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Facilitating independence in personal activities of daily living after a severe traumatic brain injury; preliminary findings.

Category of Submission: Research

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Abstract

Objective: The present study examined the effectiveness of two components of a treatment program typically used by OTs in personal activities of daily living (PADL) rehabilitation.
Design: A multiple baseline probe design across PADL tasks was used which is particularly suited to the examination of the effects of complex interventions on skill performance.
Subjects: Two male adults with severe brain injuries and cognitive impairments who were in the acute stages of recovery.
Interventions: OT treatment program consisted of a combination of errorless learning and strategy training approaches.
Main measures: The impact of the program was measured by the number of steps completed independently in each of these tasks, the level and type of assistance required, and by administering the UK FIM and the AMPS.
Results: Errorless learning and strategy training as used within an OT program was demonstrated to be effective in reducing the amount of assistance both participants required to complete the targeted PADL tasks. Further, there was evidence of generalization of training effects among trained and untrained activities.
Conclusions: Selecting and combining treatment techniques based on detailed assessment of functional performance is an area of high clinical importance but with limited research; the current study stands as an attempt towards that direction.

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Key-words: Traumatic brain injury, personal activities of daily living, rehabilitation, single-case experimental design.

Traumatic Brain Injury (TBI) is common and affects a predominantly younger population at a significant rate of 275/100,000 per year in the UK (Tennant, 2005). Despite the high incidence rates, the rate of death is low at 6-10 per 100,000 (NICE, 2007). This has resulted in higher numbers of survivors living with long-term disabilities that require specialist care. In particular, the majority of individuals with a neurological injury in the acute stages (88% - 95%) present with dependency in personal activities of daily living (PADL) (Grill et al, 2005). PADL refer to self care activities usually completed on a daily basis, such as bathing, dressing, grooming or toileting which are often a primary goal for neurological rehabilitation (Legg et al, 2006; Sunderland et al, 2006).

Typically, promotion of functional skills towards PADL training constitutes a large percentage of the occupational therapy (OT) interventions within neurological rehabilitation. Adaptation is the approach most commonly applied within functional skills training and there are two treatment techniques frequently used by OTs; strategy training (ST) and errorless learning (EL). ST refers to a hierarchical protocol developed by Heughten et al (1998) that provides a framework for providing instructions, assistance and feedback in accordance with patients' ability to initiate, execute and control an activity. EL is an approach whereby patients are taught to perform a new skill whilst they are prevented, as far as possible, from making mistakes (Page et al, 2006). Techniques such as backward and forward chaining are examples of this approach.

Undoubtedly, there have been notable gains within TBI rehabilitation research. However, there is still a lack of transparency regarding the active ingredients within rehabilitation interventions, which has caused them to be referred to as a 'black box' (Whyte and Hart, 2003). Further, there has been no research specifically investigating the effectiveness of PADL rehabilitation within the acute stages of recovery for TBI patients or the efficacy of specific interventions provided by OTs (Steultjens et al, 2005). Accordingly, the present study was designed to investigate the effectiveness of combining strategy training and errorless learning approaches within an individualized OT program in the treatment of selected PADL for individuals with cognitive impairment in the acute stages of recovery post TBI.

Method

Experimental design

A multiple baseline probe design across PADL tasks was used for each participant. This design is particularly suited to the examination of the effects of complex interventions on skill sequences in which successful performance on later steps in the sequence is impossible or unlikely before acquisition of its preceding steps (Barlow et al, 2008; Cooper et al, 2007).

Participants

Two male adults (Keith & Joe; pseudonyms) with severe brain injuries, who were in the acute stages of recovery, participated in the study. Keith was 47 years old and he was

admitted to Accident and Emergency (A&E) following an assault with a GCS of 4-5/15. When he entered the study (18 weeks post injury), aspects of his physical condition included limited passive and active range of motion (AROM) within right shoulder, reduced co-ordination and control in all four limbs and trunk with a wide based ataxic gait and high level balance problems. Joe was 58 years old and he was admitted to A&E following a fall at home which resulted in a large left acute subdural haematoma and a smaller right frontal haematoma. His GCS was 6/15 at the scene and 8/15 on admission. At the time he entered the study (25 days post injury), he presented right hemiparesis and impaired sensation, no AROM in right upper limb with increased tone throughout, no AROM right lower limb, and impaired static and dynamic sitting balance.

