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INTELLECTUAL FUNCTION TRAINING IN ADULTS WITH ACQUIRED BRAIN DAMAGE

Evaluation

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ABSTRACT. Intellectual Function Training (IFT) is an occupational therapy method for remediating cognitive functions in patients with acquired brain damage and has been presented in a previous paper. It has been evaluated by comparing a group of trained patients (n=13) using the IFT method with a control group (n=13) which underwent conventional rehabilitation. The trained group received IFT for 40 min each day, 5 days a week for about three months. Age, education and neurologial status did not differ between the groups. The measurement methods of evaluation were Intellectual Function Assessment (IFP) and three psychometric test batteries. At the beginning of the study there was no significant difference in any subtest between the two groups. After the training period there was a significant difference of at least $p<0.05$ between the trained and the control group in the IFP battery, except for the Long-term Memory subtest. The improvement for the trained group was evident six months later at the time of the follow-up measurement, clearly indicating a significant difference between the groups. In one psychometric subtest a significant difference of $p<0.01$ was found. Within the experimental group over the study time there was a slight increase in performance which was notable in seven of the psychometric subtests $p<0.05-p<0.001$. The positive effect of IFT is considered to be specific for the type of task in which the patients were trained, while evidence of the effect on general intellectual function is inconclusive. The results of the evaluation suggest that IFT is a valuable occupational therapy method in the rehabilitation of patients with acquired brain damage.

Key words: cognition disorders; brain injuries, rehabilitation; occupational therapy

An occupational therapy programme, Intellectual Function Training (IFT), has been developed for remediation of intellectual dysfunctions in patients with acquired brain damage and is presented in detail in an earlier paper (6). Over a period of 2–3 months the patient, under the guidance of an occupational therapist, works through the IFT method, which consists of a large number of pen-and-paper tasks. The literature of occupational therapy, rehabilitation medicine and neuropsychological remediation therapy contains few evaluation studies. What studies there are of neuropsychological remediation character (1, 8) have proved that patients taking part in remediation programmes improve their cognitive ability compared to control patients. To the present authors' knowledge, there are no evaluation studies on the effect of occupational therapy training of intellectual functions in CVA patients.

The aim of the present study was to compare the training effects in a group following the IFT method with those in a control group of patients undergoing conventional rehabilitation.

METHOD

The participants in the present study were selected from patients with acquired brain damage and in general cerebrovascular disease (CVA), who had been referred to three rehabilitation clinics. The population of this study (n=31) fulfilled the following three inclusion criteria during the period 1978-08-14–1981-12-29: age 20–65 years, first assessment of the study completed between two and seven months after the first onset of the disorder and that the patient had no previous history of brain damage.

Those patients who, on neurological examination, exhibited signs of intellectual dysfunction (agnosia, aphasia, apraxia, acalculia, amnesia and symptoms of frontal lobe damage) were referred for an interview with an occupational therapist. If the O.T. judged the patient to be motivated and able to take part in the IFT programme, an intellectual function assessment (IFP)[1] was carried out. Where a qualitative and a quantitative analysis of IFP showed that the patient had difficulties in solving the items of IFP, she/he became a participant in the present study. The study involved 31 patients who were divided into two groups. The experimental group (n=16) comprised patients who were referred to the rehabilitation clinic at Danderyd hospital,

[1] IFP is an abbreviation of the equivalent Swedish term (intellektuell funktionsprövning). IFP will be presented separately.

