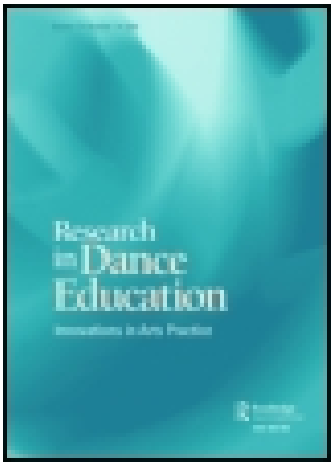

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Dancing earthquake science assists recovery from the Christchurch earthquakes

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The 2010–2012 Christchurch (Canterbury) earthquakes in New Zealand caused loss of life and psychological distress in residents throughout the region. In 2011, student dancers of the Hagley Dance Company and dance professionals choreographed the performance *Move: A Seismic Journey* for the Christchurch Body Festival that explored concepts of earthquake processes and human experiences. Choreographic design was assisted by a professional earthquake scientist and used human movement to represent seismologic and geologic processes, building response, collapse and demolition, and earthquake-induced psychological experiences. Performance reviews indicate the production was beneficial for audience earthquake recovery. Post-performance surveys of dancers and choreographers provide information on the educational and therapeutic benefits relating to their respective involvements in this project, qualitatively assessed in terms of recovery elements (hope, healing, empowerment, and connection) and quantitatively measured using a 'Recovery Index'. Involvement in this production was beneficial in assisting with earthquake recovery for both dancers and choreographers. Dancers rated their recovery higher than choreographers, which we attribute to the greater level of total immersion in the performance including participation in earthquake lectures. Christchurch-resident participants rated their personal assessment of recovery higher than non-residents. This study highlights how integrating dance with science can assist in recovery from natural disasters.

Keywords: dance education; dance therapy; earthquakes; Christchurch; science–dance collaboration; choreography; Hagley Dance Company

Introduction

In the last decade alone, earthquakes have caused over 600,000 fatalities and have traumatised millions of people around the globe. People who have been traumatised may retain an implicit memory of distressing events in their brains and bodies (Rothschild 2000). Dance has been demonstrated to be an effective vehicle for expressing post-traumatic psychological, sociological, and physiological reactions, reducing anxiety and initiating the possibility of healing (Monahon 1993). Lomas (1998) states, 'all dance has the potential to be a combination of artistic activity and therapeutic activity, to offer individuals the opportunity to self discover and to share with others' (153). Dance Movement Therapy (DMT) is the use of expressive movement and dance as a vehicle through which an individual can engage in the process

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of personal integration, growth, and healing (Payne 1992). DMT is based on the principle that there is a relationship between motion and emotion and that by exploring a more varied vocabulary of movement, people experience the possibility of becoming more securely balanced yet increasingly spontaneous and adaptable (Payne 1992). DMT does not directly aim to teach the subjects the relationship between knowledge and experience, but instead encourages them to re-experience the past and create something in that context through movement (Lee et al. 2013). Short-term DMT was recently used to examine elementary-school children suffering from earthquake trauma following the 1999 Chi Chi earthquake in Taiwan (Lee et al. 2013). An alternative approach to DMT can be defined as *dance education with therapeutic aspects*. Although there may considerable overlap between these fields, there are many important differences (Payne 1992; Meekums 2002).

The Hagley Dance Company (HDC; www.hagleydance.co.nz) at Hagley Community College in central Christchurch is a full-time contemporary post-secondary dance course for students of 16 years of age or older. In the midst of the 2010–2012 Canterbury earthquake sequence (CES) in New Zealand's South Island, student dancers from the HDC performed an earthquake-inspired dance production entitled *Move: A Seismic Journey* at the Christchurch Body Festival. Dancers' choreographies and choreographic processes were assessed by the Director as part of the National Certificate of Educational Achievement (NCEA) assessment, which is the main national qualification for secondary school students in New Zealand. This blending of educational and professional components is consistent with Smith-Autard's (2002) *midway* model of dance education. Almost 26 months after the production, former HDC dancers and choreographers were invited to answer a survey designed to assess how their participation in *Move: A Seismic Journey* impacted on their self-assessed recovery from the CES. The results were investigated to evaluate whether the participation in this production yielded any therapeutic aspects in terms of earthquake recovery. Published reviews of this production were also analysed for a similar purpose.

In this paper, we outline the context and theory behind the construction of this performance, highlighting in particular the use of geological and engineering concepts to develop dance choreographies that expressed scientific aspects of earthquakes in general and the Christchurch earthquakes in particular. We provide sufficient detail such that these choreographic elements could be used to (i) inspire future natural disaster-related performances in the dance community, whether prompted by actual events or not, (ii) teach earthquake science concepts at all levels (from elementary school to university level), and (iii) be used or modified for use by professional DMT practitioners. We then examine external reviews of the production in order to evaluate the impact of the production on a dance-literate subset of the general public. Answers to survey questions asked to dancers and choreographers are analysed to inform the extent to which the development and performance of this show resulted in changes in personal behaviour, earthquake awareness and understanding, and self-assessed recovery from the Christchurch earthquakes. Our results suggest that dancing the science and impacts of this natural disaster helped this mildly to moderately affected population to better cope and recover from the trauma associated with the earthquake experience.

Study background

Classification of study as dance education

This study fits the criteria of dance education with therapeutic aspects, as opposed to DMT, for the following reasons (cf. Payne 1992; Meekums 2002):

- this study was conducted by a high school teacher and university lecturer in earthquake science with no formal training or qualifications in DMT,
- choreography was designed by the lead author, students, and choreographers with no DMT training or qualifications,
- the therapeutic aspects were investigated only after, rather than throughout, the process of dancing and choreographing,
- the primary choreographic goals of the dance production discussed herein were largely educational and artistic in nature, as opposed to DMT practice where choreographic goals would be designed to address the therapeutic needs of the client group,
- the therapeutic benefits were self-assessed by the subjects, rather than being assessed by a DMT professional or psychologist,
- the dance production in this study was performed live to an open audience, and was designed with the aim of performing to an open audience, both of which are uncommon for DMT,
- the dance performance discussed herein emphasised the use of aesthetic elements such as integrated use of costume and lighting; DMT is unlikely to use these elements,
- no psychological theories that underpin DMT were purposely included in this study, and
- no clinical supervision or 'own therapy' that forms DMT practice was conducted in this instance.

Importantly, we use the term *therapeutic aspects* to refer to aspects with a positive influence on perceived recovery from the Canterbury earthquakes.