Further, both participants were assessed using the Westmead Post Traumatic Amnesia Scale (McCarter et al, 2007) the Apraxia Screen (Almeida et al, 2002) Assessment of Motor and Process Skills (AMPS, Fisher, 2003) and the UK Functional Independence Measure (FIM eg. Skinner and Turner-Stokes, 2006). Collectively, Keith displayed significant retrograde amnesia, poor insight and safety awareness and severely impaired ability to initiate, plan and problem solve within functional tasks. He presented with persistent levels of disorientation to place, time, and person and inability to recall any of 3 items after 1 minute delay; scoring an average of 4/12 on assessment with the Westmead Post Traumatic Amnesia (PTA) Scale (McCarter et al, 2007). However it residual memory deficits are common post TBI and he did not demonstrate any other characteristic behaviours described in PTA such as agitation, restlessness or wandering. Therefore he was deemed to have emerged from PTA based on repeated behavioural observations and in-depth functional assessment however determining emergence from PTA is an area of debate (Wilson et al 1999). He required prompting to initiate and complete all PADL as well as he needed supervision with indoor mobility and functional transfers in order to maintain safety. Joe presented attentional bias to left side, poor hand positions/distal differentiation and direction of movement, impaired attention and impulsivity within tasks, omission of key task steps, perseveration of movements and difficulty imitating actions after a short delay. He also had significant expressive dysphasia, dysarthria and oromotor apraxia. He was experiencing increased physical difficulty and effort when performing fairly simple PADL and had difficulties choosing appropriate objects, logically sequencing or modifying his actions to prevent and overcome potential problems. He was unable to mobilize and received full assistance with all PADL requiring assistance of two people with bed mobility and a hoist for all functional transfers.

The study was conducted in an acute neurosurgical unit within a regional neurosciences centre. Its protocol was approved by the School of Health Sciences and Social Care Research Ethics Committee at Brunel University and the Bromley Local Research Ethics Committee, whilst site specific approval was obtained from the respective Medical School Research Ethics Committee. Full written informed consent was also obtained from both participants.

Outcome measures

Three PADL tasks were selected for each participant. Each of these tasks was broken into smaller workable units/steps following specific suggestions and examples in the

literature for conducting a task analysis (eg. Stokes et al, 2004). The impact of the OT intervention was measured by the number of steps completed independently in each task, the level and type of assistance required. Steps were performed *independently* if they occurred within 5 seconds (secs) after the completion of the previous step in the sequence and in the absence of any further instruction or assistance. During baseline assessment if independent performance was not achieved within either this specified time during intervention or 2 minutes (mins) of the last instruction/step *assistance* was provided. Level and type of assistance were determined by collecting data for verbal and physical prompts as well as physical assistance. Whenever a respective verbal instruction or cue was provided to a participant for performing a step in the sequence, then it was measured as a *verbal prompt.* A *physical prompt* included any gestural cue such as miming how to apply deodorant, pointing to written/visual signs or indicating where to find or place items and physical facilitation which involved hand over hand guidance to enable the participant to initiate, continue or complete the task. Whenever verbal and physical prompts did not facilitate the successful performance of any step in the sequence, then direct *physical assistance* was provided; in essence the therapist completed most of the respective step for the participant.

Finally, the AMPS and the UK FIM were also used because they both have direct correlation with functional performance (Linden et al, 2005).

Procedure

During all conditions and sessions, the experimenter provided one verbal instruction/prompt; for example, 'brush your teeth'. Additional instruction such as verbal or physical prompting or assistance might be provided not only for preventing a possible task breakdown but most importantly for securing the safety of each participant.

