

Multidimensional scaling analysis of techniques used by physiotherapists in Southeast Australia: A cross-national replication

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Much of the research concerning techniques used by physiotherapists has focused upon electrothermal agents, so neglecting fundamental questions concerning practice and differences in technique use. A recent study in England addressed these deficits, and determined that techniques were used in ordered combinations which differentiate the profession into 'typologies' or specialities. The purpose of the present study was to determine whether a similar picture would emerge in Australia, and to determine the type and extent of technique use amongst Australian physiotherapists. This replication study comprised a questionnaire survey of 141 hospital physiotherapists working in Southeast Australia. Information concerning the range and frequency of techniques used over the preceding six months was obtained. Descriptive analyses indicated high frequency use of exercise therapy, manipulation, heat packs, massage and ultrasound. Multidimensional scaling revealed a clear structure concerning combination use of techniques, and a coherent typology based on this usage. Differentiation of the profession according to the typologies supports the specialist areas identified in England, namely respiratory, neurological and orthopaedic/musculoskeletal physiotherapy. A further subdivision of the latter was possible in Australia, with the emergence of both a manipulative speciality and an exercise rehabilitation speciality. While this study confirms the findings of the earlier research, it identifies important differences in practice between Australia and England. [Turner P (2002): **Multidimensional scaling analysis of techniques used by physiotherapists in Southeast Australia: A cross-national replication. *Australian Journal of Physiotherapy* 48: 123-130**]

Key words: Exercise Therapy; Methods; Questionnaire; Specialism

Introduction

The treatment techniques used by physiotherapists have been a source of considerable research interest to the profession for several decades (Robertson and Spurr 1998).

Physiotherapy practice encompasses a broad range of activities that include management and research skills, in addition to an expanding range of techniques. Given this breadth of professional activities, the ongoing monitoring of clinical practice is essential from the standpoints of both education and research. If undergraduate curricula are to remain relevant, it is essential to determine which techniques have become redundant, so time is not wasted on the acquisition of unnecessary skills (Aston-McCrimmon 1984, Robertson and Spurr 1998). In the context of evidence-based practice, knowledge of which techniques are in frequent use enables research to be specific and focused.

Many studies have focused mainly upon usage of electrothermal techniques (Lindsay et al 1995, Robertson and Spurr 1998, Robinson and Snyder-Mackler 1988). The consistent finding of most of these studies is the widespread and frequent use of ultrasound, TENS and local

heat (Lindsay et al 1995, Robertson and Spurr 1998, Turner and Whitfield 1997). According to Roebroeck et al (1998), Dutch physiotherapists used ultrasound on almost a quarter of patients treated, and frequently combined ultrasound with massage. In Canada, techniques rated as important to practice were electrotherapy (ultrasound in particular), exercise therapy and special techniques like Bobath techniques, and proprioceptive neuromuscular facilitation (PNF) (Aston-McCrimmon 1984).

In Australia, according to Dennis (1987a), physicians referring patients to private practitioners most frequently requested ultrasound and short wave diathermy, followed by exercise and passive manipulation. A further survey of Australian private practitioners indicated that 45% of treatment time was devoted to passive manipulation, 22% to electrotherapy, 20% to exercise and 13% to soft tissue techniques (Dennis 1987b). In later surveys of electrothermal technique use among private practitioners in Australia and Canada (Lindsay et al 1990 and 1995, Robinson and Snyder-Mackler 1988) over 90% of respondents ranked ultrasound and heat packs as the most frequently used techniques. Continuous short wave diathermy was used by more than 60% of Australians (Lindsay et al 1990), but by less than 10% of Canadian physiotherapists (Lindsay et al 1995), an apparent disparity

Table 1. Frequency of technique use. Techniques list provided in the questionnaire, abbreviations, percentage of respondents per frequency category (total number of respondents = 141) and median frequency of use.