Defining and assessing recovery

The term *recovery* has many contextual meanings and definitions, even when limited to descriptions concerning the human condition (Jacobson and Greenley 2001). The classical definition of recovery, 'to regain normal health, poise, or status' may be more specifically defined as consisting of internal elements including *hope, healing, empowerment,* and *connection*, in addition to external elements (Jacobson and Greenley 2001). Relevant components of hope in the context of this study include the belief that recovery is possible, looking forward rather than ruminating on the past, reordering priorities, cultivating optimism, developing a spiritual connection with nature, making art, and/or contemplating philosophical issues. Relevant components of healing in the context of this study include increasing the sense of self-esteem and respect and gaining a sense of control. Relevant components of empowerment in the context of this study include gaining a heightened sense of autonomy through increasing knowledge and self-confidence, gaining courage through the willingness to take risks, to speak in one's own voice, and to step outside of safe routines, and taking responsibility for one's actions. Relevant

components of connection in the context of this study include being in the company of others, helping others, finding roles to play, telling personal stories in public arenas, and validating and reconciling personal experiences. Dance is widely recognised as containing many of these recovery elements (Minton 2001; Stinson 2005). For instance, dance-making involves participants in activities built upon hope, belonging, individual significance, and group solidarity (Lomas 2009), and can facilitate individual empowerment, self-intimacy, interaction with one's authentic self, a sense of fulfilment, and a feeling of achievement (Lomas 1998).

For the purpose of this study, we aimed to promote and evaluate recovery through a dance production incorporating several different approaches. *Educational approaches* were used in order to increase general and specific knowledge of the trauma-inducing phenomenon (in this case, recurring local earthquakes) and thereby create a greater feeling of personal empowerment (Jacobson and Greenley 2001). *Physical approaches* were used to increase mind–body connections and to create new pleasurable experiences and memories (dancing and choreography) from past traumatic experiences. *Teamwork approaches* were used to increase social connections, and perhaps resolve unresolved experiences or unconsciously suppressed experiences by developing foundations and preparing to accept the coming of 'energetic phenomena' (Adler 2002). *Choreographic independence and creative approaches* were used to enable the dancers and choreographers to speak in their own voices through dance and thus assume responsibility for self-healing and self-confidence. Finally, *professional approaches* were used to fulfil educational (e.g. NCEA requirements) and job responsibilities through dance, thereby cultivating an optimistic outlook with respect to future possibilities (e.g. future dance study or career).

Research methods

We combined qualitative and quantitative methods to assess whether participants in *Move: A Seismic Journey* were positively impacted by their involvement in terms of recovery. Qualitative analysis places emphasis on understanding through observation and interpretation of people's words, actions, and records whereas quantitative analysis quantifies the results of these observations and seeks an understanding through statistical patterns that emerge from these data (Maykut and Morehouse 1994). Qualitative data sources include the title and written descriptions of each dance piece, transcripts of verbal discussions of choreographic meaning with the choreographers, interpretations of some of the choreographic movements, comment sections of dancer and choreographer surveys, and the external reviews of *Move: A Seismic Journey.* In terms of qualitative analysis, we first examined whether the recovery elements of Jacobson and Greenley (2001) were present in each piece of choreography using inductive reasoning and a simplified form of constant comparison analysis (Maykut and Morehouse 1994). Keywords, phrases, and topics in this data, including material written by the subjects or transcribed from verbal discussions between the lead author and the subjects were coded against the recovery elements of Jacobson and Greenley (2001). In some cases, direct wording matches enabled easy classification, in other cases, interpretation for categorisation was required. For quantitative analysis, we prescribed a series of questions to be answered with number values and studied and interpreted the statistical distributions of these values. The use of both qualitative and quantitative enquiry, shaped respectively by inductive

and deductive logic, was favoured in order to build a body of knowledge that at once captures the substance and inner dynamics of the human experience whilst retaining the objective findings of numerical survey data (Berrol 2004), thus potentially validating and increasing the robustness of our findings.

Geological, seismological, and sociological context

The CES in New Zealand's South Island initiated with the moment magnitude (Mw) 7.1 Darfield earthquake on 4 September 2010 (NZST), and was followed by over two years of frequent aftershocks. At least 300 earthquakes of sufficient magnitude to be widely felt have occurred in the region following the Darfield earthquake. On 22 February 2011 the Mw 6.2 Christchurch earthquake, one of the largest earthquakes in this sequence, caused extensive building damage, localised building collapse, and geologic processes (cliff collapse and rockfall) that collectively resulted in 185 fatalities in Christchurch. Residents throughout the Canterbury region, particularly in the city of Christchurch (pop. 380,000) experienced earthquake-induced psychological distress, including self-reported cognitive dysfunction, sleeplessness, heightened stress (Kemp et al. 2011), depression, and anxiety (Dorahy and Kannis-Dymand 2011; Kemp et al. 2011).

The Darfield earthquake occurred in an agricultural area approximately 40 km west of central Christchurch and created a surface fault rupture with up to 5.3 m of land displacement (Quigley et al. 2012). Many of the earthquakes caused extensive liquefaction (Quigley, Bastin, and Bradley 2013), a process whereby earthquake-induced ground motion causes soil collapse and increased pore water pressures in water-saturated sediments that consequently lose their strength and flow laterally and vertically. This resulted in major land damage and formation of sand volcanoes at the surface. In general, the eastern and southern parts of Christchurch were impacted by rockfall and/or liquefaction damage whereas land damage in western Christchurch was minimal, resulting in spatially disparate social, financial, and psychological impacts from the earthquakes (Dorahy and Kannis-Dymand 2011). The national government purchased more than 5000 residential properties in eastern and southern Christchurch as part of a land-rezoning plan, resulting in significant population relocations as well as long periods (up to 2 years and longer) of uncertainty in some instances while government decisions were made. A local culture of frequently checking the Internet site www.geonet.co.nz for updates on earthquake activity, particularly following major aftershocks, developed during this time. The rebuilding cost of the CES is now estimated to exceed NZ$40B (>US $31.75B) which is approximately 30% of the country's real gross domestic product.

Choreographic development

Context

In November 2010, the lead author of this paper and Director of the HDC submitted a proposal for an earthquake-inspired dance performance to be presented at the 2011 Christchurch Body Festival. After the fatal Christchurch earthquake, the theme of the performance evolved from an earthquake geology focus to topics that would encapsulate both the science and the human experiences of the earthquakes. Choreographies by both professional choreographers and HDC student dancers (forthwith

referred to as 'dancers') were developed beginning in August 2011. During the incipient phase of choreographic development, the two authors of this paper arranged a 1.5 h earthquake geology and basic engineering interactive lecture by the second author with all HDC dancers held in the HDC studio. Dancers were given the option to choose earthquake science and/or engineering-based choreographies; four of seven dancers chose this option while three dancers chose to focus on themes pertaining to individual and cultural feelings and experiences. Students were asked to do some additional research to better inform their choreographies where relevant.

The seven-member dance company performed five shows (4 nightly and 1 matinee) of *Move: A Seismic Journey* at the Christchurch Body Festival from 27 to 30 September 2011. Total estimated attendance was 400. The performance was externally reviewed by three independent reviewers and an article on the show, including a photograph, featured in the 26 September 2011 edition of *The Press*, Christchurch's daily newspaper. Below we discuss how scientific principles were implemented into the choreography. The choreographic descriptions and interpretations outlined below follow Adshead's (1988) analytical framework of dance analysis. A scientific description of an aspect of earthquake science precedes each choreographic description.