Baseline probes. The purpose of the baseline probes was to evaluate participant performance in any given PADL task before the introduction of the OT intervention. During these sessions, one verbal instruction/prompt was provided by the experimenter and if the patient failed to initiate the next appropriate step within 2 mins of the instruction or the last step, a further prompt or assistance was provided and the patient was asked 'what's next?' However, if a participant requested help, initiated an action that would place him at risk, appeared frustrated or was at risk of becoming distressed, assistance was provided in less time. In essence, during the baseline assessment participants were allowed to make errors and assistance was mainly made available if there was a risk to them. A total of nine baseline probes were conducted - three per PADL task - for each participant to establish baseline levels of independent responding.

Occupational therapy (OT) treatment program. In addition to the assessments described previously, a detailed OT assessment based on the International Classification of Functioning (ICF, WHO, 2001) and a series of observation sessions with nursing staff whilst assisting each participant in PADL were conducted to identify possible PADL tasks for training. Thus, the individualized OT program for Keith included the PADL tasks of (a) showering, drying and applying deodorant (19 steps); (b) dressing upper and lower body (6 steps); and (c) brushing teeth (10 steps). For Joe, (a) upper body dressing (10 steps); (b) upper body washing, drying and applying deodorant (21 steps); and (c) lower body

washing, drying and dressing (24 steps) constituted the initial PADL tasks of his treatment program. It is worth mentioning, here, that the above tasks were chosen in agreement with each participant (ie. client-centred practice).

For both participants, the OT treatment program consisted of a combination of EL and ST approaches. Specifically, treatment techniques included verbal or gestural instructions/prompts, physical assistance (ie. hand over hand facilitation), elements of forward chaining (continual prompting focusing on achieving the initial steps first) chunking and whole task rehearsal, use of single-word written prompts or pictorial sequence cards, labelling clothing, environmental adaptations/modifications (eg. labelling the set location of all items, use of rails, positioning clothing and toiletries in a set place and in the correct sequence to collect, limiting environmental distractions, use of familiar objects etc.), verbalization of sequence, demonstration and concurrent imitation of parts of the task, (the therapist starting to put a shirt on at same time to cue patient), consistent and repetitive practice, pointing out key aspects of the task, or verbal feedback on aspects to focus on and use of mirror feedback.

Participant's performance across each step of any task was assessed through probes conducted by the experimenter before intervention sessions. The procedure was exactly the same as in baseline with one important exception. Following the experimenter's verbal instruction/prompt, assistance was provided if a participant failed to initiate the next appropriate step within 5 secs this time (instead of 2 mins) of the instruction or the last step. This was to ensure successful, safe, and timely task completion as well as to comply with the demands of one component of the intervention (ie. EL). One probe was taken and recorded before each intervention session. However, each of the initial three probes was taken after a minimum of three training sessions. These training sessions were essential because an EL approach may initially involve constant prompts which would negatively influence the level of assistance and independence recorded; however, this usually reduces as treatment progresses (eg. Kessels and De Haan, 2003).

Each intervention session was scheduled to last approximately 30 mins and two to three sessions were conducted on any one day for each participant, Monday to Friday. When each participant succeeded in performing 80% of the steps of a given task independently (ie. in the absence of any assistance or prompts) in three consecutive sessions then he was transferred to the next condition. It was also required that successful performance should be achieved within approximately 20 sessions (eg. Wilson and Manly, 2003).

Generalization

Untrained activity probes were conducted to assess the impact that training with one task might have had on the other PADL tasks. The procedure during these probes remained the same as in baseline. Further, generalization of PADL rehabilitation to other ADL performance was measured by administering FIM and the AMPS.

Post-treatment

This procedure was exactly the same as baseline and untrained activity probes. In the absence of any training, it was assessed whether successful responding maintained after a few days from the OT intervention had passed.

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Interobserver agreement

Inter-observer agreement was assessed on an average of 15% of all observations and at least one reliability session was obtained for each participant during all conditions. A senior occupational therapist (OTst) served as the second observer who was blind to the experimental conditions as well as to the objectives of the study. The percentage of the inter-observer agreement was calculated by dividing the number of agreements by the number of agreements plus disagreements, and then multiplying the result by 100. Minimum criterion for the acceptability of inter-observer reliability was set at 80% agreement (Cooper et al, 2007). Average agreement was 84% (range, 81% to 87%), across all dependent measurements. Finally, AMPS assessments were video recorded and rated by an AMPS trained OTst who was again blind to the purpose of the study.

