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Title: Can body awareness training improve recovery following stroke: a study to assess feasibility and preliminary efficacy.

Introduction

Body awareness has been defined as "an interactive process that includes sensory awareness originating from the body's physiological states, processes (including pain and emotion), and actions (including movement) and is shaped by an individual's attitudes, perceptions, beliefs and experience of their social and cultural context". (1) (p.2) Body awareness (via internal representations) is a key platform used in the processing of body information including perception, decision making and action, and provides accurate data for precise movement control.(2) Impairments in body awareness are associated with decreased participation and performance in everyday activities after stroke. (2) However, it is unclear whether a rehabilitation approach directly targeting body awareness could improve recovery.

One type of body awareness training (BAT) is the Feldenkrais Method (FM), a somatic education approach developed by Moshe Feldenkrais. The method aims to facilitate individuals to self-organise and become self-directed learners by increasing consciousness and awareness of how the body performs tasks and utilizes attention, perception, and imagination in order to improve coordination, control, movement ease, efficiency, effectiveness and function. (3-11) Importantly, FM builds upon the theoretical foundations in motor control and motor learning principles,(6, 7, 9, 12) including intrinsic and extrinsic feedback; task-specific; variable practice; repetition; part and whole practice; transfer of learning; mental practice; exploratory learning; body awareness/image,(3, 9, 10, 13-18) and aims to induce changes in individuals' motor behaviour patterns through developing the practice of cognitive enquiry. This focuses on shifting attention from the goal (outcome) of

movement to bodily sensations and perceptions through specific guided movements (process). (6, 9, 10) It is suggested when a movement pattern is explored through cognitive enquiry, new internal representations are formed in the brain leading to more efficient motor planning and execution. (19)

Awareness Through Movement (ATM) is an application of FM conducted in a group format where the teacher guides structured sessions using verbal cues.(20) This format can be conducted in the community in a group environment which increases engagement, adherence, quality and feedback, and anyone of any level of physical fitness can participate. A typical ATM comprises a beginning body scan for the participants to orient to their current level of body awareness and particular states and traits. This is followed by structured explorations of movement sequences with key prompts for attention – in particular noticing where movement does and doesn't occur in various body areas, and the level of ease/effort. The lessons complete with a review of the body scan to highlight any changes (learning). However, experts must deliver at a central location and participants need to travel. Alternatively, home-based ATM classes are potentially more feasible and low cost, but engagement and quality may be reduced. (6, 21)

While a number of studies have investigated the effectiveness of this method, they include a wide range of participant ages and pathologies making it difficult to quantify effectiveness for a specific clinical population.(10, 12) The purpose of this study was to first explore the feasibility and safety of a body awareness program (FM) specifically after stroke, and second, identify the preliminary efficacy of class-based lessons compared to the delivery of home-based lessons on sensation, awareness, motor impairment, self-efficacy and quality of life.

Methods

A mixed methods design consisting of a two-armed pilot randomized controlled trial with a nested qualitative descriptive study was employed and reported using the CONSORT guidelines. The criteria for study participation were people considered typical of community-dwelling stroke survivors, likely to still require rehabilitation: a diagnosis of stroke (three months to six years) and discharged from all inpatient and outpatient rehabilitation programs; an ability to provide informed consent or from a guardian/family member; any domain and level of stroke-related physical impairment/s (i.e. weakness, sensory loss, incoordination); an ability to follow two-step verbal instructions; and aged 18 years or over.
Ethical approval was obtained from the University of South Australia Human Ethics Committee and the governing recruitment site (Central Adelaide Local Health Network). This trial was registered with the Australian and New Zealand Trial Registry (ACTRN12618001271291) and performed in accordance with the ethical standards in the Declaration of Helsinki. All participants provided written informed consent.