Orogenesis (mountain building)

Scientific description

New Zealand occupies the boundary zone between the Pacific and Australian tectonic plates, which converge obliquely at rates of 39–50 mm yr^{-1} (DeMets, Gordon, and Argus, 2010). The Canterbury region in the central South Island of New Zealand is squeezed in a NNW–SSE direction at a rate of approximately 2 mm yr^{-1} (Wallace et al. 2007). This squeezing causes episodic faulting and folding at depth and at the surface. Faulting causes episodic mountain uplift during earthquakes. The rate and spatial distribution of mountain building (i.e. orogenesis) within a given mountain range are variable. The mountains evolve from smooth subtle forms related to folding into rugged, jagged shapes (Figure 1) over millions of years of orogenic development.

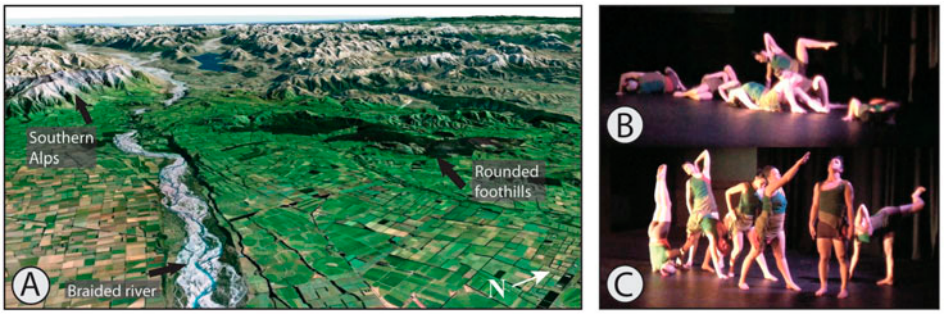

Figure 1. (A) Google Earth™ image looking north-west from the Canterbury Plains to the Southern Alps and intervening foothills. (B) Dancers emerging from low-relief plains to rounded foothills and jagged mountains. (C) Dancers as the Southern Alps, before intermittently collapsing as erosion.

Choreography ('A Seismic Journey', Table S1)

At the start of the show, all seven dancers lie in an asymmetrical clump upstage right. Independently they grow into different mountainous forms at different times and rates. The forms evolve from smoothed lumps, representing subtle folds in topography reflecting the incipient phase of mountain building, to strange and angular shapes (Figure 1(B) and (C)) that represent evolved mountains. The dancers occasionally collapse into lower elevation forms in punctuated movement, representing landslide-induced erosion, before rising again.

Erosion and sedimentation

Scientific description

Erosion of mountainous rock occurs both in slow steady processes (chemical and physical weathering on the centimetre-to-decimetre scale) and rapidly in landslides that intermittently remove large chunks of the topography. Eroded sediment is carried by rivers (braided rivers in this instance) from the mountains to the plains via suspended load that floats in the water and as bed load that is transported along the stream channel base. Large bedrock clasts (fragments of rock resulting from breakdown of larger rocks) are deposited in an imbricated fashion, such that downstream portions of clasts overlap on to the top of clasts (Figure 2(A) and (B)). Sedimentary deposits lie dormant for many thousands of years on the vegetated surface of the Canterbury Plains as tectonic strain accumulates within and beneath them.

Choreography ('A Seismic Journey', Table S1)

Two male dancers fall forward (meant to signify erosion) from standing (meant to represent mountains at full height) to plank position. They proceed to move into a series of forwards rolls, backwards shoulder rolls, handstand presses, and other gymnastic movements to represent the journey of eroded fragments in braided streams as bedload. Movement motifs are established here; sharp and angular sideways jumps represent jutting boulders, rounded and rolling arm, shoulder and hand gestures mixed with contemporary locomotion such as step-hops and fouettés and balletic side to side movements. Clockwise, oscillating pliés in second position represent the erosional rounding of jagged shapes to become smoothed river cobbles. Three dancers use spinning and turning in a tight dimension and zigzag running in erratic pathways through the space to represent sediment travel as suspended load that washes

Figure 2. (A) Imbricated river cobbles showing flow direction of river. (B) Dancers as imbricated cobbles, accumulating strain prior to fault rupture. (C) Photograph of Greendale Fault rupture in the Darfield earthquake.

in and out of stream eddies within a meandering current. The dancers gradually settle themselves lying perpendicular to the audience with feet facing forward, and each successive dancer on stage left stacks part of their body onto the dancer on stage right, representing sediment imbrication (Figure 2(B)). Once all of the dancers have settled into this depositional form, they lie together for approximately 1.5 min, initially in stillness representing dormancy but gradually accumulating tension through intermittent shaking of their whole bodies. This reflects the accumulation of tectonic strain over thousands of years within this sedimentary setting.

Fault rupture and seismic wave propagation

Scientific description

The rupture of the Greendale Fault in the 4 September 2010 earthquake caused up to 5.3 m of right-lateral displacement; the north side of the fault moved to the west and the south side of the fault moved to the east (Quigley et al. 2012) (Figure 2(C)). Obliquely oriented *tension cracks* of several meters in length and decimetres in width split open on the surface of the Canterbury Plains. The fracture of rock in the earthquake caused seismic waves to propagate outwards from the rupture zone. The waves consist of compressional 'P' (Figure 3(A)) and shear 'S' *body waves* and translational and rotational *surface waves*. The seismic energy moved from the fault outwards and towards the built environment of Christchurch.

Choreography ('A Seismic Journey', Table S1)

The dancers rotate clockwise rapidly in a sharp movement representing right-lateral fault rupture. The dancers use a rippling body motion to separate themselves along the floor while remaining in lying position. One by one (in canon), dancers rock back and forth in sitting position, pushing on the person in front; this cannoned sequence represents the compressional P-wave movement (Figure 3(B)). The

Figure 3. (A) Propagation of seismic P waves, showing alternating compressional and extensional movement. (B) Dancers as propagating seismic P waves.

rocking phrase accumulates into backwards rolls and inverted rippling shapes to transition into standing level using compression and extension of the arms with elongated leg movements back and forth in a line across stage. Compressing and extending the dimension of space between the dancers demonstrates the increased amplitude of seismic P-waves. In canon, dancers peel off from the straight line and diverge into *in-phase* rapid running to extreme upstage and then downstage to represent S waves. The occupation of the whole stage space represents the different P- and S-wave amplitudes and associated intensity of seismic shaking. In canon from the S-wave running, dancers begin to show the seismic wave being experienced through their bodies, representing the body waves turning transitioning into surface waves. Motifs include big arm circles and swings, movement of the upper body up and down using momentum, and using large body rolls to return to a standing position.

