Effects of an Explicit Problem-Solving Skills Training Program Using a Metacomponential Approach for Outpatients With Acquired Brain Injury

Kenneth N. K. Fong, Dorothy R. Howie

OBJECTIVE. We investigated the effects of an explicit problem-solving skills training program using a metacomponential approach with 33 outpatients with moderate acquired brain injury, in the Hong Kong context.

METHOD. We compared an experimental training intervention with this explicit problem-solving approach, which taught metacomponential strategies, with a conventional cognitive training approach that did not have this explicit metacognitive training.

RESULTS. We found significant advantages for the experimental group on the Metacomponential Interview measure in association with the explicit metacomponential training, but transfer to the real-life problem-solving measures was not evidenced in statistically significant findings. Small sample size, limited time of intervention, and some limitations with these tools may have been contributing factors to these results.

CONCLUSION. The training program was demonstrated to have a significantly greater effect than the conventional training approach on metacomponential functioning and the component of problem representation. However, these benefits were not transferable to real-life situations.


Problem-solving deficits are among the main obstacles many people with brain injury face in daily life. People with brain injury often exhibit decreased self-awareness and thinking skills, poor judgment, and poor self-regulation. These problems hinder their performance in everyday problem-solving tasks and interfere with their ability to cope with routine problems in independent living situations, educational and vocational settings, and interpersonal relationships (Giles & Clark-Wilson, 1993; Jacobs, 1988). The extent to which patients with brain injury can regain their independence largely relies on their ability to offset some of their problem-solving deficits through training. The use of problem-solving strategies has been listed in evidence-based practice guidelines for postacute cognitive rehabilitation of people with brain injury (Cicerone et al., 2000, 2005). However, a systematic review of the literature concerning empirical studies of cognitive control, problem solving, initiation, self-awareness, or self-monitoring relating to brain injury reported that most studies are single-case studies, only 17.5% used matched controls, and most of the work reviewed was conducted under the constraints of clinical pragmatics (Turner & Levine, 2004). Rath, Dvorah, Langenbaum, Sherr, and Diller (2003) carried out a more recent large-scale randomized control trial with 60 higher-level outpatients with traumatic brain injury. They found that an innovative cognitive rehabilitation program involving training in problem solving and emotional self-regulation could lead to greater improvement in self-report and role-play problem-solving measures for experimental compared with control participants.
The model we used in this study draws on Sternberg’s (1979) model of mental abilities, which identifies the role of metacomponents, which are the higher-order executive or control processes used in the problem-solving process. According to Sternberg (1979), who identified these metacomponents through a rigorous analysis of the problem-solving process, key metacomponential skills are used to define the problem, represent the problem, plan how the problem should be solved, monitor the selected problem-solving strategy, and evaluate their success. This metacomponential approach to problem solving has been operationalized in a measurement tool by Clements and Nastasi (1990), used for some time in the literature on the learning needs of children with learning difficulties (e.g., Brown & Ferrara, 1985; Campione & Brown, 1978) and more recently in cognitive enhancement studies with primary school children (e.g., Barry-Joyce, 2001; Barry-Joyce & Howie, 1998). In Sternberg’s (1981, 1989) view, both metacomponents (i.e., executive or strategic skills) and knowledge acquisition components (i.e., one’s accumulated knowledge concerning cognitive matters) can be taught explicitly and are essential for solving real-life problems. Sternberg also viewed explicit teaching of metacomponential skills as important for transfer or generalization of learning.

Of particular importance is the emerging literature suggesting that a new theory-driven approach emphasizing metacomponential theory for the training of problem-solving skills could be of particular value to patients with brain damage (Toglia, 1992, 2001). Moreover, Cicerone and Giacino (1992) used a metacognitive approach in developing a self-instructional procedure to include metacomponential skills for six patients with brain injury. Birnboim (1995) used a metacognitive training approach in a computer-based cognitive rehabilitation program for patients with brain injury that involved both implicit and explicit training. Von Cramon, Matthes-von Cramon, and Mai (1991) carried out a study that involved explicit strategy training with problem-solving behaviors in real-life problem-solving situations for patients with acquired brain injury (ABI).