Following consent and baseline testing, participants were randomized to class or home-based groups using a computer-generated, blocked sequence (10 per group), and allocated by a person not involved in recruitment, intervention or assessment (SH). This sample size was selected based on the minimum participants required for a feasibility study.(22) Participants were blinded to the nature of the research question and all measures were conducted pre- and immediately post-intervention by a blinded assessor.

The intervention consisted of two lessons of 45-minutes in duration delivered each week for 10 weeks (total of 20 sessions) to both groups. The class-based group (experimental) participated in lessons in a face-to-face setting at a metropolitan hall. The home-based group (control) participated in lessons individually, by listening to emailed audio-recordings in their

home. Adherence was monitored via an attendance roll (class-based group) and by weekly phone calls and email contact (home-based group). Participants in both groups received lessons from the 'Awareness Through Movement for the Elder Citizen' program.(19) The program involved a series of ten lessons that targeted the learning of strategies to improve balance, coordination, flexibility and overall proprioceptive orientation. The lessons were simple and aimed at sensorimotor skills relevant for basic daily function, such as getting up from lying, sitting, rolling and turning. These lessons have been analysed from a motor control and learning point of view (see appendix 1). Class-based group lessons were conducted by two experienced and trained neuro-physiotherapists and Feldenkrais practitioners. Each lesson was repeated twice per week, at least two days apart, with a primary focus on body awareness and quality of movement. The home-based group received the same lessons via audio-recording recorded by another experienced Physiotherapist and Feldenkrais practitioner (SH) to perform at home alone. All participants continued with usual care while undertaking the program.

All participants completed baseline testing of sensation (Erasmus Nottingham Sensory Assessment Upper Limb- EmNSA-UL); body awareness (Body Perception Disturbance-BPD UL and LL Scale, Multidimensional Assessment of Interoceptive Awareness- MAIA); self-efficacy (Stroke Self-Efficacy Questionnaire- SSEQ); quality of life (Stroke Impact Scale- SIS, Stroke Specific Quality of Life Scale- SSQoL); and motor impairment/function (Fugl-Meyer Upper Extremity- FMA-UE and Lower Extremity-FMA-LE, Motor Activity Log- MAL, Ten metre walk test- 10MWT, Patient Specific Functional Scale- PSFS). Feasibility was tested by recording attendance during each lesson for the class-based group and by weekly phone calls for the home-based group. Qualitative interviews were conducted after the program finished (appendix 2), this included narrative accounts and numerical

counts of participants experience. Safety was similarly captured by monitoring for adverse events during and after each group class or during the weekly phone call to the home-based participants.

Analyses were performed in IBM SPSS Statistics 25 with significance level set at $p<0.05$. Between-group analysis was performed for age (independent t-test), time since stroke (Mann-Whitney U Test), and sex (Fisher-Exact Test). Linear Mixed Models analyzed response to treatment. For each clinical outcome measure, fixed effects of VISIT (pre, post), GROUP (class, home) and VISIT x GROUP effects were determined. Pairwise comparisons adjusting for multiple comparisons (Bonferroni) were performed to calculate the mean difference, standard error and significance at each time point. Safety and feasibility were analyzed and reported descriptively.

Interviews were analyzed using an inductive qualitative content analysis and numerical counts of participants experience were extracted. (23) All interviews were recorded and transcribed verbatim. An analysis of manifest content (objective, evidence that is directly seen such as words in an interview) and not latent content (subjective, refers to the underlying meaning of content such as the interpretation of an interview) were employed. Each transcribed manuscript was read independently by two people (IS and CF) not involved in the intervention or the interviewing process. Open-coding of each transcript was undertaken independently by both researchers and transferred to an Excel spreadsheet (Microsoft Excel 2019 Version 16.26). (24) Meaning units were determined from content relating to the same central meaning. Each unit was then labelled with a code by the researcher that summarized the meaning of the data. After initial coding, the two researchers independently categorized the coded data and then met to discuss the coding and

categorization, to ensure consensus. This continued until all meaning units were incorporated into categories and themes. (23) Comparison between individual researcher's impressions of the data and agreement on coding was established by regular discussions during the analysis process.(23, 24)