Results

Figure 1 depicts the percentages of the steps that were completed independently within each session as well as those that Keith required assistance for across the three selected PADL tasks (ie. Task 1: showering, drying and applying deodorant; Task 2: upper and lower body dressing; & Task 3: brushing teeth). Following 3 baseline sessions, OT intervention was introduced for Task 1 and criterion performance was met within 20 sessions. Collectively, the percentages of the steps requiring assistance for Task 1 reduced from an average of 54% (range, 52% to 58%) per session during baseline to an average of 25% (range, 15% to 62%) during OT intervention whereas the percentages of the steps completed independently increased from 46% (range, 43% to 47%) to 75% (range, 47% to 85%), respectively. Similar percentages were obtained in the post treatment condition. At the time that intervention for Task 1 was in place, 10 and 11 probes were conducted to determine whether changes in participant's performance had occurred for Tasks 2 and 3, respectively, but in the absence of any intervention. Specifically, Keith's performance in Task 2 demonstrated a moderate improvement since percentages of the steps completed independently increased from an average of 22% (range, 0% to 50%) per session during baseline to an average of 47% (range, 35% to 67%) per session during untrained activity probes. The same average of 47% was recorded during the subsequent 5 intervention sessions for Task 2. The intervention was terminated unexpectedly as Keith was discharged to a nursing home prior to the completion of the study. For the same reason, intervention did not commence for Task 3. Nevertheless, his performance for this task was close to criterion performance in both baseline and untrained activity probes conditions.

[Insert figure 1 about here]

More details about the level and type of assistance provided for Keith during all conditions are presented in table 1. Collectively, the mean percentages of verbal prompts reduced from an overall average of 42.1% (range, 21% to 78%) per session during baseline to an overall average of 26.6% (range, 8% to 67%) per session during the remaining conditions and across all three tasks. Similar trends were observed for the physical prompts and physical assistance. Finally, Keith showed a clinically significant increase in his AMPS process score (0.51 logits) and a clinically meaningful increase in his motor score (0.31 logits); however, there was only a minimal increase (5 points) in his total FIM score (table 2).

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[Insert tables 1 & 2 about here]

Results for Joe's performance across his PADL tasks (ie. Task 1: upper body dressing; Task 2: upper body washing, drying and applying deodorant; & Task 3: lower body washing, drying and dressing) are presented in figure 2. In baseline, the percentages of the steps requiring prompts/assistance for Task 1 were at a very high level as evidenced by an average of 90% per session. During intervention, though, Joe's performance improved substantially, when the percentages of the steps requiring prompts/assistance dropped to an average of 45% (range, 20% to 80%) per session and criterion was met within 15 sessions. This average was further reduced to an impressive one of 18% (range, 10% to 30%) per session during the subsequent post treatment condition. At the same time probes for Tasks 2 and 3 showed some evidence of generalized independent responding. That is, percentages of the steps completed independently increased from the averages of 18% (range, 17% to 20%) and 15% (range, 13% to 21%) per session during baseline to the averages of 37% (range, 10% to 62%) and 36 % (range, 27% to 46%) during untrained activity probes respectively, for these two tasks. This patient was transferred to a specialist neurorehabilitation facility prior to the completion of the study; therefore, training was not completed for Task 2 or even commenced for Task 3. Nevertheless, changes in his performance within the 8 sessions of the OT intervention were remarkable since the percentages of the steps completed independently further increased to an average of 66% (range, 43% to 87% per session).

[Insert figure 2 about here]

The above improvements in Joe's performance are further illustrated in table 3 which presents the mean percentages of the level and type of assistance provided for this participant during all conditions. In general, the mean percentages of verbal prompts, physical prompts and physical assistance reduced from an overall average of 31.8% (range, 27% to 38%), 19.2% (range, 14% to 23%), and 34.7% (range, 25% to 41%) per session during baseline to an overall average of 18.5% (range, 0% to 42%), 4.9% (range, 0% to 22%), and 21.3% (range, 0% to 53%) per session during the remaining conditions and across all three tasks, respectively. Finally, Joe demonstrated a clinically significant increase in his FIM motor score (18 points) but showed a minimal decrease in his AMPs motor (0.03 logit) and a statistically significant decrease in his process scores (0.93 logits) (table 4).