Table I. *Review of study sample*

Patient	Age	Sex	Education	Occupation	Medical diagnosis
Experimental group (n=13)					
1	40	F	Lower secondary	Nursing orderly	Haematoma subduralis sin op
2	46	M	Upper secondary	Architect	Hemiparesis sin post embolia
3	64	F	Lower secondary	Nursing orderly	Status post meningioma regionis frontalis sin op
4	36	M	Elementary	Electrician	Contusio cerebri. Op: Resectio lobi frontalis dx
5	29	M	Lower secondary	Building worker	Status post contusio cerebri, lobi frontalis sin
6	59	M	Elementary	Clerk	Status post haemorrhagia subarachnoidalis
7	44	M	Upper secondary	Auditor	Hemiparesis dx post aneurysma arteriae basilaris
8	51	M	Lower secondary	Banker	Hemiparesis sin, infarctus arteriae cerebralis mediae
9	39	M	Upper secondary	Teacher	Hemiparesis dx, insultus arteriae carotis
10	32	M	Upper secondary	Doctor	Contusio cerebri frontalis
11	38	M	Upper secondary	Photographer	Hemiparesis dx post contusio cerebri
12	28	F	Upper secondary	Teacher	Contusio cerebri
13	54	M	Lower secondary	Ship captain	Hemiparesis sin, thrombosis arteriae cerebri mediae
Control group (n=13)					
1	49	F	Upper secondary	Laboratory worker	Hemiparesis dx post haemorrhagia subarachnoidalis
2	57	F	Lower secondary	Clerk	Hemiparesis sin, thrombosis arteriae cerebri mediae
3	36	F	Elementary	Clerk	Hemiparesis sin post thrombosis
4	61	M	Lower secondary	Lathe operator	Hemiparesis sin post haemorrhagia subarachnoidalis
5	59	M	Lower secondary	Electrician	Haemorrhagia cerebri
6	59	M	Lower secondary	Office manager	Hemiparesis sin post thrombosis
7	57	M	Elementary	Engineer	Hemiparesis dx post thrombosis
8	25	M	Upper secondary	Teacher	Hemiparesis sin post thrombosis
9	47	M	Upper secondary	Engineer	Hemiparesis dx post contusio cerebri
10	49	F	Elementary	Executive	Haemorrhagia subarachnoidalis
11	55	F	Lower secondary	Teacher	Haemorrhagia subarachnoidalis arteriae communicans arterioris dx
12	47	F	Lower secondary	Salesman	Hemiparesis sin post infarctus
13	51	F	Elementary	Cashier	Hemiparesis dx post haemorrhagia subarachnoidalis et thrombosis fronto-basilaris

and the control group (n=15) comprised patients referred to other rehabilitation clinics.

A review of the population regarding age, sex, education, occupation and medical diagnosis is given in Table I, regarding the main symptoms of intellectual dysfunctions in Table II and regarding medical examinations in Table III.

Design

In the present study a nonequivalent control group design (7) was used (Fig. 1).

As the two groups were not selected by randomization, critical background variables were checked as follows. The experimental group was compared to the control group regarding age (U=1.7), the time elapsing from the onset of the disorder to IFP1 (U=1.3), the time between IFP1 and IFP2 (U=0.4) and the time between IFP2 and IFP3 (U=0.5). In the above variables there was no statistically significant difference between the groups, when tested with the Mann-Whitney U-test. Both the experimental and the control group participated in a general medical rehabilitation programme, including occupational therapy and physiotherapy, and had access to a psychologist and a speech therapist.

Experimental group

The experimental group comprised 13 patients, 10 men and 3 women with a mean age of 43 years (range 28–64 years). Two patients dropped out whilst experiencing crisis reactions, one before the training began and the other after the training period.

Control group

The control group comprised 13 patients, 6 men and 7 women with a mean age of 41 years (range 24–64 years).