Results

Twenty participants entered the trial within the data collection period of three months, with 16 (80%) completing the program (Figure 1). Most participants had a 'moderate' disability post-stroke (see table 1 for demographics and stroke details). Four participants (two per group) dropped out within the first three weeks due to anxiety, transportation difficulties and fatigue. Therefore, eight people completed the class-based program (age 62-89 years, five male, five left hemiparesis) and eight completed the home-based program (age 48-80 years, eight male, six left hemiparesis). There were no differences between-groups for age ($t_{(14)}$=1.69, p=0.113); time since stroke (U=16, p=0.105); or gender (p=0.200).

Program feasibility, adherence and acceptability of the intervention in the class-based group was very good with 87.5% of participants achieving a 100% adherence rate and completing all 20 lessons within the 10-week timeframe, while the remainder completed a minimum 80%. While for the eight in the home-based group adherence was variable, with half of the group completing over 75% of lessons and the other half less than 50%. The timeframe of the program for the home-based group was conducted over a longer time period of 13-25 weeks, with participants completing less than two sessions a week compared to the two sessions for the class-based group. Lack of adherence in the class-based group were due to medical issues or illness, while for the home-based group adherence was difficult due to time restrictions

(busy daily life), lack of motivation or were not convinced of the value of the program. No adverse events were reported in either group. An attrition rate of 20% in each of the two groups was observed prior to the commencement of the study, again due to time restrictions and other medical issues.

Pre- and post-intervention data to explore the aim of preliminary efficacy, are summarised in Table 2. Analyses revealed significant GROUP by VISIT effects for the arm and leg motor impairment scales (FMA-UE p=0.025 and FMA-LE p=0.005 respectively) with a 5.50 (4.24) and 6.00 (-3.63) point improvement in the class-based group compared to a 1.00 (2.78) and 1.13 (1.89) in the home-based group, respectively for the FMA-UE and FMA-LE (see table 2 and appendix 3). There was also a significant GROUP by VISIT effect for body awareness on the MAIA (p=0.002), with a 12.6 (7.61) point improvement (class-based group) compared to 0.31 (4.70) (home-based group); and a significant GROUP by VISIT effect for quality of life using the SIS total (p=0.002), with a 19.5 (11.5) point improvement (class-based group) compared to a deterioration of -0.88 (9.39) in the home-based group. The MAL, EmNSA-UL and LL, 10MWT, BPDUL and LL, SSEQ and SIS% did not show significant change in either group (p=0.109-1.000).

Seven main questions were administered (using numerical counts) to summarize and understand individual participants' experience of the programs. Two participants did not wish to participate in an interview (one in each group) due to time constraints (see appendix 4). Acceptance and perceived effects were greater for the class-based group than the home-based group regarding satisfaction with the program, feeling better after involvement in the program, preference for group lessons, and likelihood to continue practice of the FM following program completion.

Analysis of the interviews raised three themes of *Awareness, Achievement, and Connection* (see appendix 5 and 6). Individual comments from these themes are highlighted in Box 1-3. Within the theme *of Awareness,* the category *Awareness of what the body and brain can do* was derived. Although fewer statements in the home-based group, this was the only category for which both groups shared. Participants reported greater awareness of the connection between their mind and body, and how this translated into their movement. The sub-categories also highlighted a heightened sense of awareness following the completion of the body awareness program.

The theme of *Achievement* was categorized as *Achieved more and Gained Confidence* in the class-based group, whereas *Achieved same or better* and *needed self-motivation* was reported in the home-based group. The class-based group showed a clear interest and like for the program; they appreciated the ability to do more and wanted to improve with reports of an increase in self-confidence as well as functional ability including getting on and off the floor and performing daily activities. While in the home-based group many perceived they had not changed. Like the class-based group, the home-based emphasized the need for a good attitude; to be self-motivated and determined to continue with rehabilitation. They also reported the program needed to be personalized and adapted to the individual.

