e.g., Do approximately the same number or per cent of data points overlap across A> B comparisons?)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Was overlap expected a priori? (e.g., Was variability or a delay in treatment effect expected, given	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

	knowledge about participant behavior and past research?)																							
	Does presence of overlap impede confidence in a functional relation? (Does the degree to which data are similar between conditions result in lower confidence for more than one comparison?)	✓	×	×	✓	✓	✓	✓	×	×	✓	✓	×	✓	✓	×	×	×	×	✓	✓	×	✓	×	×
	Are changes between tiers immediate, in the intended direction?	×	×	✓	×	×	×	×	×	✓	×	✓	✓	✓	×	×	✓	×	×	×	✓	×	×	×	×
Immediacy	If no, are delays in change consistent across tiers (e.g., if there is a 3 session delay in tier 1, is there a 2-4 session delay in Tier 2?)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Does lack of immediacy impede confidence in a functional relation?	✓	×	×	✓	✓	✓	✓	×	×	✓	×	×	×	✓	×	×	×	×	✓	×	×	✓	×	×

Note. PHQ-9 = Patient Health Questionnaire (9 item); GAD-7 = Generalized Anxiety Disorder Assessment (7 item); CSI-8 = Couples Satisfaction Index (8 item)



Effect of BCT on patient (A) and partner (B) CSI-8 scores. In all cases, x-axis represents time point, and y-axis represents CSI-8 score. Data demonstrates pre-intervention and intervention phases.

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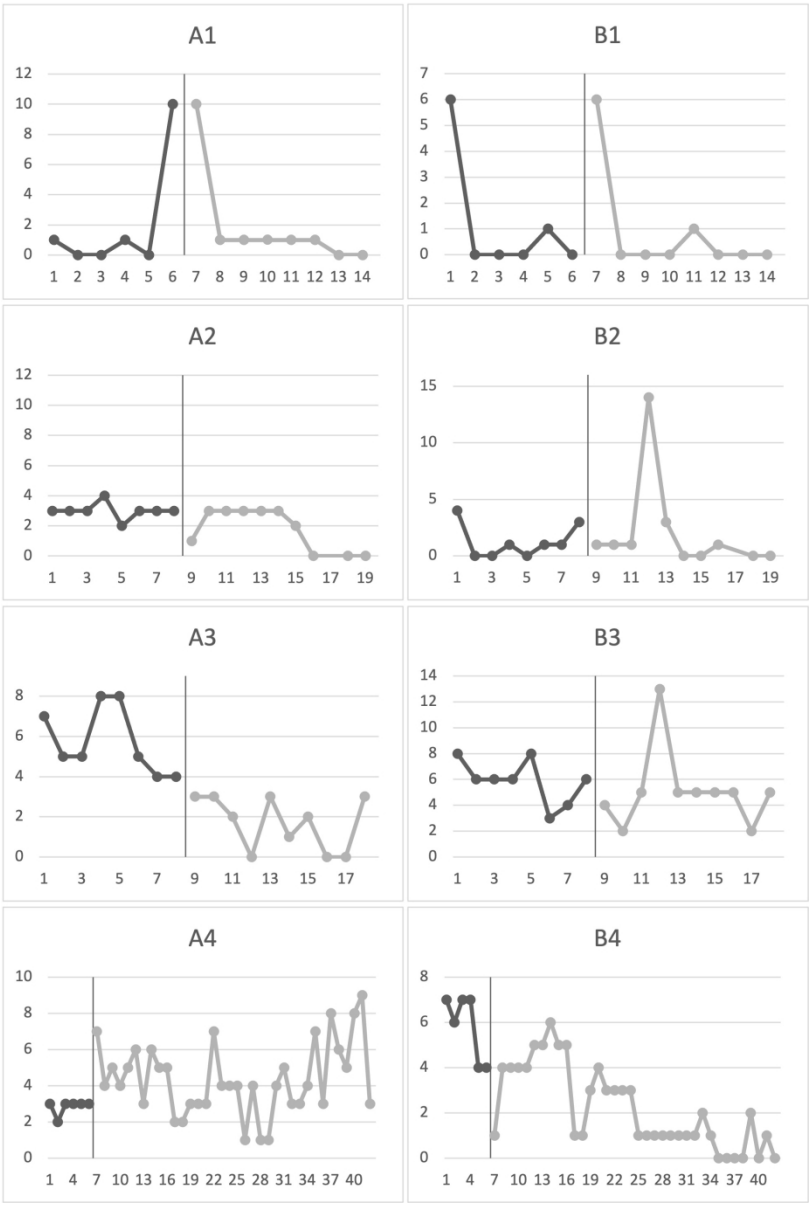