Liquefaction

Scientific description

The passage of seismic waves into the city and associated strong ground shaking causes mobilisation of sedimentary grain boundaries in water-saturated sediments. Water pressure builds up within the sediments until it reaches a threshold level, at which stage the sediments lose strength and liquefy, causes them to move laterally and vertically from depths of 1 m to 20 m. Sand volcanoes form as liquefied sediment erupts on to the surface (Figure 4(A) and (B)). Liquefaction occurs throughout Christchurch, particularly in eastern Christchurch.

Choreography ('A Seismic Journey', Table S1)

A large grey mesh fabric is stretched out across the entire stage with two male dancers squirming beneath it. The remaining dancers hold the outer edges of the fabric. The liquefaction dancers move from a low to high level using gymnastics lifts and weight bearing movements showing from under the mesh fabric that represent the processes of sand mobility beneath the surface (Figure 4(B)). There is an emphasis of developing angular peaked forms representing the vents of sand volcanoes

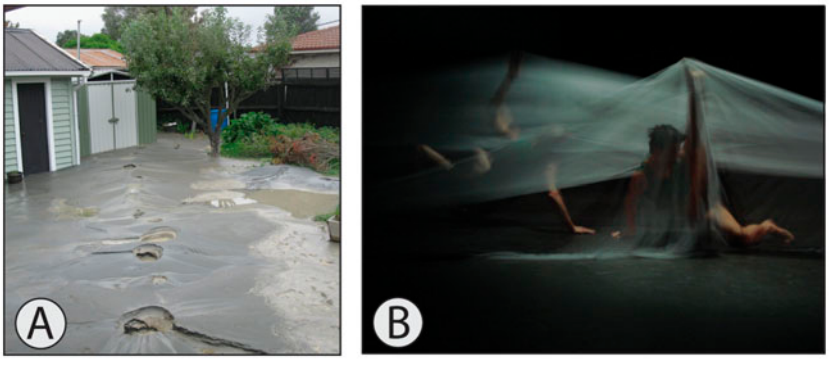

Figure 4. (A) Photograph of liquefaction-induced 'sand volcanoes' in Christchurch. (B) Dancers as sand volcanoes, with movements representing liquefaction.

(Figure 4(B)). The movement of the dancers to a vertically stacked lift position represents the growth of the sand volcanoes to larger forms. The dancers eventually settle back down to a low level, lying under the fabric, to represent the cessation of liquefaction after earthquake shaking has subsided. The remaining dancers then move their way under the mesh and form different sized forms under the fabric, representing the liquefaction-affected land around the city buildings. Dancers move into positions of varying heights facing different directions to represent buildings.

Response of built environment to seismic shaking

Scientific description

Different buildings respond in different ways to seismic shaking. The response of a building is controlled by the design, shape, height, and material properties of the building (Figure 5(A)). Some buildings oscillate *in-phase* with the seismic shaking, while others display more chaotic patterns of shaking. In general, shorter buildings are more affected by high-frequency energy, and taller buildings are more affected by lower-frequency shaking (Figure 5(A)). The ground conditions upon which the buildings reside also impact on the behaviour of the buildings in the earthquake.

Choreography ('Buildings', Table S1)

As the 'Buildings' part of the choreography starts, the prop of the liquefaction fabric that is draped over the cityscape formation is slowly pulled away, revealing five dancers. The dancers sway and shake at different rates and frequencies (Figure 5(B)). Some dancers collapse in a heavy movement, designed to represent building destruction. A key movement motif phrase is the collapse of parts of the body in a fragmented manner (Figure 5(B)) and then tumbling on to the floor; abstraction is used to display the collapsing, ripping, and destruction of buildings through gesture and whole body shape. The lasting image is a clump of strewn bodies (buildings) with only one building left swaying, to represent loneliness and destruction.

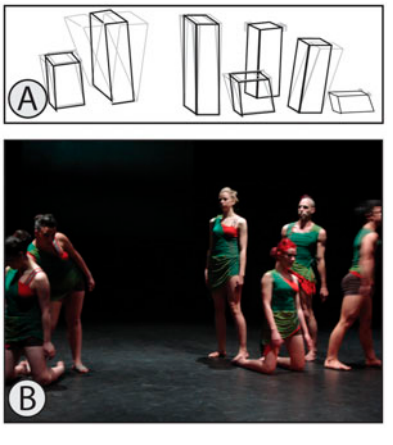

Figure 5. (A) Schematic of building shaking in earthquakes, showing differential shaking response relating to building height, geometry, and materials. (B) Dancers as shaking buildings, displaying differential responses (resonance).

Tectonic plate movement

Scientific description

There are 25 major tectonic plates on Earth that can be defined by measurements of plate motions relative to reference frames or relative movements between adjacent plates (DeMets, Gordon, and Argus 2010). Plates typically move at several cm to several 10's of cm per year with respect to adjacent plates, and plate boundaries consist of convergent, divergent, or transverse motions. The slow build up of elastic strain at plate boundary interfaces, such as major subduction zones, is eventually released in major earthquakes such as the 2011 Tohoku, Japan earthquake. The collision of large continental masses (e.g. India and Asia) results in large mountain ranges (e.g. Himalaya). Mountain ranges may build to heights that are unable to be supported by the thickening of continental crust, resulting in orogenic collapse.

Choreography ('Tectonic Plates' Table S1)

To represent the dynamics of tectonic plate movement and interaction, choreographic themes include constant movement, the catch and cessation of movement, the build up of tension, the sudden release of energy, and slip. Slow and sustained choreographic dynamics reinforce the constant movement of tectonic plates, and specific movement pathways were used to represent the relative movement of the Australian and Pacific plates. Phrases involve oscillating movement between strong, steady poses (legs in wide second, arms either by sides, or in a triangle with the forearms touching) and unstable/non-supportive poses (popped heels, rolled in ankles, and leaning upper-bodies). Unstable poses and repetition are used at the end of the piece to create a linear travelling movement that takes the dancers off stage step by step, leaving the audience with the image that the dancers (tectonic plates) continue to move even when they are offstage (i.e. over long periods of time). Choreography involves contemporary partnering where one person is manipulated by the other (lifting of partner's limp arm, then halting this movement path by pushing the arm back down by the elbow; catching a falling partner and lifting them back up again) to represent how the movement of plates can be influenced by forces created by changing plate interactions. The falling of the dancers' bodies from different height levels represents the changing dimensions and earthquake energy release associated with different faults at plate boundaries. Tension and distortion is created by partnered dancers travelling in the same direction, but with only one partner using force to move them both in that direction. The other resists the force briefly (holding to the choreographic intention of building tension) and then moves away from the force making space for the process to start again. Partnered 'rolling' sequences synthesise all of the themes; partners roll over one another and release themselves, feeling their weight and letting it drop into the floor. When they are on their side they can slip suddenly over onto their front/back; these qualities highlight the idea of faults slipping and releasing their energy, the pause of balance before the slip shows how the movement is 'caught' (it is halted before it can release). The rolling is also representative of the constant movement of tectonic plates. As two bodies roll towards each other on the floor, tension builds in the space between them as they get closer and closer and this embodies the tension that builds between plates that are being pushed together.