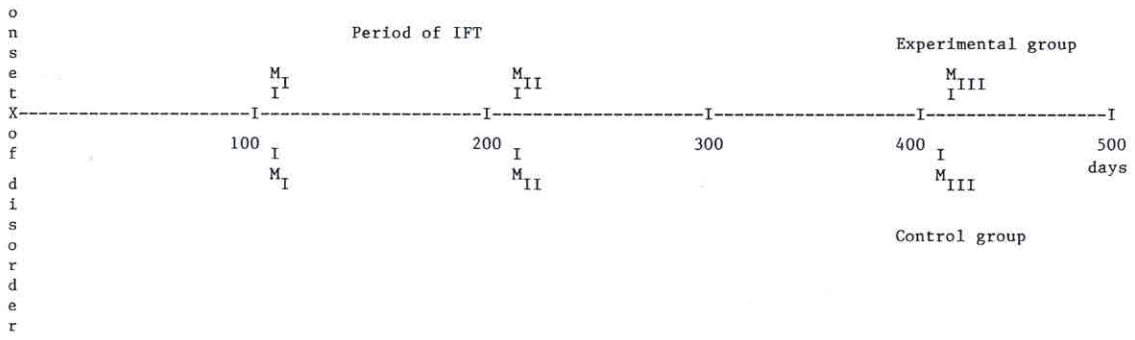

Fig. 1. Design of the study.

Two patients dropped out. One woman died and one man disappeared before the third measurement.

Intellectual function training (IFT)

The IFT-programme in which only the experimental group participated, is described in detail in an earlier article (6). Each patient received a mean number of 60 (range 52–68 s15) training sessions with the programme over a mean period of 142 days (range 89–185 days). Each training session lasted between 30 and 60 min. Sessions were held 4–5 days a week. The IFT was conducted by the same occupational therapist (I. S.) throughout the entire study, and was individualized for each patient. Table IV presents an overview of the tasks used.

Assessment methods

The effect of IFT was assessed using IFP and psychometric test batteries.

Table II. *Main symptoms of intellectual dysfunction*

Symptoms	Experimental group (n=13)	Control group (n=13)
Visual objectagnosia	5	7
Simultaneous agnosia	4	5
Colour agnosia	2	3
Prosopagnosia	1	1
Anosognosia	3	6
Unilateral neglect	3	4
Visuospatial agnosia	6	8
Constructional apraxia	3	6
Dressing apraxia	4	4
Afferent motor aphasia	1	1
Acoustic mnestic aphasia	2	2
Semantic aphasia	1	2
Alexia	1	1
Agraphia	3	1
Acalculia	4	8
Disturbance of arousal	5	5
Amnesia	8	11
Disturbance of problem solving	5	4

Every patient showed one to four different symptoms.

IFP consists of three booklets which include 75 items each, containing paper-and-pencil material. The 75 items (IFP), are divided into 8 subtests: visual perception ability (IFP:P), spatial ability (IFP:S), verbal understanding (IFP:V) and verbal fluency ability (IFP:W), numerical ability (IFP:N), short-term memory (IFP:Mk) and long-term memory ability (IFP:Ml) (5 items only) and logical ability (IFP:L). The three IFP batteries were administered by an occupational therapist on the separate measurement occasions (see Fig. 1). IFP1 was given at the beginning of the study, measurement time point 1 (M_I), at the end of the IFT period or at the corresponding point for the control group, IFP2 measurement time point 2 (M_{II}), and IFP3 six months later, measurement time point 3 (M_{III}).

The psychometric test batteries (PM), consist of the CBV

Table III. *Clinical examination*

	Degree of impairment			
	None	Slight	Moderate	Serious
Experimental group (n=13)				
Voluntary motor function				
Arm	4	5	0	4
Leg	5	4	3	1
Sensibility function				
Superficial	8	2	3	0
Deep	9	1	2	1
Activities of daily living	4	5	2	2
Control group (n=13)				
Voluntary motor function				
Arm	3	5	1	4
Leg	4	4	3	2
Sensibility function				
Superficial	9	3	1	0
Deep	10	1	2	0
Activities of daily living	5	4	2	2

Table IV. *Intellectual function training tasks used by the experimental group (n=13)*