Effect of BCT on patient (A) and partner (B) PHQ-9 scores. In all cases, x-axis represents time point, and y-axis represents PHQ-9 score. Data demonstrates pre-intervention and intervention phases.

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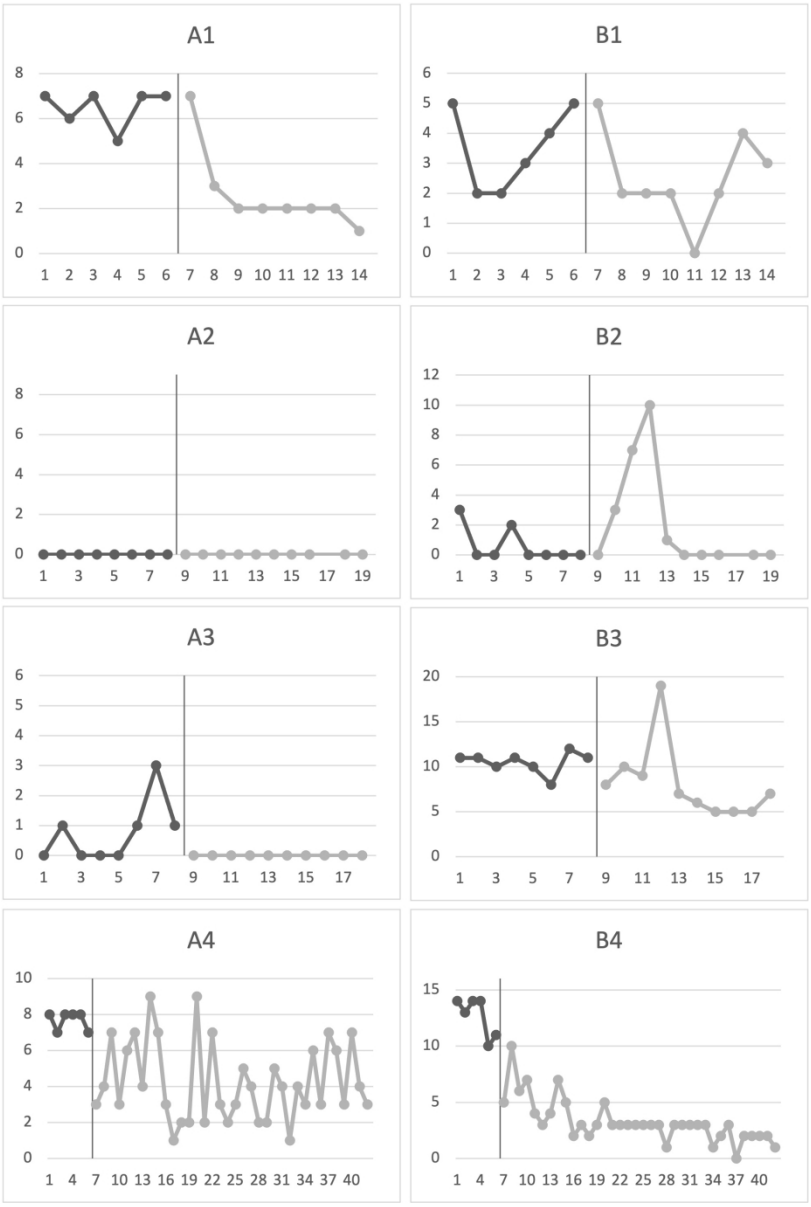

Effect of BCT on patient (A) and partner (B) GAD-7 scores. In all cases, x-axis represents time point, and y-axis represents GAD-7 score. Data demonstrates pre-intervention and intervention phases.

152x226mm (330 x 330 DPI)