Technique	Abbreviation	Never	(% respondents)			Median score (IQR)
			*Rare	*Regular	*Frequent	
Acupuncture	Acu	95.0	2.8	0.8	1.4	0 (0-0)
Electrical stimulation	E-stimulation	42.1	23.6	28.8	19.9	1 (0-5.5)
Ice	Ice	15.0	18.5	18.3	48.2	6 (2-8)
Interferential	Interferential	33.6	15.7	15.0	45.7	3.5 (3.5-8)
Infrared	IRR	93.5	3.5	0.8	2.2	0 (0-0)
Local Heat	L-heat	7.1	12.2	12.7	68.0	8 (5-9)
Short wave diathermy - Continuous	Swd-c	84.3	8.6	4.3	2.8	0 (0-0)
Short wave diathermy - Pulsed	Swd-p	85.7	8.3	4.9	1.1	0 (0-0)
Transcutaneous nerve stimulation	TENS	22.9	30.1	27.1	19.9	3 (1-6)
Ultrasound	US	7.1	15.8	14.0	63.1	8 (4-9)
Neuro/motor/development techniques	Neuro	45.0	13.6	12.2	29.2	1.0 (1-8)
Massage	Mass	7.1	11.5	22.0	59.5	7.6 (5-9)
McKenzie	McKenzie	15.0	16.4	21.4	47.2	6 (2-8.8)
Passive mobilising/manipulation	PMT	10.7	4.3	10.4	74.6	9 (6-10)
Exercise	Ex	2.1	0.7	4.2	93.0	10 (9-10)
Hydrotherapy	Hydro	42.1	11.3	5.0	41.6	2 (2-9)
Proprioceptive neuromuscular facilitation	PNF	30.7	33.0	18.6	17.7	2 (2-5)
Respiratory	Resp	30.7;	12.9	12.5	43.9	5 (5-9)
Strapping/Splints	Strap/splint	11.5	16.5	24.4	47.6	6 (2-8)
Suspension	Susp	50.0	13.6	14.9	21.5	0.5 (0-7)

From 10cm analogue scale with extremes marked 'never used' and 'daily'. Never used = <5%; Rare = 5-39%; Regular = 40-69%; Frequent = 7-100%. IQR = interquartile range.

that might be accounted for by the five-year gap between these two studies. According to Robertson and Spurr (1998) in their survey of Australian facilities providing undergraduate physiotherapy clinical education, short wave diathermy was used by few facilities, but ultrasound, hot packs, TENS and interferential were techniques in frequent use.

A wider survey of the extent and type of treatment techniques used by physiotherapists in National Health Service (NHS) hospitals in England indicated frequent, widespread use of exercise therapy and most electrothermal modalities (Turner and Whitfield 1997). Non-electrothermal techniques used by over 70% of respondents, included respiratory, neurological and passive mobilisation/manipulation techniques (Turner and Whitfield 1997). The latter authors considered, however, that the insight into physiotherapy practice afforded by this exclusive focus upon the relative frequency of technique use is limited, because this fails to address the questions of combination technique use, and whether differences in usage exist amongst physiotherapists. By using multivariate-scaling analyses on their data, Turner and

Whitfield (1997) identified a clear structure concerning combinations of techniques used, with a coherent typology based upon this usage. Differentiation of the profession was possible according to the use of particular technique combinations, and three natural specialisms emerged, namely musculoskeletal physiotherapy (exemplified by the use of passive mobilisation/manipulation and McKenzie techniques), respiratory physiotherapy and neurological physiotherapy. A further feature that emerged was the frequent use of passive mobilisation/manipulation and McKenzie techniques in association with equally frequent use of electrothermal techniques. In contrast, respondents who employed mainly neurological or respiratory techniques made little use of electrothermal techniques. The combination use of passive mobilisation/manipulation, McKenzie techniques and electrotherapy identified by Turner and Whitfield (1997), was verified in a comprehensive audit of physiotherapy records of patient treatment in England (Turner et al 1999).

The purpose of this present study was to replicate the Turner and Whitfield (1997) study, to determine the type and extent of technique use amongst physiotherapists in

Table 2. Techniques as listed by respondents in open category 'other'.