In this study, we addressed this key research question: Is there a significantly greater improvement in problem-solving performance in outpatients with ABI in association with explicit problem-solving skills training emphasizing metacomponential strategies compared with conventional cognitive training?

Method

Research Design

This study was a controlled trial using matched pairs to compare the effects of explicit problem-solving skills training emphasizing metacomponential strategies with conventional cognitive training in outpatients with brain injury displaying problem-solving deficits. The independent variable was participation in the experimental intervention, with outpatients assigned to receive (experimental group) or not to receive (comparison group) the main intervention.

Instruments

The test battery consisted of five instruments that we used to assess all participants.

Key Search and the Modified Six Elements Tests. These two measures are both subtests in a test battery called the Behavioural Assessment of the Dysexecutive Syndrome (BADS), an instrument developed by Wilson, Alderman, Burgess, Emslie, and Evans (1996) to assess skills resembling everyday problem-solving and executive functions for people with brain injuries. We selected these instruments from the test battery for use in this study because they are analogous to common problems found in planning, strategy formation, and monitoring aspects of metacognition in real-life problem solving. The rationale for using these subtests is that they represent the metacomponents behind the processes involved in problem solving within the task domain.

Both subtests were validated in a study of 78 patients with brain injury, which demonstrated that performance on all BADS subtests predicted ratings on the Dysexecutive Questionnaire and was sensitive to the everyday problems experienced by people with brain injury (Wilson et al., 1996). The subtests are easily administered and evaluated, with a single score and with references to scoring methods and rating criteria in user manuals.

Social Problem-Solving Video Measure. We chose this measure to assess real-life problem-solving skills. The Social Problem-Solving Video Measure (SPSVM) uses video presentation of problem-solving vignettes to assess social problem-solving skills in adults with brain injuries (Kendall, Shum, Halson, Bunning, & Teh, 1997; Rath et al., 2004). In the validation study, Kendall et al. (1997) found that people with brain injury performed similarly to the control sample in their ability to recognize and define social problems and generate a range of solutions using measurement by the video vignettes. Kendall et al. (1997) also recommended further study to establish the measure’s reliability in people with brain injury.

The SPSVM contains many scenarios derived from the following five categories of real-life social problems: (1) dealing with criticism, (2) refusing unreasonable requests, (3) dealing with others’ objectionable behavior, (4) understanding interpersonal situations, and (5) implementing interpersonal agreements. These categories were chosen because they represent major real-life issues that people with brain...
injury must confront (Kendall et al., 1997). The measure has four subscores and a total score. The four subscores and the total score address content areas similar to the metacomponents measured in the Metacomponential Interview measure used. We developed a local prototype based on Kendall et al.’s (1997) framework for this study. We adapted the vignettes aided by four adult Chinese volunteer actors. Each vignette was role-played by volunteer Chinese actors, and participants were asked to indicate how they thought characters should respond.

Means–Ends Problem-Solving Measure. The Means–Ends Problem-Solving Measure (MEPSM) was first developed by Spivack and Levine in 1963 and has undergone several modifications (see Spivack, Platt, & Shure, 1976). Concerning validity, the MEPSM has been found to have a significant relationship to planning ability in interpersonal problem solving in studies with adult psychiatric patients presenting with cognitive deficits (Butler & Meichenbaum, 1981; Spivack et al., 1976). Although low to moderate test–retest reliabilities of .43 to .64 were reported, a satisfactory internal consistency of .80 in Kuder–Richardson 20 for an adult version have been noted (Butler & Meichenbaum, 1981). The task is presented as a test of imagination in either verbal or written form, and participants are asked to “fill in the middle of the story/scenario” using a thinking-aloud protocol. Each scenario has a beginning in which a need is aroused in the protagonist and an ending in which the participant has succeeded in satisfying the protagonist’s need. The participant must consider each step in the scenario before proceeding to the next step. The version used in this study consisted of the six chosen scenarios applicable to local Hong Kong culture: (1) finding a lost watch, (2) acquiring a job, (3) becoming a leader, (4) getting revenge, (5) finding a girlfriend or boyfriend, and (6) making friends. The assessment involved verbal reporting, which was recorded by cassette recorder so that the examiner could score it afterward and record results on a recording sheet. Two total scores were derived: (1) the number of effective responses as indicated by the number of relevant means (as opposed to no means or irrelevant means) and (2) the relevancy score.