Factor	Subsections	Number of patients	Factor	Subsections	Number of patients
P	Eye–hand coordination (1–2)	4	N	Concept numbers	0
	Figure–background (3–6)	5		Arithmetical numbers (2–8, 12)	6
	Perceptual synthesis (7–9)	5		Arithmetical words (9–11)	3
	Combinations	4		Systems of measurement (13–20)	6
S	Body awareness (1–3)	6	MK, ML	Memory learning through visual perception (1–3)	9
	Position in space (4–10)	7		Memory learning through auditory perception (7–9)	7
	Three-dimensional design (11–14)	6		Combinations (4–6)	4
V, W	Matching Word–picture (1–6, 18)	4	L	Serial understanding (1–4)	6
	Filling in words (7–9)	3		Word, analogies games (5–8)	8
	Description of words (10–11)	6		Classification (8–9)	3
	Word game (12–14)	4		Conclusions (10–13)	9
	Stories (15)	4			
	Rebuses	2			
	Cross-words	3			

scale (4), the SRB battery (3) and the memory test battery (2). The PM consists of the following subtests: Information (Info.), Comprehension (Com.), Arithmetic (Arit.), Similarities (Sim.), Vocabulary (V), Picture completion (P.c.), Picture arrangement (P.arr.), Digit span (Digit), Block design (Block), Figure one (F.one), Word pairs one (W.one), Personal data one (P.one), Figure two (F.two), Word pairs two (W.two) and Personal data two (P.two). These PM batteries were administered by four psychologists at the beginning of the study, which corresponded to M_I, and again at the end of the study (M_{III}).

Statistics

The statistics used in this study was a two-way analysis of variance (ANOVA), split-plot repeated measurements design, followed by orthogonal comparisons (5). The distribution of scores was found to be approximately normal when studied separately, in groups and by measurement time points.

RESULTS

Comparisons between the groups

Tables V and VI show the results of the ANOVA. For IFP:IFP (Table V), a significant group × time factor was found, which means that the groups have developed differently. In order to ascertain where the difference between the groups lay, orthogonal comparisons were made. These comparisons do not show

Table V. *Results of study (IFP)*

Test battery	*F*-value for interactions group × time		Between groups Measurement time point: (one–two, three)						*F*-value for orthogonal comparisons Within groups over time					
									Experimental group (M_I, M_{II}, M_{III})			Control group (M_I, M_{II}, M_{III})		
	$F_{g\times t}$	df	M_I	*n*	M_{II}	*n*	M_{III}	*n*		df	*n*		df	*n*
IFP:IFP	18.62***	(1,72)	<1 NS	26	24.3***	26	16.3***	26	53.8***	2,48	13	2.5 NS	2,48	13
IFP:P	4.59*	(1,72)	<1 NS	26	14.6***	26	13.3***	26	15.6***	2,48	13	<1 NS	2,48	13
IFP:S	7.87**	(1,72)	1.1 NS	26	11.9**	26	16.9***	26	20.6***	2,48	13	<1 NS	2,48	13
IFP:V	4.10*	(1,72)	<1 NS	26	4.4*	26	<1 NS	26	10.9***	2,48	13	1.1 NS	2,48	13
IFP:W	4.90*	(1,72)	<1 NS	26	6.8*	26	1.7 NS	26	11.4***	2,48	13	<1 NS	2,48	13
IFP:N	6.28**	(1,72)	<1 NS	26	14.6**	26	4.8*	26	9.7***	2,48	13	<1 NS	2,48	13
IFP:Mk	2.40(*)	(1,72)	<1 NS	26	4.1*	26	3.7(*)	26	7.7***	2,48	13	<1 NS	2,48	13
IFP:Ml	5.90 NS	(1,72)							5.9**	2,44	13	5.9**	2,48	13
IFP:L	2.81(*)	(1,72)	1.9 NS	26	12.4***	26	13.2***	26	8.9***	2,48	13	<1 NS	2,48	13

(*) =$p<0.10$. * =$p<0.05$. ** =$p<0.01$. *** =$p<0.001$.