Other earthquake impacts represented through choreography

In addition to the effects on buildings, the impact of seismic waves in the city on humans is represented ('A Seismic Journey', Table S1). Choreography intersperses everyday-type gestures such as people checking watches, typing on the computer at work, and tourists taking pictures, with panicked facial expressions, slow motion running in opposite directions, and frightened looks upward towards damaged buildings. It shows that common gestures were not abandoned despite earthquakes; rather, the gestures transpire with heightened intensity and a different purpose. The use of flashlights in a dark transition represents the loss of electricity for many residents, together with the role of search and rescue teams (also represented by the costume change; Table S1). Other choreographic elements include people searching for and finding one another. Dancers hold hands, hold and catch each other, use weight-bearing movements and manoeuvre around one another's bodies with swift changes in timing and energy to show fear, urgency, and love for one another.

Subsequent choreography represents the experience of finding your home re-arranged after a major aftershock, to see things broken and misplaced ('Everything in it's Right Place' Table S1). Abstracted motifs include the use of hand sweeps to represent sweeping broken glass from the floor and gestures of placing and moving things. The larger movement phrase consists of large sweeps of the legs entwined with moving chairs around, placing them in different positions – on top, beside, in between, and upside down. Individual dancers perform variations on the key movement phrase, performing these on, underneath, and through the chairs and other dancers. The use of a mixture of canon, unison, and contrasting movement sequences represents both the randomness in location and the want for re-organisation of home items. As the dance progresses, the dancers adopt the identity of 'the object' and movement and pathways become more complex and intricate.

Choreography then transitions to the concepts of hope, determination, and resilience; three dancers combine outward and upward reaching poses and embraces to represent the struggle towards a feeling of hopefulness and empowerment ('Hope and Resilience', Table S1). The impacts of continuous and sustained aftershocks on personal trauma and jumpiness are explored by choreography with continuous jumping on the spot motif ('Keep on Keepin' On', Table S1). The earthquake-induced loss of sleep is explored through a solo piece involving a dancer writhing uncomfortably on a mattress ('Sleepless', Table S1) (Figure 6(A)). Sharp, jerky movements show her constantly being woken and tossing and turning movements showing a restless sleep. The disparate experiences of couples living on different sides of the city are represented by two duets of dancers on either side of a large open frame (Figure 6(B)); the dancers from the harder hit side of the city attempt to pull the other group through the frame in an attempt of forced empathy ('Contrasts', Table S1). The forceful dancing involving pushing and pulling signifies the rise of domestic abuse and fraying relationships resulting from earthquake trauma. Choreography representing the demolition of buildings uses dancers in angular, stacked poses being pulled apart and carried away by dancers representing machines ('Demolition', Table S1). The associated costume change (Table S1) represents the idea of stripping away the familiar and replacing it with naked and unrecognisable cityscape ('Unrecognizable City', Table S1). Key contemporary movement phrases include ideas of hanging, wrapping, holding, partnering, and upside down and backwards crawling. Close partner dancing is used to represent the intimate nature of

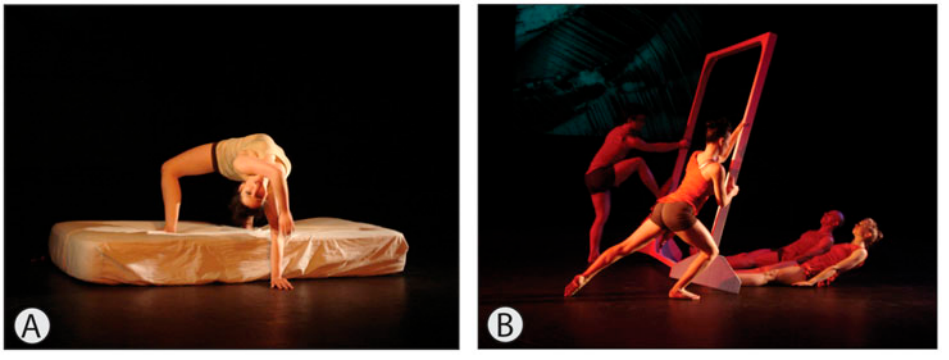

Figure 6. (A) Sleepless nights for Christchurch residents reflected in the piece 'Sleepless'. (B) Contrasting experiences of couples in eastern and western Christchurch reflected in the piece 'Contrasts'.

machine and building during the demolition process. A highly technical solo piece uses a mix of gestural movement and phrases of angst with a combination of contemporary leaps and turns through high and low levels to represent inner turmoil and human need to gain control and make sense of the earthquake aftermath ('Found', Table S1). The production ends with a testament to the prolonged nature of continuing seismicity; constant jumping and moving the shoulders back and forth to the beat of the music and transitional movements from solo to clustered formations representing the 'new normal' of constant aftershocks, and the fragility of the human condition as people work towards putting themselves back together ('Unbroken', Table S1). Contemporary dance principles include fall and recovery, the use of momentum, and subtle physical articulation of the boundary between strength and crumbling using tentative, searching and collapsing elements. A standing clump centre stage for the finale is formed with the dancers performing a circular sway in unison with their heads looking upwards to the soundscape of a helicopter, representing the surreal reality of continued aftershocks, emergency operations, and the uncertain seismic and personal futures.

Recovery characteristics in choreography and movement

A detailed dance analysis (Adshead 1988) and evaluative study of possible therapeutic elements of individual movements (e.g. pliés vs. fouettés) and group structures (e.g. canon vs. unison) are beyond the scope of this study. However, we use Table S1 to illustrate how the basic recovery characteristics of hope, healing, empowerment, and connection (Jacobson and Greenley 2001) were encapsulated in the choreography of *Move: A Seismic Journey.*

Choreographic structure and production technologies

Structure

Move: A Seismic Journey was structured into a progressive, episodic narrative form that was designed to represent a chronologic journey. The opening part of the show begins deep in geologic time, with the formation and erosion of mountains and the

deposition of sediment occurring over millions of years and long before human arrival. Subsequent choreographies reflect the contemporary human experience and science of the CES. Later choreographies probe issues pertaining to the seismic future. The use of multimedia and costume integrated within the choreography followed the same progressive journey. The running order of the production appears in Supplementary Information Table S1 and detailed information pertaining to lighting and projection appears in Supplementary Information S2. For a list of the music used see Table S1.