Raven’s Progressive Matrices. Raven’s Progressive Matrices (RPM; Raven, Raven, & Court, 2003) were first published by Raven in 1938 to measure inductive reasoning, a component of Spearman’s g related to the ability to induce relationships in a series of matrices. The RPM contain a series of three nonverbal tests assessing different ability levels and require that each examinee solve problems presented in abstract figures and designs. It has the advantage of not requiring any verbal instructions; therefore, it is less culturally biased. We used the U.S. progressive matrices, standardized in 1995, in this study. The RPM have a good test–retest reliability of approximately .9, which validates their use in repeated testing, for which they were used in Fong (2004).

Metacomponential Interview. The Metacomponential Interview (MI) specifically addresses the use of metacomponents through a series of paper-and-pencil reasoning tasks; however, these tasks are not real-life problem-solving tasks that would likely be experienced by people with brain injury. The measure chosen was an adaptation of Clements and Nastasi’s (1990) measure of metacomponential use. It also involved their incorporation of a concurrent interview to explore the reasoning processes used by participants while solving problems. The interviewer explores through questioning and then scores four dimensions: nature of the problem, problem representation, planning, and monitoring. When scoring the MI, two different scores are generated: (1) a correctness score, that is, the number of prompts necessary for a participant to respond correctly, and (2) a metacomponential score, that is, the number of prompts necessary for a participant to exhibit use of the particular metacomponent, even if the answer is not correct.

We adapted the prototype of this measure for use in the Hong Kong Chinese cultural context. Kenneth N. K. Fong carried out the first Chinese translation of the instrument, which was then checked by a professional translator. Fong then adapted the content, which was checked by two other occupational therapists for cultural relevance and relevance in relation to treatment of brain damage.

Participants

Over a 2-year period, Kenneth Fong recruited by means of convenience sampling 33 consecutive outpatients with ABI who had been referred to the occupational therapy department of a major Hong Kong convalescent hospital for the purpose of cognitive rehabilitation. Three participants dropped out at the beginning of the study for reasons having nothing to do with the training program. Eleven participants, 6 in the experimental group and 5 in the comparison group, could not attend the final follow-up measurement because they had returned to work, been readmitted to the acute care hospital, or been admitted to a vocational training institution. The drop-out rate of 32% was comparable to that of an earlier study with outpatients with brain injury (Rath et al., 2003), and a review of the demographic information on these missing participants suggests little likely bias to the study resulting from this attrition. Participant drop-out affected only the follow-up measurement, not the crucial postintervention measurement.

All participants had sustained ABI, including ABI caused by extrinsic injury factors such as traumatic brain injury (TBI) from a car accident or hitting an external object or intrinsic injury factors such as intracerebral hemorrhage,
arterial–venous malformation, or brain tumor. Participants could either be undergoing neurosurgical intervention or not. They included both male and female adults of working age, 18 to 55 years. All participants were literate, having ≥26 years of formal primary school education, and were able to comprehend written instruction and perform simple arithmetic. Participants were excluded if they were <18 years or >55 years; could not complete testing because of reduced concentration, eyesight, or hearing; or had evidence of aphasia.

The 33 participants were allocated by a matched-pairs procedure to the experimental group (which received the main intervention) or to the comparison group (which did not receive the main intervention). They were matched in pairs as carefully as possible in terms of age, gender, diagnosis, educational level, time of injury, and severity of injury. After matching was complete, a member of each pair was then randomly assigned to either the experimental or the comparison group.