Table VI. *Results of study (PM-test)*

Test battery	*F*-value for interactions group × time		Between groups Measurement time point: (one–two, three)				*F*-value for orthogonal comparisons Within groups over time					
							Experimental group (M_I–M_{III})			Control group (M_I–M_{III})		
	$F_{g\times t}$	df	M_I	*n*	M_{III}	*n*		df	*n*		df	*n*
PM:Info.	3.0(*)	(1,24)	<1 NS	14	1.0 NS	14	<1 NS	1,12	7	2.14 NS	1,12	7
PM:Com.	0.58 NS	(1,26)					5.2*	1,13	8	5.2*	1,13	7
PM:Arit.	5.69*	(1,26)	<1 NS	15	3.9 NS	15	2.7 NS	1,13	8	3 NS	1,13	7
PM:Sim.	0.44 NS	(1,26)					<1 NS	1,13	8	<1 NS	1,13	7
PM:V	1.88 NS	(1,26)					<1 NS	1,13	8	<1 NS	1,13	7
PM:P.c.	5.84*	(1,26)	<1 NS	15	8.6**	15	9.8**	1,13	8	<1 NS	1,13	7
PM:P.arr.	2.11 NS	(1,26)					7.2*	1.13	8	<1 NS	1,13	7
PM:Digit	0.42 NS	(1,26)					<1 NS	1.13	8	<1 NS	1,13	7
PM:Block	1.26 NS	(1,20)					<1 NS	1.20	8	<1 NS	1,20	9
PM:F.one	0.66 NS	(1,20)					7.7*	1.20	10	7.7*	1,20	12
PM:W.one	1.57 NS	(1,19)					4.7*	1.19	10	4.7*	1,19	11
PM:P.one	0.27 NS	(1,19)					<1 NS	1.20	9	<1 NS	1,20	9
PM:F.two	0.99 NS	(1,19)					29.0***	1.19	10	29.0***	1,19	11
PM:W.two	1.57 NS	(1,18)					10.0**	1.18	10	10.0**	1,18	10
PM:P.two	0.47 NS	(1,19)					<1 NS	1.18	10	<1 NS	1,18	10

(*) $=p<0.10$. * $=p<0.05$. ** $=p<0.01$. *** $=p<0.001$.

any difference between the experimental and the control group at M_I. However, there was a significant difference ($p<0.001$) at M_{II} and M_{III}. The remaining subtests of the IFP battery were analysed in the same way and except for the group × time factor in "long-term memory" the results were significant. For the "verbal understanding" (V) and "verbal fluency" (W) subtests there was a significance between the groups at M_{II} ($p<0.05$) but not at M_{III}. In the psychometric test battery (PM) (Table VI) there were no significant group × time factors in any of the subtests except for "PM:Info.", "PM:Arit." and "PM:P.c." ($p<0.05$). When studying the orthogonal comparison to locate the difference between the groups, no-significance effects were found at M_I and M_{III} except for subtest "PM:P.c.". However a significant difference between the groups was found in "PM:P.c." at M_{III} ($p<0.01$).

Comparisons over time within groups

The orthogonal comparisons within the experimental and control groups for periods M_I–M_{II}, M_{II}–M_{III} and M_I–M_{III} were studied.

Experimental group

Table V shows that significant improvements were found for all IFP battery results over time. Results of the PM test battery (Table VI) show improvement in the following subtests; "PM:Com.", "PM:.P.c", "PM:P.arr.", "PM:F.one", "PM:W.one", "PM:F.two" and "PM:W.two" at least $p<0.05$.

Control group

For both time comparisons there are significant differences in the ML subtest of the IFP battery (Table V) and in the following psychometric subtests, "PM:Com.", "PM:F.one", "PM:W.one" "PM:F.two" and "PM:W.two" ($p<0.05$) (Table VI). In these subtests, which are not mentioned above, the results were non-significant for both measurement occasions.