[Insert tables 3 & 4 about here]

Discussion

The main aim of this research was to investigate the relationship between the provision of a short individualized occupational therapy program (23 to 25 treatment sessions) to two patients with cognitive impairments in the acute stages of recovery post TBI and their performance in PADL. Results showed that a combination of errorless learning (EL) and strategy training (ST) was effective in increasing performance independence for both participants, at an accelerated rate within the two targeted PADL tasks. These positive findings are in line with previous results indicating the effectiveness of PADL rehabilitation with patients in the chronic stages of recovery (eg. Mastos et al, 2007; Parish and Oddy, 2007) or following stroke (eg. Sunderland et al, 2006).

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Alongside the positive effects during direct training, there was evidence of some relative improvement within target behaviours in the untrained tasks for both participants. This could be attributed to a number of potential factors. First, spontaneous recovery might have played a role since both participants were in the acute stage of recovery (between 25 days to 4 months post TBI), when the potential for spontaneous recovery is thought to be relatively high (Trombly et al, 2002). Second, the design and administration of untrained activity probes provided participants with the opportunity to explore and attempt personal care tasks without assistance. Third, the administration of untrained activity probes essentially constituted a trial and error approach, whilst the therapist allowed errors and provided prompts and assistance whenever necessary and therefore some kind of experiential learning might have occurred. Fourth, although during the course of the intervention, functional tasks were not practiced outside of the OT sessions, the parallel provision of other therapeutic interventions such as physiotherapy or maximum nursing assistance might have had the potential to influence target behaviours. Finally, an alternative explanation is that the improvements just reflected a generalization of training effect between trained and untrained tasks as noted in previous studies (eg. Geusgens et al, 2006). This is further reinforced by the fact that there was not any clear establishment for generalization.

Inevitably, although essential if we are to ensure that high quality evidence-based practice is delivered to our patients, conducting research within a real world setting with multiple changing variables presents challenges to the researcher, and this study was not without its limitations than inform routes for further research. For example, whilst it is important to obtain a stable data pattern before introducing the intervention, this was not consistently achieved due to time constraints of the study. Even if baseline was extended it might be likely that stability in the data would not be achieved, as variability of performance due to poor sustained attention is common in TBI (Dockree et al, 2006). Furthermore, although at the time of recruitment it was anticipated that both patients would be on the unit for the entire duration of the study, unavoidably they were both discharged prior to its completion; a typical risk when conducting research within an acute setting. However the positive outcomes identified in this study and literature to support early rehabilitation post TBI indicates that it is appropriate to commence intervention within the acute setting to optimise recovery and reduce the risks of learnt dependency. Also, there was the potential for interdependency between PADL tasks; however, the use of a more diverse range of tasks, might not be clinically relevant or appropriate in the acute setting where the primary concern is establishing independence in PADL (Grill, 2005). Nonetheless, an area of significant further research is the establishment of the mechanisms that may produce generalized effects of the training across more diverse range of contexts and tasks. Questions regarding sample size are often raised in relation to single-case experimental designs and have been addressed elsewhere (eg. Johnston and Pennypacker, 2008). The search for functional relations between dependent and independent variables is advanced if experimental control over behaviour can be demonstrated. This we demonstrated for each of the participants. Of course, replication with additional patients needs to be addressed in future studies.

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Designing and monitoring an effective intervention places high demands on the clinician (Mastos et al, 2007) and it is important that the tools used to evaluate outcomes of intervention are informative and guide practice. Global ADL measures such as the AMPS offer valuable information regarding treatment approach and an overview of ADL efficiency and independence, but cannot provide in-depth information regarding the daily effectiveness of treatment interventions. For example, Joe demonstrated deterioration within his AMPS assessment despite the positive gains he had demonstrated in the trained tasks! On the contrary, the use of single-case experimental methods (eg. a multiple baseline probe design) offers immediate feedback regarding treatment effectiveness based on direct and repeated measurements of the target behaviour. Thus, these methods can provide a powerful set of tools for the clinicians to evaluate their practice and make data-driven decisions as well as share progress with patients and adjust treatment approaches (eg. Morgan and Morgan, 2001), addressing sufficiently the demands for evidence-based and client-centred practice in health care provision.