**Intervention**

The study included two major groups of participants: the experimental group, who received the experimental intervention, and the comparison group, who did not. Both groups had received conventional cognitive training composed of functional skills training without explicit metacomponential skills training. This functional skills training involved the use of compensatory techniques that aimed at improving performance in daily functional tasks (relying on residual cognitive functions) rather than attempting to restore cognitive abilities. The conventional cognitive training also involved the use of computer-based or paper-and-pencil exercises that were designed to provide cognitive drilling to address a specifically targeted cognitive impairment. The comparison group received only this conventional training.

The experimental group, in addition to receiving this conventional training, received the experimental intervention. This experimental intervention consisted of explicit training in problem-solving skills with an emphasis on metacomponential strategies. The training program consisted of 22 sessions, with 2 sessions provided each week because participants could not attend sessions on a daily basis. Hence, the experimental intervention lasted 15 weeks. Each training session involved a 45-min educational session covering the metacomponential facets being addressed and a 30-min computer-based cognitive training session during which the participant could make use of the metacomponential skills taught during the theoretical session.

Table 1 illustrates the content of the experimental intervention program, which was oriented toward the primary metacomponents of problem solving: defining the problem, representing the problem, planning problem-solving strategies, monitoring selected strategies, and evaluating outcomes (Clements & Nastasi, 1990). A further facet, training for everyday attention, was added because the literature suggests that patients with brain injury often oversimplify problems by neglecting information (Duncan, 1986; Shallice & Burgess, 1991). As shown in Table 1, this facet preceded defining the nature of the problem.

Activities used to practice the key metacomponential skills consisted of the following:

<table>
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<tr>
<th>Table 1. Summary of Content of the Experimental Intervention Program</th>
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<tr>
<td><strong>Week</strong></td>
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<tr>
<td>Theme</td>
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<tr>
<td>Examples of group activities</td>
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<tr>
<td>Heuristics involved</td>
</tr>
<tr>
<td>Examples of homework</td>
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</table>
Defining the problem: Verbalizing and thinking-aloud activities were used. Egocentric speech (i.e., thinking aloud) appears to have a strong self-regulatory function. Andre (1986) found that asking participants to verbalize their thoughts had a greater effect when they were given explicit rather than implicit information about problem solving, suggesting the value of this strategy in a meta-componential training approach.

Planning: Brainstorming and means–ends analysis were used. Participants had to generate as many alternative solutions to identified problems as possible. They were then asked to evaluate each of these potential solutions, using trial and error, to test whether the alternatives worked (Sternberg, 1995; von Cramon & Matthes-von Cramon, 1992).

Problem representation: Forward and backward chaining were used. In forward chaining, participants were asked to start at the beginning of a problem and continue toward a final solution; in backward chaining, participants were instructed to start by perceiving the final solution and work backward to their current position. In both cases, the chaining involved visual representation. This chaining strategy was suggested by Sternberg (1983) to address the problem representation metacomponent.

Self-monitoring: This important subcategory of self-awareness was targeted because deficits in self-awareness are a common sequela of brain injury (Turner & Levine, 2004). Particular attention was paid to anticipatory awareness of future consequences, accurately assessing one’s own strengths and weaknesses, comparing predicted versus actual performance, and monitoring feedback so that participants could review and reflect on their own performance on various training tasks in the program (von Cramon & Matthes-von Cramon, 1992).

This experimental intervention was carried out in a group format, with each group consisting of 4 to 5 participants. Small-group learning generally fosters cooperation, competition, and mutual assistance—important social skills that must be exercised in everyday problem solving and that encourage patients to abandon their egocentric perspective and view problems through others’ eyes (Andre, 1986; Foxx, Martella, & Marchand-Martella, 1989; von Cramon & Matthes-von Cramon, 1992). Individual training was used only with participants who could not work in group situations.

The experimental intervention was carried out by one of three occupational therapists with extensive experience in brain injury rehabilitation. Initial modeling of the intervention was provided for therapists by Kenneth Fong. Additionally, a program manual was offered that detailed intervention guidelines. All therapists followed this program manual.