<i>Movement and exercise related techniques</i>	<i>Electrotherapy or equipment related techniques</i>
Motor science approach to neurology/ motor relearning/movement science (9)	CPAP (Continuous positive airways pressure) (2)
Gait re-education (3)	Ultraviolet light (1)
Posture (3)	Biofeedback (6)
Vestibular training (1)	Traction (5)
Balance training (2)	<i>Passive techniques</i>
McConnell program (1)	Relaxation (2)
Muscle energy (2)	Muscle stretching (5)
Fitness training (1)	Rotator cuff stretch (1)
Gym equipment (2)	Soft tissue massage (2)
<i>Miscellaneous</i>	Adverse neural tension/neural stretching (9)
Education: Patient (4)	
Education: Physiotherapy (2)	
Butler (2)	
Management (2)	

(n) denotes respondents per technique (total n = 40 respondents; 31 respondents reported more than one technique).

Southeast Australia, and establish whether similar typologies would emerge. This was a direct replication, in which an equivalent postal questionnaire was administered to physiotherapists working in hospitals in the Australian states of Victoria and Tasmania.

Method

The questionnaire The questionnaire, which included a covering explanatory letter to each prospective participant, sought information on professional characteristics of participants and physiotherapists' use of treatment techniques. Professional characteristics requested were the number of years since original qualification; type of original qualification (diploma or degree); post-qualification education (practice related courses, diploma, degree or higher degree) and current enrolment for post-qualification education.

Treatment technique use covered physiotherapy practice during the six months preceding the completion of the questionnaire. A list of physiotherapy techniques and modalities was compiled, based on the original study (Turner and Whitfield 1997). This list was not comprehensive, but covered 20 techniques in common use. These were divided into three broad categories: movement/exercise techniques including neuro-motor development techniques (eg Bobath); passive techniques including massage and passive manipulation (eg Maitland, Cyriax) and electrothermal techniques including local heat

(eg. hot packs, wax; Table 1). Respondents were able to name techniques not on the list by completing the open category "other - please specify".

For each technique, frequency of use was indicated by means of a 10cm analogue scale, with the two extremes marked "never" and "daily". To assist respondents, and in particular part-time clinicians, indicative headings were also included, in the following sequence between the extremes: rarely; occasionally - less than once per month; regularly - 1 to 3 times per month; frequently - more than once per week; and daily. Respondents marked an "X" at the point on the scale that represented their frequency of technique use. The frequency of use was rated by scoring it as a percentage of the scale length (Turner and Whitfield 1997).

The sample A convenience sample was used. In Victoria and Tasmania, hospitals including rural facilities known to be centres for physiotherapy student clinical education were approached. Seventeen out of 21 hospitals responded and agreed to participate. The range of hospitals employed was to obtain a sufficiently broad sample from the two Australian states to counter possible bias from using only a single major city sample. Also, by using providers of student clinical education, more comprehensive facilities and treatment techniques could reasonably be anticipated.