Properties

Properties were frequently used in the production. To represent liquefaction in *A Seismic Journey*, several large pieces of grey mesh fabric sewn together was drawn out across the stage by the dancers to create a sheer layer for two dancers to perform gymnastic movements under (Figure 4(B)). High-pitched string music was played in the background to increase audience tension (Table S1). The remaining five dancers held the edges of the fabric in place. This fabric sheet was also used to create a transition into the next dance piece 'Buildings' in order to relate the concepts of how liquefaction created land instability that affected the city buildings. 'Everything In It's Right Place' used three white chairs which dancers used to represent the normality of rearranging and fixing into place everyday objects after they had moved from a large aftershock. The chairs were also used as a stimulus for the dancers to create individual movement phrases based on their own experience of replacing objects after the earthquakes. 'Hope and Resilience' integrated the abstract use of a white staircase to represent the Christchurch community working their way back, and aspiring for hope and resilience. Dancers interacted with this staircase by performing dance phrases that abstracted the human experience of gaining hope and resilience through intentional and prominent use of level. The concept of community resilience was represented by the three dancers holding on to each other and using assisted lifts on and off the staircase. In the dance work 'Contrasts' a large white standing frame (Figure 6(B)) was used to distinguish the varying experiences of two couples from different sides of the city. The frame created a clear visual effect of two sides and dancers initially perform two different variations on the developed movement vocabulary of everyday gestures and contemporary partnering. As the dance progressed dancers tilted the frame back and forth to accentuate the pressures that each couple faced in the aftermath. In the climax of the dance, both couples came together on one side of the frame to demonstrate the shared experience of the earthquake. The resolution of the dance is realised through each couple returning to their side of the frame and repeating earlier movement phrases of everyday gestures. The work 'Sleepless' used a standard single mattress (Figure 6(A)).

Costume

The costume design/used in *Move: A Seismic Journey* consisted of three layers. The outer layer was a three-toned, green tunic of asymmetrical design with one sleeve and jagged fringing down one side (Figure 1(B) and (C)). This mesh layer represented the green Canterbury plains and the jaggedness was inspired by images of the fault rupture. This was used intermittently throughout the show as a reminder of

the human connection with the earth. It was worn in the dance pieces that were communicating the science of the earthquakes or to mark the end of the journey. The next layer was an orange, cotton-lycra tunic which followed the same asymmetrical pattern as the green but with a stripe of reflector tape on the shoulder (Figure 6(B)). This layer represented the state of emergency in Christchurch following the February quake and the high number of rescue workers and high visibility jackets that now occupied the city. The final layer was a nude-coloured slip dress (singlet for males) (Figure 6(A)). This layer was worn as a representation of how the quakes had created a sense of human rawness, loss, and displacement and was only worn for one piece in the show at a point which marked the state of grief many people at the time were in and forced to deal with. Brown shorts were worn by all the dancers in the show for its entirety and the colour was chosen to represent earth and groundedness.

There was a strong interaction between the costume, choreography, and the dancers. For example, the fringing on the green costume took on a grass-like effect when the dancers lay in the position of the fault surface trace (Figure 2(B)); as the shaking of the bodies intensified, the movement of the fringing also moved more. At other times throughout the show, layers of costume were removed visibly on stage to give physical representation of transitioning from one concept to another. For example, after the dance 'Demolition', dancers removed the orange layer (emergency and rescue response) to reveal the nude layer for 'Unrecognisable City' representing human loss and displacement.

Recovery characteristics in properties and costume

Dosamantes-Beaudry (1997) indicated that the initiation of arts-based process approach to healing may begin with facilitating the conditions that help to promote the emergence of creative 'potential space', and by encouraging subjects to become immersed in the creation of illusion-making, pretend playing, and the novel manipulation of objects, symbols, and metaphors that they derive from their own experiences and imaginations. It is possible that the use of lighting, costume, properties, and music may have assisted in creating a space (i.e. the dance theatre) and providing objects (i.e. costume and properties) that created additional therapeutic outlets for expression (i.e. comprising characteristics of hope, empowerment, and connection) although this is not addressed in detail by this study.

Performance reviews

Reviews

Move: A Seismic Journey received three independent reviews.

T. Behan from *DANZ Quarterly* commented that

> 'the focus of the performance is the unity of the dancers and the concept being portrayed … ', that the, '… wonderfully varied grouping of works based on insight and reflection into the personal and scientific responses to the earthquakes in Canterbury were on show', and that the opening work A Seismic Journey 'was intelligently layered and effectively represented a scientific study of the quakes' origins through the medium of dance (Behan 2011).

K. Sullivan from *Theatreview* commented that

> '… I wonder whether HDC's interpretation of events will incite any new emotions', that '… the irritability of the many sleepless nights is clear in the movements of the dancers' constant shuffling and changing of position on the mattress. A feeling I'm sure most of us Cantabrians can relate to and '[the] portrayal of the earthquake is exciting and uplifting. I am comforted by the fact that all of the dancers and choreographers have shared experiences that relate so well to what most of us are feeling, making me feel more normal' (Sullivan 2011).

A.P. Wood from *The Christchurch Press* commented that

> 'In the first instance I was a little worried that earthquake fatigue might prevent me from enjoying this seismically themed dance production', that '[*Move: A Seismic Journey*] draws on … contemporary dance moves … and immediately recognisable gestures (checking your watch after an aftershock and checking its size on the internet, for example, or searching around in the dark with a torch)', that 'Dancers … convincingly enact the geological forces behind a quake, the falling of buildings, and post-disaster human interactions in a believable, enthralling way', and that '… *Move* [*A Seismic Journey*] is mesmerising' (Wood 2011).

Recovery elements in reviews

It is clear from these anecdotes that two of three reviewers expressed initial apprehension and a lack of overt enthusiasm for the production given the subject matter and their negative personal experiences of earthquakes. The reviewers were able to relate their own observations and experiences to those represented by the dance choreography (i.e. experience heightened *connection*; Jacobson and Greenley 2001). They understood that earthquake science was represented by the movement in the choreography (i.e. experienced heightened *empowerment* through knowledge; Jacobson and Greenley 2001). One of the reviewers commented on the effect of feeling more normal therapeutic effect of the performance, and all gave the performance highly complimentary reviews. We deduce from these reviews that the performance enabled audiences to relate some of their traumatic experiences to contemporary dance movement, and that this had a beneficial effect on recovery, at least for the dance-literate proportion of the audience audiences.

Dancer and choreographer responses to survey

Dancers ($n = 7$) and choreographers ($n = 4$) were invited to answer a series of questions approximately 26 months after the production of *Move: A Seismic Journey*. This long intervening period assured that no conflict of interest occurred between the HDC Director and the solicited subjects; for example, one member of the 2011 HDC returned in 2012 and thus could not be approached until 2013. Participation in the survey was voluntary on an 'opt-in' basis. The survey methodology and questions were approved by the University of Canterbury Ethics Committee. Dancers and choreographers responded to the questions in written form directly to the Director. The identity of each individual is confidential between the Director and the individual. The questions appear in Figure 7; caption and tabulation of results appear in Figure 7(A) (dancers) and Figure 7(B) (choreographers).