The final theme of *Connection* was categorized into *Helped by/liked connections, comparisons and therapists* in the class-based group, whereas *Wanted feedback and social connections* was reported in the home-based group. The importance of the therapist and a connection with others for feedback, company and socialization, comparison and motivation were of utmost importance for the class-based group. Similarly, while this was also reported

by the home-based group, they recognized and sought the need for a therapist and social connection for company, comparison and motivation.

Discussion

This pilot study was the first to investigate the effect of a body awareness program (Feldenkrais Method) on sensation, awareness, motor impairment, self-efficacy and quality of life in a typical community-dwelling stroke population. We found that feasibility, tolerance and adherence to the intervention was high when delivered in a class-based format but reduced when delivered as a home-based, audio-recorded program. The program was safe and no significant adverse effects were reported or observed in either group. The home group took longer to complete and had reduced adherence, perhaps reflecting the effect of peer-group versus individual motivation. Participant drop-out and withdrawal rate although low and equally distributed between groups was an issue. However, this likely reflects working with a patient group (physical challenges for people with stroke) so 100% adherence is very unlikely.

Qualitative data supported the study's numerical findings. The main theme that both groups drew upon was *'awareness of what the brain and body can do'*. Even though this was stronger in the class-based group, both groups were able to derive this essential link from the program. The preliminary efficacy of this pilot trial suggests superior effects being found for body awareness, motor impairment and quality of life when delivered as a class-based group. In addition to the statistically significant group level improvements for the class-based group, the minimal clinically important difference (MCID) for the FMA-UE (6.6 points) and FMA-LE (3.4 points) were exceeded in the class-based group.(25) Similarly, the MCID for the SIS total (4.5-17.8 points) was exceeded by the class-based group.(26) These promising results

suggest a body awareness program delivered in a class-based group might be therapeutically beneficial for improving arm and leg impairments and quality of life.

The existing quantitative literature around BAT has focused on different outcome measures making it difficult to draw direct comparison with the findings of this current study. One study by Batson 2005 conducted a non-randomized pilot study of BAT post-stroke using the FM approach. They demonstrated contrasting effects as the SIS% did not change significantly but SIS total significantly improved. (7) Four other studies have conducted trials using a different type of BAT. Two RCTs conducted by Bang 2014(27) and 2015,(28) involved intensive three- and four-week programs, and both reporting the experimental and control groups showed significant improvements across the activity-based domains of balance and mobility compared with baseline results. However, the experimental BAT group showed greater improvements in balance and walking, and a larger change across the body function and activity-based domains of vision, perception and daily activities compared to the control. Lindvall 2014 (29) and 2016 (pilot RCT, (30) similarly investigated the use of BAT, reporting no significant differences between the experimental and control group.

No research to date has qualitatively explored the experience of body awareness focusing on FM (ATM) in people with stroke. The BAT study(30) by Lindvall 2016 identified five key themes: facing one's limitations, individualized movements, a feeling of harmony, integrated knowledge, and frustration and doubt. These align well with the observations in this study because both groups reported how the program forced them to face individual limitations related to their stroke, and through this discomfort it allowed them to develop a new awareness and explore a different way of using their body. It also highlighted the need for personalization and individual adjustments and feedback. Importantly, the previous research and this study's findings showed individuals developed a greater sense of wellbeing, patience

and confidence. Individuals were able to integrate these new 'movement awareness' changes and patterns of thinking into daily life, ultimately improving their engagement, participation and overall quality of life.