Procedure A university project and ethics committee in

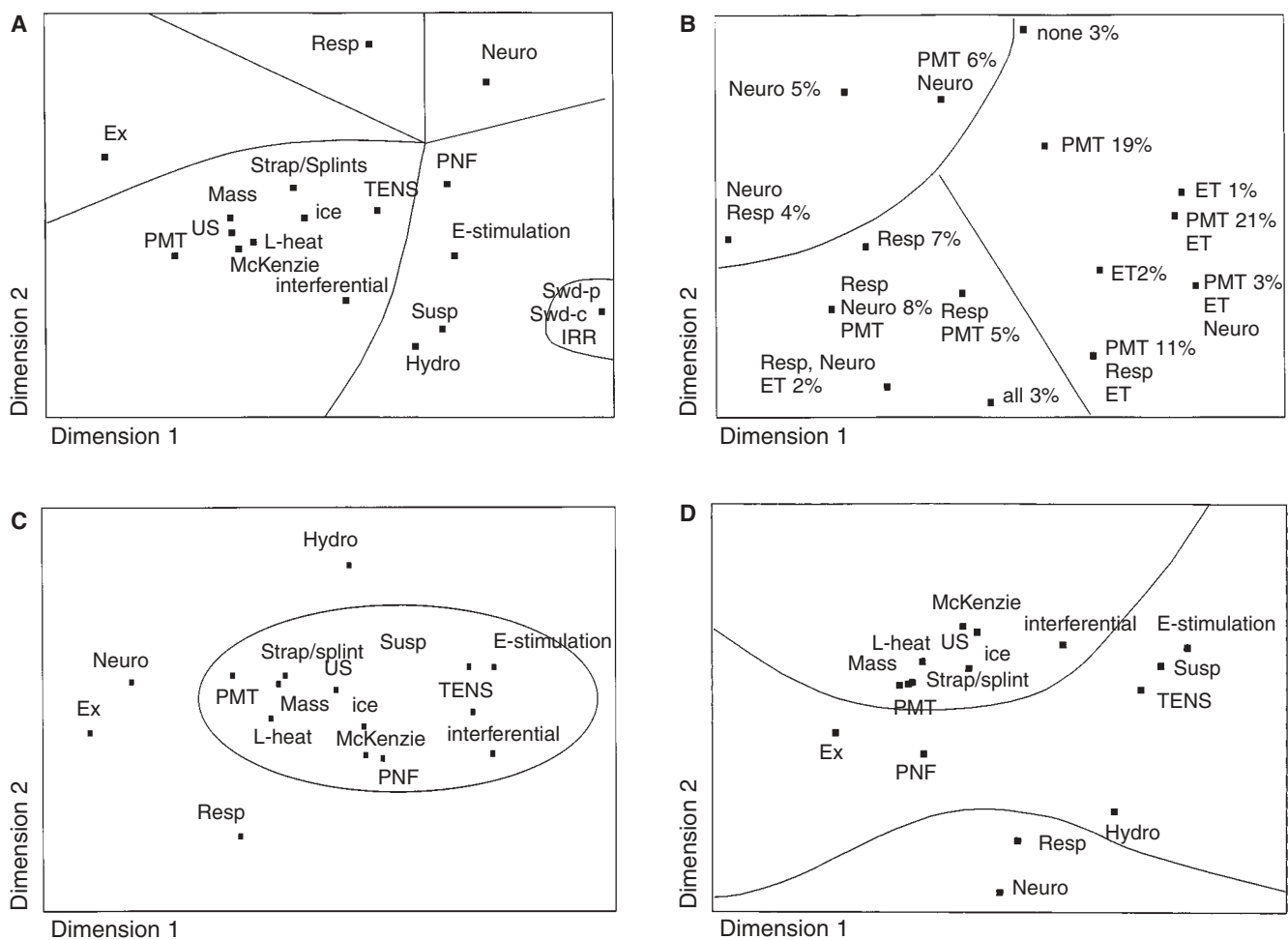


Figure 1. Typology identification with multidimensional scaling. Two-dimensional derived stimulus configurations using Euclidean distance models. Typologies identified by lines partitioning each multidimensional scaling based according to Groupings. Abbreviations according to key provided in Table 1. A: Location of techniques in the multidimensional scale space: Differentiation of 'movement-related' versus 'ET-passive' techniques. B: Location of profiles in the multidimensional scale space: Differentiation of 100 respondents' profiles (use of key techniques) demonstrating natural specialisms of neurological, respiratory and musculo-skeletal physiotherapy. C: Location of techniques in multidimensional scale space for high-use neurological technique respondents. D: Identification of sub-type (rehabilitation techniques) for high use PNF respondents.

Australia (La Trobe University, Melbourne) formally approved the project. The same methodology has been described elsewhere in related studies (Turner and Whitfield 1996 and 1997).

A letter and an example questionnaire were sent to the physiotherapy manager at each of the selected hospitals. The letter requested the manager's assistance in distribution of the questionnaires to the physiotherapy staff under their respective management. Each physiotherapy manager was asked to indicate their willingness to participate and if so, the numbers of physiotherapy staff at their hospital so that the required number of questionnaires could be dispatched. Individual respondents could return each questionnaire by means of a pre-paid envelope provided. Both individual participants and hospitals were assured of anonymity.

Analyses The Statistical Package for the Social Sciences (SPSS 7.5) was used for the analyses. The main feature of the data analysis was the use of Multidimensional Scaling (mds) (see Appendix). The analyses were non-metric, using ordinal measures in an Euclidean space restricted to two dimensions. Kruskal's Stress ranged acceptably between 0.10 and 0.13, and the RSQ ranged acceptably between 0.85 to 0.96 (Kruskal 1964). The resulting spatial figures were partitioned and interpreted using a modified facet theory approach (Canter 1996, Shye 1978, Turner and Whitfield 1997).