We analysed the survey results qualitatively and quantitatively. Qualitative analysis of the survey answers and associated comments was conducted by comparing

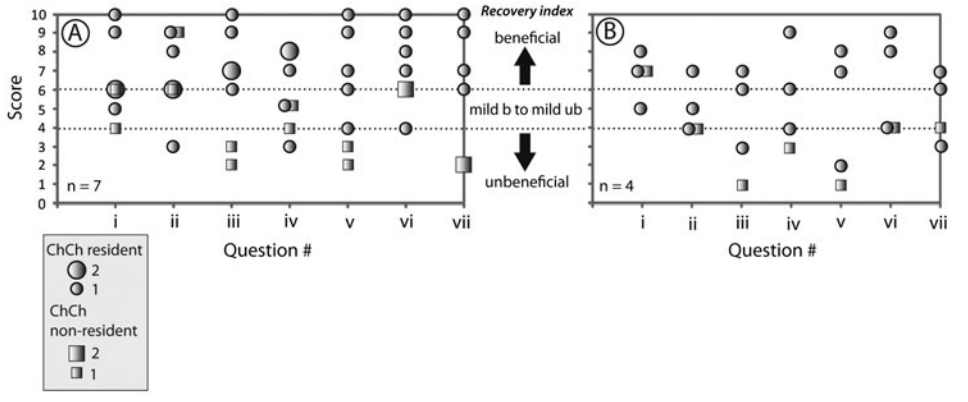

Figure 7. Summary of dancer (A) and choreographer (B) responses to questions pertaining to their experience in MOVE. Questions are as listed: (i) What effect did MOVE: A seismic journey have on your overall understanding of the Canterbury Quakes? (ii) At the time, what effect did your participation in the dance show MOVE: a seismic journey have on your understanding of the science of earthquakes? (iii) At the time, what effect did your participation/choreographing in the dance show MOVE: A seismic journey have on your immediate recovery from experiencing the earthquakes? (iv) Do you think about the show today (please answer using a rating of 1–10. 1 = never think about it, 10 = that you think about it everyday)? (v) To what extent did being a performer/choreographer in the show MOVE help you to gain closure from the trauma caused from being in the earthquakes? (vi) To what extent do you feel that dancing/choreographing for MOVE helped the whole HDC deal with the earthquake experience/trauma? (vii) To what extent did dancing in/choreographing for this show help you to cope with the earthquakes?

these data with the recovery characteristics described above (see *Defining and assessing recovery*). Quantitative analysis was conducted by separating the numeric 'Recovery Index' (*RI*) scores between 1 and 10 (Figure 7) into beneficial ($RI \geq 7$), mildly beneficial to mildly unbeneficial (*RI* 4–6), and unbeneficial ($RI \leq 3$). Quantitative interpretations and detailed statistical analysis are limited by the small sample size. To investigate the extent to which being a Christchurch resident or non-resident at the time of the earthquakes was relevant to dancer and choreographer responses, we also distinguished resident (i.e. living within the greater Christchurch area) from non-resident (living ≥10 km from central Christchurch) responses.

Survey results

For the total of seven dancer questions (Figure 7(A)), 22 responses were $RI \geq 7$ (46%), 18 *RI*s were 6–4 (38%), and 8 *RI*s were ≤3 (17%). For Christchurch resident dancers only, 20 responses were $RI \geq 7$ (60%), 11 *RI*s were 6–4 (33%), and 2 *RI*s were ≤3 (6%). The mean for dancer responses ranged from 5.9 to 7.1 (average = 6.3) and responses exhibited a high degree of variability (standard deviation ranged from 2.0 to 3.4, average = 2.5). The mean for resident dancer data (range = 6.2–8, average = 7.2, stdev = 2.1) was markedly higher than the all-dancer response scores. The highest all-dancer average score and the only average of ≥7 (=7.1) was for Question (vi). Five Christchurch resident dancer-only average scores were >7, with

the highest average (and largest difference from the all-dancer average) recorded for Question (vii) ($RI = 8.0$).

For the choreographer data (Figure 7(B)), 12 responses were $RI \geq 7$ (43%), 10 *RI*s were 6–4 (36%), and 6 *RI*s were ≤3 (21%). For Christchurch resident choreographers only, 11 responses were $RI \geq 7$ (50%), 8 *RI*s were 6–4 (36%), and 3 *RI*s were ≤3. The mean *RI* for choreographer questions ranged from 4.3 to 6.8 (average = 5.4) and responses exhibited a high degree of variability (standard deviation ranged from 1.3 to 3.5, average = 2.4). The mean for resident choreographer data ranged from $RI = 5.3$ to 7.0 (average = 6.0, stdev = 2.3). The highest *RI* average scores for both all-choreographer and resident-only choreographer data were recorded for Questions (i) and (vi).

'Resident-only' total mean *RI* scores are higher than 'all' participant *RI* scores for both dancers (13% higher) and choreographers (12%). For almost every question, the 'resident-only' mean *RI* is higher than the 'all' mean *RI*. Total mean standard deviations were higher for 'all' than 'resident-only' for dancers but consistent for choreographers. Mean *RI* values for all questions are higher for dancers than for choreographers for both 'all' (17% higher) and 'resident-only' (19% higher) datasets. Mean dancer *RI* scores were higher than choreographer *RI* scores for virtually every question asked within the survey.

Additional comments

Some dancers and choreographers added additional comments to their survey responses. Selected dancer comments include:

> If anyone talks about the Canterbury earthquakes, or if I think about it myself, I think about the show *Move* [*A Seismic Journey*]
>
> The show gave me a release at the time the earthquakes were occurring, and because I love to show emotions through dance the show enabled me to express some of my feelings about the earthquakes
>
> Because I had done research on the earthquakes and now have a better understanding of what happens during a earthquake, and once again being able to express myself through dance was a valuable experience
>
> Having [a scientist] as an educator was great for my understanding as I felt in the end I really knew what I was dancing about
>
> I learnt more about the experience of earthquakes from being in [dance] pieces - everyone experienced the quakes differently (were affected differently) even though we all went through the same event. The range of choreographic takes included in *Move* [*A Seismic Journey*] shows how differently everyone processed this event to form an artistic outcome
>
> Overall *Move* [*A Seismic Journey*] was a very special show that really helped me understand my environment at the time better and it was a very memorable experience

Choreographer comments included,

> [My favourite part was] drawing on my own experiences from the EQ's and merging them with the dancers' experiences
>
> As I didn't get to experience the quakes first hand it was a great experience for me to do this choreography as it helped me better understand what the people of Christchurch went through

Recovery characteristics in survey results and comments

Both the survey answers to Questions (i) and (ii) and associated comments provide strong evidence that participation in *Move: A Seismic Journey* had the beneficial impact of increasing scientific and overall knowledge and understanding of the Canterbury earthquakes, thereby empowering the participants. The comments and highly positive responses to questions pertaining to self-perceived recovery (iii), gaining closure (v), dealing with trauma (vi), and coping with the earthquakes (vii) through dancing and choreographing include several components of the hope recovery characteristic (believing recovery is possible, looking optimistically to the future, developing connections with nature, and making art). Many of the participants still think about the production (Question (iv) and associated comments) and some appear to have incorporated pleasurable memories of the production into their overall (generally traumatic) memories of the earthquakes, thereby validating and reconciling their personal experiences (connection recovery characteristic). Other comments and answers (Question (vi)) indicate that involvement in *Move: A Seismic Journey* helped participants empathise and better connect with each other through sharing their personal experiences and telling their personal stories (connection recovery characteristic).