Conclusions

- Individuals with cognitive deficits after a severe TBI can improve their performance in personal ADL following a short OT program comprising of a combination of errorless learning and strategy training approaches.
- Improving rehabilitation practice will become more promising when clinicians can constantly evaluate their practice and make data-driven decisions; the use of single-case experimental methods can efficiently facilitate this process.

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Legends for figures

1 Percentage of steps completed with assistance and independently across tasks during the baseline, OT intervention, post-treatment and untrained activity probes conditions for Keith. Shaded areas indicate those occasions when probes were taken after a minimum of three training sessions.

2 Percentage of steps completed with assistance and independently across tasks during the baseline, OT intervention, post-treatment and untrained activity probes conditions for Joe. Shaded areas indicate those occasions when probes were taken after a minimum of three training sessions.

Legends for tables

1 The mean percentages (range) of the level and type of assistance - verbal and physical prompts, physical assistance - provided for Keith across all conditions.

2 The FIM and AMPS main scores before and after intervention for Keith.

3 The mean percentages (range) of the level and type of assistance - verbal and physical prompts, physical assistance - provided for Joe across all conditions.

4 The FIM and AMPS main scores before and after intervention for Joe.

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Competing interests

None competing interest declared. The authors alone are responsible for the content and writing of the paper.

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Table 1. The mean percentages (range) of the level and type of assistance - verbal and physical prompts, physical assistance - provided for Keith across all conditions.

	Verbal prompts	**Physical prompts**	**Physical assistance**
Task 1			
Baseline	40 (35-40)	3 (2-5)	11 (10-13)
OT Intervention	19.5 (16-41)	2.5 (0-11)	3 (0-11)
Post-treatment	18.5 (16-21)	7.5 (7-8)	0 (0-0)
Task 2			
Baseline	62.5 (40-78)	0 (0-0)	15.5 (11-22)
Untrained probes	30 (8-67)	10 (0-20)	13 (0-28)
OT Intervention	44 (26-67)	4.8 (0-12)	4.2 (0-14)
Task 3			
Baseline	24 (21-30)	0 (0-0)	0 (0-0)
Untrained probes	21 (11-32)	3.8 (0-11)	.7 (0-8)

Table 2. The FIM and AMPS main scores before and after intervention for Keith.

	FIM [a]		AMPS [b]	
	Baseline	**Post Intervention**	**Baseline**	**Post Intervention**
Motor Score	81 / 112	85 / 112	0.33	0.64
Cognitive/ Process Score	21 / 35	22 / 35	-0.64	-0.13
Total Score	102 / 147	107 / 147	N/A	N/A

Note: [a] FIM stands for Functional Independence Measure
[b] AMPS stands for Assessment of Motor and Process Skills

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Table 3. The mean percentages (range) of the level and type of assistance - verbal and physical prompts, physical assistance - provided for Joe across all conditions.

	Verbal prompts	**Physical prompts**	**Physical assistance**
Task 1			
Baseline	33.5 (33-35)	19 (14-21)	37.5 (34-40)
OT Intervention	22 (8-40)	9.5 (0-22)	13.5 (0-31)
Post-treatment	9.5 (0-30)	2.5 (0-18)	6 (0-14)
Task 2			
Baseline	33 (29-38)	18.5 (16-22)	30.5 (25-36)
Untrained probes	20.2 (13-42)	4.1 (0-10)	38.7 (22-53)
OT Intervention	15.2 (0-29)	2.3 (0-11)	16.5 (18-29)
Task 3			
Baseline	29 (27-32)	20 (15-23)	36 (29-41)
Untrained probes	25.8 (18-41)	6.3 (0-12)	31.9 (25-46)

Table 4. The FIM and AMPS main scores before and after intervention for Joe.