The key repeated measurements in relation to the experimental intervention were carried out for all of the groups at three time points: (1) at Week 1, the preintervention assessment (Time 1); (2) at Week 28 after the experimental intervention (Time 2); and (3) 3 months after the conclusion of the experimental intervention, the follow-up assessment (Time 3). This follow-up measurement allowed participants who had completed the main intervention program sufficient time to transfer learned skills to their own real-life situations (Foxx et al., 1989). Kenneth Fong was responsible for conducting all measurements with all participants. He obtained written informed consent from all participants before data collection commenced.

Statistical Analysis

To avoid bias regarding the discrepancies in baseline measurements, we used an analysis based on the comparison of change scores. This analysis used the nonparametric Mann–Whitney U test to compare two independent change scores (change was Time 2 – Time 1 for postintervention or Time 3 – Time 2 for follow-up) for the experimental group and the comparison group. Using Mann–Whitney analysis gave protection against Type II errors owing to small sample size and high drop-out.

Results

Table 2 provides the participants’ demographic information. The groups consisted of 27 men (82%) and 6 women (18%), with a mean age of 33.4 years (standard deviation [SD] = 11.5, range = 16–53) and a mean educational level of 10.4 years (SD = 3.2, range = 6–22). Participants were diagnosed as having ABI, which according to the Brain Injury Association of America (2005) is an injury to the brain that occurred after birth and is not hereditary, congenital, degenerative, or induced by birth trauma. In the sample, 55% (n = 18) of participants had TBI, 27% (n = 9) had intracerebral hemorrhage, 9% (n = 3) had arteriovenous malformations, 6% (n = 2) had brain tumor, and 3% (n = 1) had encephalitis. The largest percentage (42%) experienced right brain injury or lesions; 27% had left brain injury, 21% had bilateral brain injury and 9% had diffuse brain injury. The average duration since onset of injury was 12.3 months (SD = 13.3), indicating chronic injury.

As screened, all participants also exhibited moderate functional disability, scoring at cognitive functional Level VII on the Rancho Los Amigos Scale, eight-level version (Center for Outcome Measurement for Brain Injury, 2003), indicating that each participant exhibited behaviors that were purposeful and appropriate, even though cognitive deficits were identified. Participants needed supervision
while performing activities of daily living, but they were also able to attend outpatient training after a period of time. Significant problem-solving deficits in daily functioning were documented in all participants at the time of recruitment. Their mean baseline score of everyday memory ability, as measured by the Rivermead Behavioural Memory Test (RBMT; Cantonese version; Ng et al., 1998), was 16.2 (SD = 5.1, range = 6–24), which indicated that most had mild to moderate impairments in everyday memory function (Wilson, Cockburn, Baddeley, & Hiorns, 1989).
No significant differences in mean age, mean years of education, mean time from brain injury, and mean RBMT score were found across the two groups ($p = .055-.567$). In addition, no significant differences were found in the baselines of all dependent variables across the two groups ($p = .072-.971$), except for the significant differences in the baselines of the MI representation metacomponent correctness score ($p = .021$) and the MI total average metacomponent correctness score ($p = .043$; Table 2).

Regarding the results after intervention, a Mann–Whitney analysis indicated no significant differences between the change scores of the experimental group and those of the comparison group for the Key Search test ($p = .362$; Table 3). No significant difference was found in the change scores for the Key Search test of the two groups over the follow-up period ($p = .133$), although there was a negative drop in the change score for the experimental group (mean $= -2.1$; Table 4).