There are limitations to this pilot RCT. The sample size was small and not powered for a phase one clinical effectiveness trial. Consequently, no definitive statement on the usefulness of body awareness for this overall population can be made based on the present results. A post-hoc power calculation following completion of the study indicates a future effectiveness trial will require a sample size of n=55 participants per group. Further we had broad inclusion criteria to ensure a pragmatic sample of community-dwelling stroke survivors rather than specific stroke types. The lack of distribution of females to males in the home-based group may also have impacted on the findings. It may be important to acknowledge the class-based group tended to have lower baseline scores across measures compared to the home-based group potentially increasing the opportunity for greater improvement, however the mixed models analysis takes this into consideration. The relatively unstructured (unsupervised) home-based group led to a longer intervention period and coupled with a less 'intense' experience could have impacted on results. However, both formats were taught from the same transcripts meaning there was a level of standardization across both groups. We chose the home-based delivery as a control because it allowed a meaningful active comparison (unlike a sham or usual care control). However, this group was conceptualised to control for content only, not as a true group alternative. This pragmatic trial highlighted the importance of personalization and the difference between face-to-face group sessions versus voice recordings at home. Inherent adherence to monitor engagement in the program's content, in addition to adherence to attending the program was documented in the face-to-face group but not for the home group. Attempts were made to measure engagement via self-

report (phone calls) and further validation through qualitative interviews. Additionally, standardized personalization and monitoring adherence to the content of the program in the home-based group could be considered via digital means such as video.

This trial pre-dates the Covid-19 pandemic and the increased focus on telerehabilitation. Future trials could investigate the differential effect of face to face versus on-line group delivery or differentiate the effect of an active movement class with and without cues for awareness. Implementing longer-term follow-up assessments after the program would demonstrate whether the effects of the body awareness movement program are sustained over a longer period of time. Finally, the development of a reliable and valid body awareness measure specifically for stroke is now required prior to further intervention trials. The BPD measure appeared to gather the basic responses intended and in a timely fashion; however, its overall psychometric strength should be determined to appropriately assess and isolate all aspects of body awareness in stroke.

This is the first study to use mixed methods to investigate the effect of a body awareness intervention on sensation, awareness, motor impairment, self-efficacy and quality of life outcomes following stroke. The findings from this pilot study are promising and appear to support the notion that participation in this program, particularly a class-based delivery of the Feldenkrais Method (ATM) program per se, in comparison to a home-based program can provide benefits and may be useful for people after stroke. This therapy might supplement current rehabilitation methods, providing opportunity to deliver more holistic rehabilitation to assist recovery of body awareness impairments. These results strongly support further high-quality research being conducted to investigate the effectiveness of this rehabilitation method

for individuals after stroke, using larger samples and more responsive and specific body awareness measures.

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Table 1 | Demographics

Participant total n=16	
Gender, n (male, female)	13, 3
Side affected, n (left, right)	11, 5
Age (years)	68.4
Time since stroke (years)	2.8
Type of stroke, n (ischemic, haemorrhagic)	8, 8
Modified Rankin Scale, n 1 2 3 4	Category 2 4 7 3

Table 2 | Baseline (pre) and follow-up (post) results of body awareness training program on recovery measures