DISCUSSION

The results of the present study show that patients treated with the IFT programme improve their intellectual functions more than a control group treated only with an ordinary rehabilitation programme. The results also show that the improvement is attributable to changes in the experimental group while the control group hardly changed at all. The patients in the experimental group increased their task-solving ability, especially in the IFP-battery, where items are similar to those of the training material itself. This may explain the evident difference between the two

measurement methods: the larger number of significant levels of the IFP battery compared to the single subtest "picture completion" (PM:P.c.) in the psychometric battery. This underlines the fact that the results of the IFT programme seem to be specific, indicating that the patient has learnt strategies for solving problems of this type. The ability to transfer these strategies to activities of practical importance in daily life may be questioned, and further investigations will be undertaken to elucidate this.

The study sample was too small to permit generalization. The selection of subjects was not randomized. However, score distribution was found to be approximately normal in both groups, so that lack of randomization has probably not influenced our conclusions. IFT produced no obvious effect on the IFP battery subtest "Long-term Memory" when the groups were compared. The explanation may be that the training material was inadequate or that the type of brain dysfunction treated is more resistant to training by IFT. Within-group improvement in the "memory test battery" over time may be ascribable to the general rehabilitation programme.

The results of the present study may have been influenced by factors that were uncontrolled: IFT is a new method of treatment in occupational therapy (published in 1982) and the fact that the same therapist carried out both IFT and IFP may have increased the expectations. The reason that this quasi-experimental method was used, was that there was only one original example of the IFT material and IFP manual. This had been developed (6), and was available at, the Rehabilitation Clinic (DH). There may also have been a Hawthorne effect in the form of the longer individual training period and the attention shown to the patients in the experimental group.

Furthermore, the individual diagnoses are not comparable and may have different prognoses due to differences in brain plasticity. This may have affected the result in spite of the fact that the patient was not allotted to both groups. However, in our opinion, the variables mentioned above have not affected the significance of the improvement after training in the IFT programme.

Few controlled studies relating to remediation effects of brain-damaged patients are available, but there are three which are in accordance with this study. Carter et al. (1) have evaluated the effect of cognitive skill remediation in stroke and non-stroke elderly people trained in a way similar to IFT. The training comprised 30–40 min sessions, three times a week for four weeks. Visual scanning, visuo-spatial orientation, short-term memory, verbal learning and time-judging skills were trained. A comparison of the pretest–post-test improvement scores showed significantly greater overall improvement for the remediation patients compared to the control patients. The result in that study also tallies with the present study in that memory free recall ability did not improve.

Carter also noted a greater improvement over time in the experimental group compared to the control. Weinberg et al. (8) have evaluated the specific training effect of systematic training of visual perception deficiency, and later extended the training to include sensory awareness and spatial cognition (9). The training period was 20 hours and the result was evaluated by measuring 26 variables. This revealed that the performance of the experimental group was better than that of the controls. The authors also noted that multiple treatment produced greater generalization than the original single-treatment programme. In the present study, seven factors were trained over 60 hours, which also resulted in a general increase in performance in the IFP battery and subtests, and this agrees with Weinberg's results.

The long-term effect of the IFT method is evident. However, the slight decrease in performance of the experimental group referred to the subtests "verbal fluency ability" and "numerical ability" of the IFT battery may be explained by the presence of so few aphasia patients (Table II), who were trained with IFT material of verbal character.

This study was carried out in the area of clinical reality and therefore it is impossible to control all variables, so alternative interpretations are possible. The true answer of using the IFT method can be given when further investigations about other diagnoses of brain damage than CVA, and individual studies with control of other treatments within the rehabilitation programme, have been made. For the present, it may be concluded that the IFT method is clinically valuable within occupational therapy.

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The Intellectual Function Training Material is available in Swedish from Psykologiförlaget AB, Box 461, 126 04 Hägersten.

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