### Table 3. Comparison of Change Scores of Dependent Variables Between the Experimental Group and the Comparison Group

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Experimental Group</th>
<th>Comparison Group</th>
<th>Mann–Whitney</th>
</tr>
</thead>
<tbody>
<tr>
<td>RPM</td>
<td>M (SD)</td>
<td>M (SD)</td>
<td>U</td>
</tr>
<tr>
<td>Key Search test</td>
<td>3.9 (3.0)</td>
<td>2.8 (4.0)</td>
<td>103.5</td>
</tr>
<tr>
<td>Modified Six Elements test</td>
<td>1.5 (1.5)</td>
<td>0.7 (1.2)</td>
<td>77.0</td>
</tr>
<tr>
<td>MEPSM</td>
<td>3.3 (5.4)</td>
<td>0.7 (3.6)</td>
<td>77.0</td>
</tr>
<tr>
<td>Ratio</td>
<td>1.0 (1.4)</td>
<td>0.9 (1.1)</td>
<td>110.5</td>
</tr>
<tr>
<td>MI</td>
<td>1.4 (1.1)</td>
<td>1.0 (1.1)</td>
<td>94.5</td>
</tr>
<tr>
<td>Nat (Cor)</td>
<td>1.5 (1.3)</td>
<td>0.9 (1.4)</td>
<td>97.0</td>
</tr>
<tr>
<td>Plan (Cor)</td>
<td>0.9 (0.9)</td>
<td>0.3 (1.0)</td>
<td>81.0</td>
</tr>
<tr>
<td>Plan (Meta)</td>
<td>0.6 (0.8)</td>
<td>0.3 (1.1)</td>
<td>101.0</td>
</tr>
<tr>
<td>Rep (Cor)</td>
<td>0.9 (1.0)</td>
<td>0.2 (0.7)</td>
<td>68.5</td>
</tr>
<tr>
<td>Rep (Meta)</td>
<td>0.8 (1.1)</td>
<td>0.3 (0.7)</td>
<td>88.0</td>
</tr>
<tr>
<td>Mon (Cor)</td>
<td>0.6 (1.2)</td>
<td>0.5 (0.8)</td>
<td>115.5</td>
</tr>
<tr>
<td>Mon (Meta)</td>
<td>0.5 (1.0)</td>
<td>0.7 (1.0)</td>
<td>107.5</td>
</tr>
<tr>
<td>Total Cor</td>
<td>3.8 (2.5)</td>
<td>2.0 (0.8)</td>
<td>53.5</td>
</tr>
<tr>
<td>Total Meta</td>
<td>3.3 (2.7)</td>
<td>2.2 (1.2)</td>
<td>85.0</td>
</tr>
</tbody>
</table>

### Table 4. Differences in Change Scores of RPM, Key Search Test, and Modified Six Elements Test at Follow-Up Between the Experimental Group and the Comparison Group

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Experimental Group</th>
<th>Comparison Group</th>
<th>Mann–Whitney</th>
</tr>
</thead>
<tbody>
<tr>
<td>RPM</td>
<td>1.7 (5.1)</td>
<td>1.2 (3.4)</td>
<td>89.0</td>
</tr>
<tr>
<td>Key Search test</td>
<td>-2.1 (2.3)</td>
<td>0.1 (3.3)</td>
<td>34.0</td>
</tr>
<tr>
<td>Modified Six Elements test</td>
<td>-1.1 (1.8)</td>
<td>0.5 (0.5)</td>
<td>20.0</td>
</tr>
</tbody>
</table>

Note. $M = \text{mean; SD} = \text{standard deviation; RPM} = \text{Raven’s Progressive Matrices; MEPSM} = \text{Means–Ends Problem-Solving Measure; MI = Metacomponent Interview; Nat = Nature subtest; Plan = Planning subtest; Rep = Representation; Mon = Monitoring subtest; Total = Total average score; Cor = Average correctness score; Meta = Average metacomponent score; SPSVM = Social Problem-Solving Video Measure.}^* p \leq .05$

For the Modified Six Elements Test, a Mann–Whitney analysis indicated no significant differences between the gain scores for the experimental group and those for the comparison group, although the improvement in the higher gain score for the experimental group almost allowed the comparison group to meet the .05 cut-off point for significance ($p = .079$; Table 3). However, this benefit to the experimental group appeared to be somewhat lost over the follow-up period (change score: $T_3 - T_2 = \text{mean of} -1.1$; Table 4). By contrast, the comparison group, receiving only conventional training, made a gain over this period (change score: $T_3 - T_2 = \text{mean of} 0.5$), yielding a significant group difference ($p = .032$) for the follow-up change (Table 4).