Results

The response rate was 58.8%, with 141 questionnaires returned out of the 242 distributed.

Background characteristics Most respondents (41.8%) had been qualified for more than 10 years; 27.7% for 5-10 years; 20% for 2-5 years; and 15.6% for less than two years.

Seventy five per cent of respondents qualified originally by means of a degree; eight with honours. A quarter of respondents (26.6%) had completed post-qualification diplomas or degrees, and more than half (57.4%) had attended practice related courses. Twenty-five respondents (17.7%) were enrolled for post-qualification courses: 12 for higher degrees, two for bachelor degrees and 11 for diploma courses.

Techniques used Exercise had the highest frequency score and percentage use (Table 2). Manual techniques used by at least 85% of respondents were massage, passive mobilisation/manipulation, strapping/splints, and the McKenzie techniques. Respiratory techniques, PNF, neurological techniques and hydrotherapy were used by more than 50%; and with the exception of shortwave diathermy and infrared, all electrothermal techniques had moderate to frequent use. Acupuncture, with minimal use, was discarded from further analyses.

Forty respondents (28.4%) completed the open category "other" techniques (Table 2), and identified 21 techniques with regular to frequent use, some of which could be subsumed under those listed; eg continuous positive airways pressure was subsumed under "special respiratory" technique.

Multivariate analyses For the purposes of the multidimensional scaling, three ordinal categories of technique-use frequency were calculated (frequent use: 70% and above; regular use: 40% to 69%, and rare usage: less than 40%).

Two-dimensional multidimensional scaling analysis was carried out firstly to establish the existence of a structure between the variables (ie the techniques).

The structure that emerged (Figure 1A) depicts five, and possibly six, 'types': one occupies the central portion of the space and consists of an undifferentiated group of techniques that includes massage, passive mobilisation/manipulation, McKenzie techniques and many electrotherapy techniques. Respiratory, neurological and exercise techniques each constitute a separate type because they are well differentiated and occupy separate, distant positions in the space. The position occupied by "exercise" reflects its frequent, widespread use. Electrical stimulation, PNF, hydrotherapy and suspension may constitute a special exercise-rehabilitation type. The three rarely used techniques of infrared and shortwave diathermy (constant and pulsed) occupy a common location, and constitute a redundant type, and were excluded from further analyses. The space (Figure 1A) can be partitioned to demonstrate these types. The partitioning also reveals the differentiation between the exercise-movement types (Category 1) and the group of techniques forming the

"manipulation-electrotherapy" type (Category 2).

To establish empirical verification of the apparent differentiation between manipulation-electrotherapy and movement-related techniques, a second scaling analysis was carried out on an SPSS generated random sample of 100 respondents' data. This sample size reflects the demands of the statistical program. In this instance, the multidimensional scaling performed was to investigate similarities between cases (ie individual responses). Cases with similar responses (ie similar profiles of technique use) occupy the same location in the space, whereas those with dissimilar profiles are located at a distance from one another. The data consisted of the use or not of four techniques which reflect the main types identified in Figure 1A: two from Category 1 (respiratory and neurological) and two from Category 2 (passive mobilisation/manipulation and interferential, representing electrotherapy).

The results (Figure 1B) indicate that the profiles of the 100 respondents have been reduced to 15 types. The space is dominated by six profiles that account for 69% of respondents: three unitary profiles; of passive mobilisation/manipulation; neurological and respiratory; and three combination profiles – passive mobilisation/manipulation plus electrotherapy; passive mobilisation/manipulation, respiratory and electrotherapy; and neurological plus passive mobilisation/manipulation. Seventy-four per cent of the profiles include passive mobilisation/manipulation.

Three major divisions of the space were possible, corresponding to neurological, respiratory and passive manipulative techniques (Figure 1B). These divisions clearly support the structure originally identified (Figure 1A). A feature of the space is that passive mobilisation/manipulation occupies a large, central portion giving it focality, equidistant from both neurological and respiratory techniques indicating its usage is distinct from both. In addition, the electrotherapy combinations are confined to a discrete portion of the passive mobilisation/manipulation space, suggesting selective use of electrotherapy.