	FIM [a]		AMPS [b]	
	Baseline	**Post Intervention**	**Baseline**	**Post Intervention**
Motor Score	35 / 112	53 / 112	0.70	0.67
Cognitive/ Process Score	16 / 35	16 / 35	0.58	-0.35
Total Score	51 / 147	69 / 147	N/A	N/A

Note: [a] FIM stands for Functional Independence Measure
[b] AMPS stands for Assessment of Motor and Process Skills

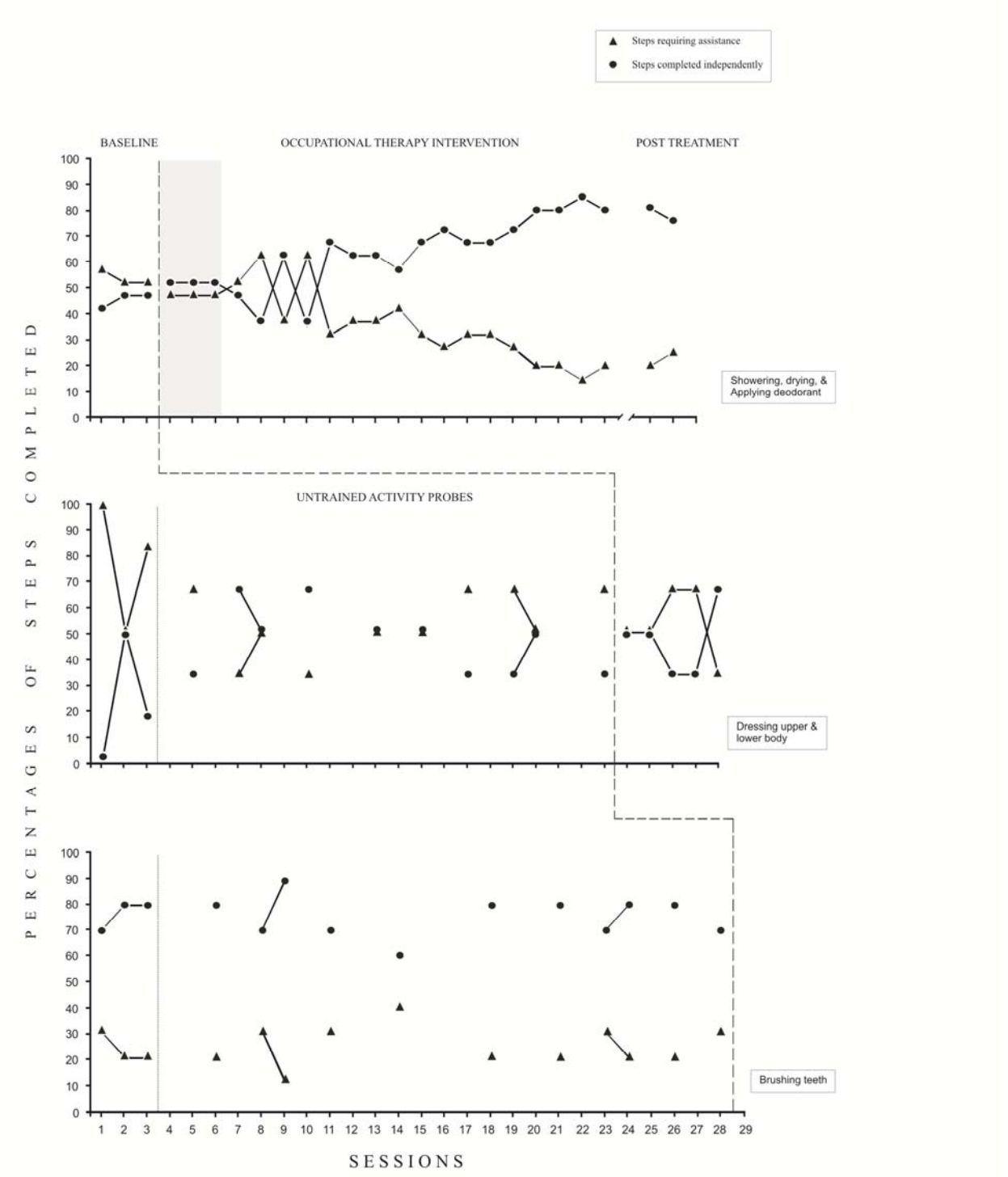

Figure 1.