For the SPSVM, the results of a Mann–Whitney analysis indicated no significant differences between the change scores for the experimental group and those for the comparison group for all of the subtest scores and for the SPSVM total score ($p = .083-.890$; Table 3).

For the MEPSM, the Mann–Whitney analysis found no significant differences between the change scores of either the number of relevant means or the relevancy ratio of the MEPSM for the experimental group as compared with the comparison group ($p = .139$ and .934, respectively; Table 3).

For the RPM, the results of a Mann–Whitney analysis indicated no significant differences between the change scores of the RPM total score for the experimental group as compared with the comparison group ($p = .470$; Table 3).

For the MI, the Mann–Whitney analysis found significant differences between the change scores of the experimental group and those of the comparison group for the representation metacomponent correctness score ($p = .041$) and the total average metacomponent correctness score ($p = .009$; Table 3).

### Discussion

The explicit problem-solving training approach emphasizing metacognitive principles showed greater effectiveness than conventional training only for the representation correctness.
subtest and the total correctness score of the MI measure using Mann–Whitney analysis. For both the representation correctness subtest and the total correctness score, there was a significant advantage for the experimental group at pre-intervention testing, possibly making the significantly greater change (gain) scores even more noteworthy.

The SPSVM, the MEPSM, and the Modified Six Elements Test—all far-transfer tasks focusing on real-life problem-solving skills—showed gain score differences for the experimental group compared with the comparison group, to the experimental group’s advantage. In the case of the Modified Six Elements Test, this difference nearly achieved significance using Mann–Whitney analysis. However, this advantage was lost in the follow-up result. Failure to find a statistically significant difference in these findings may have related to the small number of participants involved. No other key group differences were found on the remaining measures.

Given that the comparison group was receiving a highly regarded conventional cognitive training program, the fact that the experimental group had a significant advantage (on the MI measure) when exposed to the explicit metacomponential training suggests that explicit metacomponential training is of value in general problem solving for people with moderate ABI who are ≥1 year postinjury. The significant result for the MI total score is important in substantiating the effectiveness of explicit training in metacomponential strategy use. This explicit metacomponential training was the key difference between the experimental and the comparison programs. This finding is in line with those of prior studies on the value of explicit strategy training for patients with brain injury (Rath et al., 2003; von Cramon et al., 1991).

Moreover, it is effective, in spite of the suggestion by Lawson and Hopkins (1995) that for patients with brain injury, strategy training may impose an excessive cognitive load, especially for those with slower information-processing speed. The significant finding for the MI’s representation subtest revealed the effectiveness of explicit problem solving using metacomponential strategy training. In the training for problem representation, which the experimental group received, participants were first taught a strategy involving a switch from linguistic to spatial information, to be carried out systematically and in order of importance, by means of visualizing a mental picture. Second, they were given meaningful daily exercises so that they could practice visualizing mental pictures. We hoped that this metacognitive knowledge might become mentally embedded, thus enhancing their preserved representation skills. Solso (1998) stated that the way in which information is represented, in terms of visual imagery, is very important in representing a problem. Moreover, what patients with brain injuries or students with learning disabilities are less able to do than healthy people is to construct a mental representation of an action sequence and use higher-level strategies focused on problem representation (Giles & Clark-Wilson, 1993; Wong, 1995). By contrast, expert problem solvers seem to create more effective representations, spending time constructing representations of the problem at deep structural levels, using superficial characteristics stated in the problem (Andre, 1986; Gredler, 1997). Moreover, the formation of solutions to a problem may depend on the spatial form in which the problem is presented, and this procedure does not demand much working memory (von Cramon & Mattes-von Cramon, 1992). This study suggests that problem representation may be less reliant than other metacomponents on working memory, which may be weaker in patients with brain injuries. This might be one reason why explicit training, aimed at aiding representation of problems, appeared to be more successful than the training of other metacomponents.