The relationship between these typologies of technique use was investigated further, to determine patterns of association. Multidimensional scaling was carried out in three separate analyses, involving respondents from the total sample who scored high on use of passive mobilisation/manipulation, neurological and respiratory techniques respectively. In each case the results confirmed the patterns of association, as illustrated by the results for high use neurological respondents (Figure 1C). Neurological techniques occupy a separate, distinct part of their multidimensional scaling space, associated with exercise but separate from the central electrotherapy-group and distant from respiratory and hydrotherapy. This supports its independence, and indicates neurological and electrotherapy techniques are not used in combination.

The structure that emerged for high-use respiratory respondents was comparable with that of Figure 1C. Respiratory was separate, distant from both the electrotherapy group and neurological techniques. For high use passive mobilisation/manipulation respondents, the multidimensional scaling space revealed a structure with passive mobilisation/manipulation positioned close to an undifferentiated group of techniques consisting of electrotherapy, massage, strapping, and McKenzie techniques. Passive mobilisation/manipulation was separate, suggesting its use in both isolation and combination.

To investigate the apparent existence of a rehabilitation exercise group (as indicated in Figure 1A), a final multidimensional scaling analysis was carried out on data from respondents who scored high on use of PNF. The mid-portion of the space occupied by PNF (Figure 1D), includes exercise and the related movement techniques of suspension, hydrotherapy and electrical stimulation, suggesting that these techniques are not used in combination, but form a further "type".

Discussion

This study was designed to determine which techniques were in common use in Southeast Australia, whether Australian physiotherapists used techniques in an order comparable with that of their English counterparts, and whether Australian physiotherapists also differed in their employment of such techniques. Exercise therapy, passive mobilisation/manipulation, massage and ultrasound emerged as the most common and frequently used techniques, together with evidence of combination use of techniques comparable with the findings in England (Turner and Whitfield 1997). However, differences in the employment of the techniques emerged for the two national groups.

Responses This survey had a moderate return rate of nearly 59%, comparable with the 56% for the original survey (Turner and Whitfield 1997). This represents a good response rate for a single mailing and is sufficiently high to be considered cautiously representative of the sample (Shepard 1993). The method precludes repeat mailing, which is a limitation, as is the sample specific nature of the results.

Technique use According to Murphy (1993) and Lamb and Frost (1993) exercise therapy and massage are the two roots of the profession. While exercise therapy emerged as the most widely and frequently used technique in both this and the original survey, the 'hands on' techniques of massage and passive mobilisation/manipulation were used more widely and frequently in Australia than in England (Turner and Whitfield 1997). Although physiotherapy is essentially a hands-on profession, in England it appears more dependent on electrotherapy (Murphy 1993). These results suggest the converse may be true for Australia.

For most electrothermal techniques, the results reported

here are comparable with other studies in Australia (Lindsay et al 1990, Robertson and Spurr 1998). Compared with England, where shortwave diathermy and infrared remain in moderate use (Robertson and Spurr 1998) these techniques appear to be redundant in Australia. Given the paucity of evidence for these techniques (Kitchen and Partridge 1992, Whitehouse 1996) their demise is understandable and perhaps desirable. Electrical stimulation, which could arguably be considered as an exercise-related technique given its effects and use on muscle tissue, had moderate use in this study, in contrast to its rare and infrequent use in England (Turner and Whitfield 1997, Turner et al 1999).

Multivariate results As postulated in the introduction, it cannot be assumed that treatment techniques are used in isolation or that physiotherapists constitute an homogenous group. The multivariate analyses revealed a clear structure to the use of techniques, and clear divisions (a typology) within the profession in terms of techniques used. These served to both confirm the findings of the earlier study (Turner and Whitfield 1997) and to emphasise the contrast between physiotherapy practice in Australia and England.

On the basis of these results, and in replication of the earlier study (Turner and Whitfield 1997), facet theory principles (Canter 1996, Shye 1978) are used to interpret the structures (facets of practice) that emerged in the multidimensional scaling analyses. These "facets" are presented as a set of statements – or hypotheses – of presumed heuristic value in the context of further research.