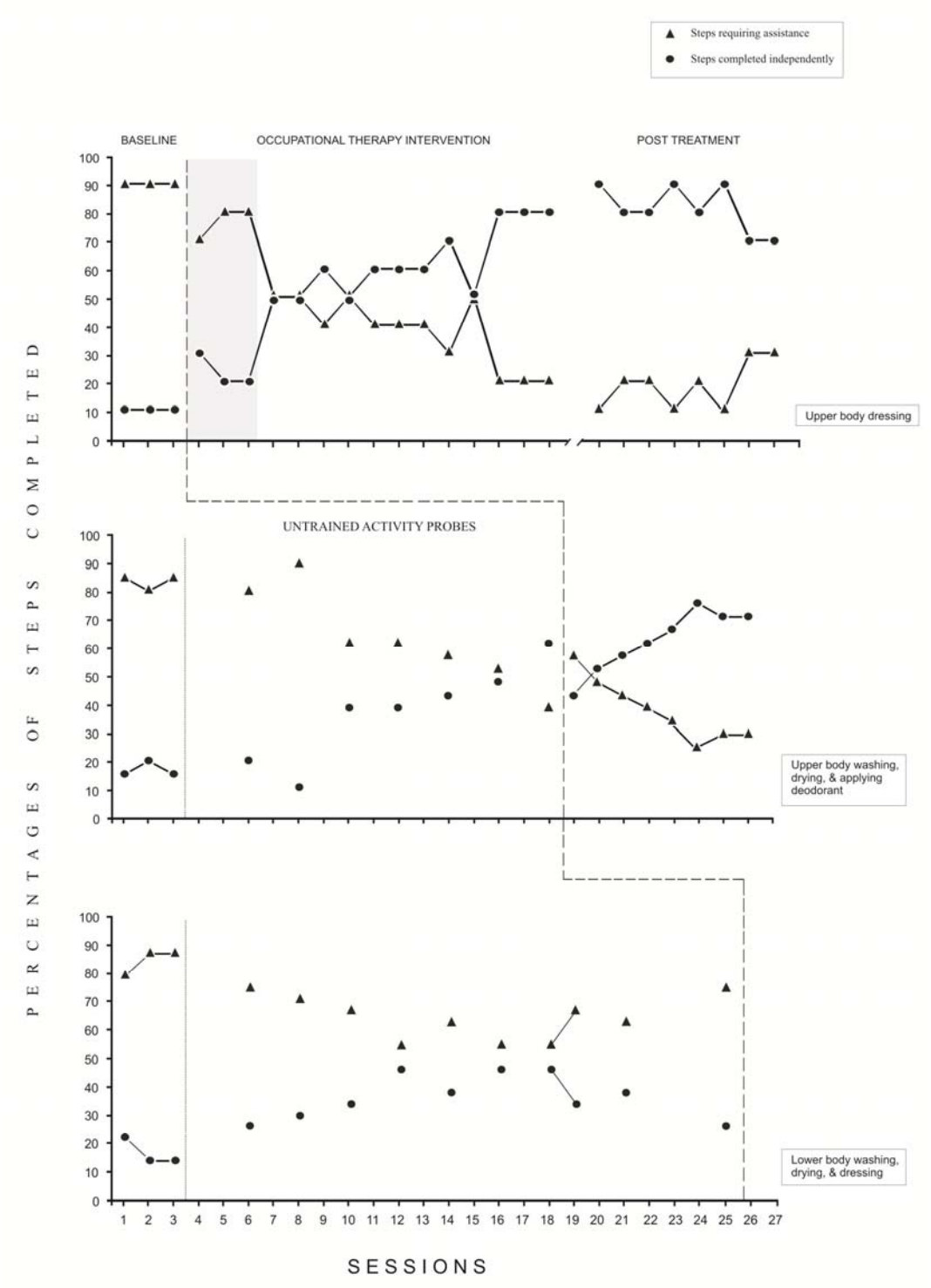

Figure 2.