However, it is of interest that we found no advantage to the experimental group in the SPSVM representation subtest mean gain scores (0.9 vs. 1.1), whereas group members achieved a significant difference in the MI representation subtest gain scores. One explanation is that this video measure did have a limitation in that a few participants scored at ceiling level in the initial assessment, leaving little room for improvement on experimental intervention.

One reason why we found few statistically significant group differences in this study could have been the limited length of time for the experimental intervention. Newly developed strategies may require a longer time to become embedded, especially for patients with slow information-processing speed (Fong, Chan, Ng, & Ng, 2009). Many studies have emphasized the importance of training length for transfer of problem-solving strategies, including that of von Cramon et al. (1991), which involved patients with brain injury. This study also included single-subject trend analysis, which suggested that for some participants, the full length of the intervention time along with the follow-up time was required to consolidate some of the metacognitive strategies (Fong & Howie, 2007).

**Limitations of the Study**

There were some possible threats to this study’s validity that could not be overcome within its practical limitations. The first was a history threat relating to participant withdrawals. However, these withdrawals were fairly evenly spread over the experimental and comparison groups and occurred before the final follow-up measure (Time 3) rather than before the crucial postintervention (Time 2) measurement point, thus limiting impact. Moreover, the sample was drawn from a convenience sample of patients with ABI recruited from an
outpatient occupational therapy department of a convalescent hospital in Hong Kong, which limited the sample’s representativeness and therefore the generalizability of the findings. However, the careful matching procedures used in the group allocation strengthen the study and enhance its rigor in comparison to most other studies of problem-solving interventions with patients with brain injury. Additionally, because the study took place in Hong Kong, the findings contribute to the cultural richness of the literature in this research area.

Another possible validity threat relates to the limited extent to which the measures were validated on and adapted for the Hong Kong Chinese population. Given the limited patient population available for the full intervention, carrying out prior validity studies on patients with brain injury in Hong Kong would have been very difficult. The key metacognitive measure used, the MI, and the two measures requiring use of metacognitive strategies in real-life problem-solving—the SPVSM and the MEP— all involved careful adaptation for the Hong Kong cultural context.

We did attempt to use a Mann–Whitney nonparametric approach by comparing only the change scores between two groups to reduce the possibility of Type II errors and to take into account the small numbers involved. Given such protection throughout, we made no further adjustment to the analyses or significance levels (the $p < .05$ level was used).

Previous studies have produced more beneficial results than this study, using behavior ratings or interviews in the natural environment (Foxx et al., 1989; von Cramon et al., 1991). However, Rath et al. (2004) reported that performance in role playing by patients with brain damage is independent of both self-reported problem-solving inventories and strategy tests, which may explain the different findings for this study.

We were not able to measure effectively how the participants themselves felt about the intervention programs. Kenneth Fong attempted to access patients’ viewpoints, but the resulting comments were very general, and more work is needed to develop a culturally sensitive instrument (including a problem-solving self-appraisal tool) that can enhance the investigation into client viewpoint and partnership in the research process. However, the multiple measures used in this study, including the key MI measure, add to the richness of research knowledge on how such innovative measures operate in association with an explicit metacognitive intervention by occupational therapists for patients with ABI in a unique cultural context.

**Future Research**

This study has identified certain issues that need to be taken into account in future research regarding the learning of brain-injured clients with moderate functional disability. It is clear that the training program developed in this study was valuable in enhancing problem representation and metacognition, but thought needs to be directed toward strengthening other problem-solving metacomponents. The intervention also needs to be conducted over a longer period of time and strengthened in its application of the metacomponential skills to real-life situations. In addition, replication of this study with a larger sample size would increase the study’s power and then possibly reveal more significant findings.

The use of formal training using explicit strategies to enhance problem-solving skills in everyday situations has already been listed among the evidence-based practice guidelines for postacute cognitive rehabilitation of people with brain injuries (Cicerone et al., 2000, 2005). This study contributes to the work relating to controlled studies in this area (Turner & Levine, 2004) and suggests the value of research in occupational therapy that explores the effectiveness of the metacomponential approach for outpatients with ABI.

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**References**