1. The typology that emerged indicates that physiotherapists in Australia are no more homogenous in terms of technique use than their English counterparts.
2. Three categories of intra-related techniques are used and can be classified as respiratory, neurological and orthopaedic/musculoskeletal. These categories correspond to those defined in the original study (Turner and Whitfield 1997) and constitute the main areas of specialisation for the profession, as identified by Carr and Shepherd (1996).
3. Passive mobilisation/manipulation techniques are central to physiotherapy treatments in Australia, given that these emerged in nearly three-quarters of the profiles identified.
4. Certain techniques are used in combination. As identified in England by Turner and Whitfield (1997), passive manipulation and McKenzie techniques are used in conjunction with electrothermal techniques in Australia also, but certain cross-country differences emerged. In Australia short wave diathermy is absent from the combinations identified, while massage is frequently used together with passive manipulation, and ultrasound. Evidence of combination use of massage and ultrasound has emerged elsewhere (Roebroek et al 1998). While the clinical research evidence available for most electrothermal techniques

is limited (Robertson and Spurrin 1998), even less is known about the effects of techniques used in combination (Helders et al 1999). The need for further research to address this deficit is acknowledged (Helders et al 1999, Turner and Whitfield 1997).

5. Electrotherapy does not form a physiotherapy specialisation, because of its use in combination. In Australia, however, physiotherapists appear more selective in their use of electrothermal techniques than their English counterparts.
6. While the wide range of techniques that constituted the orthopaedic/musculoskeletal group was comparable with the findings of the original study in England (Turner and Whitfield 1997), certain differences were apparent. Two sub-groups emerged, one of which was not identified in the earlier study. The first group, common to both studies, is represented by the high use of passive mobilisation/manipulation and McKenzie techniques, and is the most undifferentiated because its internal structure indicates the high use of techniques in combination. The second sub-group is more differentiated, and consists of exercise/rehabilitation techniques – represented by hydrotherapy, PNF, suspension therapy and electrical stimulation.
7. Exercise is a common technique in both Australia and England. In Australia, it underpins all practice and as such, can be interpreted as being the core of the profession's treatments. The emergence of a specialist exercise/rehabilitation group in Australia and the more frequent reported use of most exercise-related techniques by Australian respondents is evidence of this.

In conclusion, the results of this study provide further evidence of a typology underlying physiotherapists' use of techniques. There is evidence of more extensive use of movement-related and manual techniques amongst Australian clinicians, and the emergence of an additional musculoskeletal exercise specialism. Whilst this survey did not encompass a complete range of treatment techniques, it does highlight the limitations of studies that focus only on individual techniques. The multivariate approach provided a structure of physiotherapists' use of techniques, and verification of this structure is possible through further research and audit. It is acknowledged that the results of this study are sample specific, and it would therefore be informative to sample physiotherapists in other areas of Australia.

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Appendix

Multidimensional scaling is a way of spatially representing the measured similarities or differences amongst a set of objects or variables. The more similar the objects, the closer together they are positioned in the space, and vice versa. Two important advantages of this technique are that (a) complex relationships amongst a set of objects can be

represented spatially, and (b) the dimensions of the space (axes) are not pre-determined; rather, the dimensions emerge from an interpretation of the locations of the objects in the space. For example, if the data input to a multidimensional scale were a matrix of all the distances between all of the cities in mainland Britain, then an output would be a 'spatial' map representing the relative locations of British cities. This map could then be partitioned into English, Scottish and Welsh cities. In order to establish the goodness of fit between the data and their spatial representations, Kruskal's Stress and the R^2 (squared correlation distances) are normally calculated. Using the "cities" example, both measures would indicate the extent to which the spatial map accurately represented the distances contained in the data matrix. If the fit were unacceptable, then a higher dimensional solution would be sought. These procedures are normally employed within the framework of facet theory (Shye 1978), which enables a theory or model to be postulated with reference to the structures that emerge in the relevant multidimensional scaling analyses.

Multidimensional scaling is an established technique that has been used in such diverse areas as the occupational prestige profiling (Turner 2001); journal readership profiles (Turner and Whitfield 1996); and the classification of alcoholics (Peters 1997). Detailed treatments can be found in Shiffman et al (1981).



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