Domain	**Measure**	**Class-based group (mean +/- SD)**		**Home-based group (mean +/- SD)**		**P-value**
		Pre	**Post**	**Pre**	**Post**	
Sensation	EmNSA UL tactile	18.0 (13.4)	24.5 (11.2)	23.5 (10.9)	24.8 (10.9)	0.172
	EmNSA UL proprioception	7.00 (2.83)	7.13 (2.47)	7.50 (0.93)	7.63 (1.06)	1.000
	EmNSA LL tactile	20.0 (14.2)	26.8 (11.0)	24.4 (7.58)	23.8 (9.24)	0.082
	EmNSA LL proprioception	7.00 (2.83)	7.75 (0.71)	7.75 (0.71)	7.75 (0.71)	0.334
Body Awareness	BPDUL	15.3 (11.2)	17.8 (10.7)	19.8 (11.5)	19.6 (11.8)	0.319
	BPDLL	10.3 (9.62)	17.3 (10.7)	19.5 (11.6)	19.4 (11.9)	0.109
	MAIA	18.4 (7.44)	31.0 (2.72)	24.4 (6.87)	24.7 (5.43)	0.002*
Self-Efficacy	SSEQ	89.0 (39.8)	91.9 (28.1)	90.5 (27.3)	87.4 (31.1)	0.407
Quality of Life	SIS total	188.1 (38.2)	207.6 (39.4)	203.6 (29.5)	202.8 (25.6)	0.002*
	SIS %	49.1 (21.0)	50.0 (26.9)	53.8 (23.3)	50.0 (23.3)	0.618
	SSQoL	161.1 (41.6)	166.1 (37.9)	159.6 (30.0)	171.8 (27.3)	0.230
Motor Impairment/ Function	MALQOM	1.61 (1.91)	1.51 (1.71)	1.26 (1.31)	1.12 (1.09)	0.951
	MAL AOU	1.57 (1.92)	1.64 (1.81)	1.41 (1.38)	1.33 (1.12)	0.580
	FMA- UE	35.0 (23.9)	40.5 (20.5)	42.4 (20.4)	43.4 (19.7)	0.025*
	FMA- LE	20.9 (9.46)	26.9 (6.40)	23.9 (5.89)	25.0 (7.17)	0.005*
	10MWT	55.7 (53.7)	54.2 (54.7)	43.2 (48.0)	37.3 (38.7)	0.503
	PSFS	1.95 (2.00)	3.54 (2.17)	2.77 (1.38)	3.64 (1.74)	0.371

Abbreviations: BPD (Body Perception Disturbance Scale); EmNSA UL tactile (Erasmus modified Nottingham Sensory Assessment-Upper Limb); FMA-UE (Fugl-Meyer Assessment- Upper Extremity); MAIA (Multidimensional Assessment of Interoceptive Awareness Questionnaire); MAL QOM/AOU (Motor Activity Log- Quality of Movement/Amount of Use); PSFS (patient specific functional scale); proprio. (proprioception); SSEQ (Stroke Self-Efficacy Questionnaire); SIS (Stroke Impact Scale); SSQoL (Stroke-Specific Quality of Life Scale); 10MWT (Ten-Metre Walk Test)

Awareness

Class-based

"…to be shown again how to actually use the part of your body that's working well and to be able to get up was a bit of a revelation when it happened" (P7)

"…feel more aware of my body, don't think I could feel where things even were but after the program could feel where I was touching and where things were" (P2)

Home-based

"…every movement that you make you have to think about it, so thought I was just trying to reinforce that link between brain and limb" (P12)

"negatively, it brought home certain things I find very difficult to do and I don't dwell on but made me think about it" (P9)

Box 1: Examples of participants responses categorised as awareness.

Achievement

Class-based

"… all challenging but doing things initially afraid of and finding I was able to do it was important" (P5)

"…certainly being able to work out how to get up and off the floor was confidence building in a way because you really lose confidence when you fall over, it does shake you up" (P7)

Home-based

"would have been nice personally if focused on leg because that's the bit I want to get going" (P12)

"…come to the realization it's a slow process recovery. Have to have patience and it's just going to take time" (P13)

Box 2: Examples of participants responses categorised as achievement.

Connection

Class-based

"...it was good to be with a group of people with similar injuries. The experience of being with a group of people that have the same sort of issues, realize not the only one that has that sort of problem" (P6)

"...really astounded and gave positivity to see how well others were doing, wonderful to see their ability to stand up from the seat on their own and also seeing the person lying down most of the time trying so hard with certain things" (P2)

Home-based

"...certainly like to do it in a group for the social and motivation" (P12)

"...one to one would have been beneficial in the early stages of the program, being supervised if doing slightly incorrectly instead of sorting them out for myself and potentially continuing them incorrectly- followed by group, don't get out and meet a lot of new people, relationships between different people doing the same thing" (P9)

Box 3: Examples of participants responses categorised as connection.