Survey interpretations

Survey results indicate that *Move: A Seismic Journey* was beneficial to mildly beneficial in assisting with earthquake recovery for both dancers and choreographers. The majority of individual (47 out of 76) and mean RI scores (11 out of 14) are ≥6. Survey answers and comments include characteristics of recovery such as hope, empowerment, and connection.

Dancers had higher mean RI scores than choreographers. This could reflect that (i) dancers were more traumatically affected by the earthquakes than the choreographers, and thus were more conscious of a positive emotional shift brought upon by their involvement in this performance because they were starting from a more traumatic state, and/or (ii) dancers simply experienced more therapeutic benefits from this performance than the choreographers, independent of the severity of the trauma brought on by the earthquakes. It is possible that the act of choreographing, practising, and performing dance was more therapeutic than choreographing alone. The total immersion of dancers in the performance compared to the comparably short-time commitment of the choreographers may also have yielded more therapeutic aspects (i.e. increased exposure to components of connection, hope, and empowerment). Most dancers danced in almost every piece, all choreographed at least one piece, and all dancers were involved in the whole process of the show, from the initial conception of ideas to developing and participating in choreography and movement concepts. Conversely, the professional choreographers, apart from the Director of the show, were only involved in devising and applying their own choreography. The choreographers, apart from the Director, did not take part in geological lectures during the undertaking of the production, therefore not improving their scientific knowledge of the earthquake (empowerment characteristic). When the dancer and choreographer responses are compared, it appears that integrating scientists into the choreographic process to increase the knowledge and thus empower the participants may have a significant therapeutic benefit to recovery and/or perceived recovery.

Choreographers also informally commented that channelling energy into choreography (enhanced hope characteristic in terms of making art and looking forward) rather than worrying about the earthquakes was beneficial for their well-being, and that they also found it beneficial to know they were providing the dancers with an outlet through their choreography (enhanced connection).

Christchurch residents had higher mean RI scores than non-residents. This could indicate that resident dancers and choreographers were more traumatically affected by the earthquakes, and thus rated their recovery (or perceived recovery) higher than the non-residents, and/or that residents simply experienced more therapeutic benefits from this performance than the non-residents. Non-resident dancers had low RI scores for questions particularly related to trauma (i.e. (iv) and (v)) and one response included the comment, 'I wasn't traumatized'. However, non-residents acknowledged that the performance had therapeutic benefits for the whole company (Question (vi)). Residents, particularly dancer residents, gave very high scores for all questions relating to trauma recovery.

Discussion and conclusions

How does one know how much a particular experience helps them to recover from a traumatic event? In this case, it appears that all dancers and choreographers drew positive experiences from participating in an earthquake science and experience-motivated performance. Those who were most subjected to potential earthquake trauma, due to their residence within the earthquake zone, appear also to have also been most positively affected by their participation in this performance, as indicated from the differing RI scores for residents and non-residents (Figure 7). Through observation one may conclude that the very fact these dancers were kept busy, were engaged in the task of learning and performing dance, and actively choreographing about the very concept that they are meant to be recovering from means that they were experiencing therapy through this production. By providing dancers with both an opportunity to learn scientific fundamentals pertaining to their traumatic experience through geology and engineering lectures, and the choice of whether to focus their assessed choreography on emotional concepts (3 out of 7) or physical science concepts (e.g. plate tectonics, building behaviour, building demolition – 4 out of 7), a balance was struck between empowering the dancers to 'choose their own concepts' and encouraging earthquake recovery through self-expression while fulfilling NCEA curriculum requirements and thus cultivating optimism for the future. The most intellectual benefit in terms of increased knowledge of earthquake science (Question (ii)) was gained by dancers who used science-based choreography and dancing rather than dancing alone. Clearly, being able to link this traumatic experience with scientific knowledge encouraged them to contemplate their connections with nature, to regain self-control (or to acknowledge and thus cope with elements that are out of their control), and to validate their experiences with others, thereby empowering them and enhancing their recovery. This conclusion is consistent with the hypothesis of Lomas (1998), who states,

> I believe it is possible to redress the negative experiences for the individual … and to respond proactively to disempowerment and disenfranchisement by using dance as a mediator in relation to nature and culture. Dance … offers the individual the opportunity to organise experience, make sense of self, problem-solve, and represent self-expression in metaphor.

In this instance, it appears that the blending of educational, physical, teamwork, creative, and professional goals within a dance production was highly successful in cultivating an environment favourable for earthquake recovery. Clearly, the merger of science-based empirical enquiry and the aesthetic goals of dance into an embodied narrative promoted aspects such as being imaginative, risk-taking, question-posing, question-responding, self-determination, innovation, playfulness, and immersion (Chappell 2009) that may lie at the heart of creativity (Craft et al. 2007).

The therapeutic benefits of *Move: A Seismic Journey* extended beyond the dancers and choreographers to the general audience of the production. Concepts of unity and shared personal and scientific responses to the earthquakes created an environment that the reviewers (a proxy for the general audience) found exciting, uplifting, believable, enthralling, mesmerising, and effective for 'feeling more normal'. *Move: A Seismic Journey* was also a highly emotional experience for both the participants and audience in ways that have not been completely captured by the surveys, comments, and reviews. Several audience members cried at various stages throughout the performance. Some dancers wept while performing a piece related to the demolition of buildings in their home city. There was clearly a cathartic element in the act of expressing the deep, possibly repressed or ignored emotions through dance (cf. Lomas 1998; Yagi 2010).

The statistically small data-set and lack of participating professional dance therapists or psychologists require that similar studies should be conducted before implementation into DMT practice, particularly in the case of more severely traumatised subjects following natural disasters. However, the evidence from the dancer and choreographer surveys and comments, professional reviews, our personal experiences, and our observations of dancers, choreographers, and audience indicates that a performance focused on the science and experience of a natural disaster yields therapeutic aspects, particularly for those most affected by the disaster (i.e. local residents). The creation of positive memories associated with a traumatic event assists with earthquake recovery in both the short and long term. This study highlights the scope, power, and potential of dance for aiding recovery from natural disasters.

Supplementary material

The supplementary material for this paper is available online at http://dx.doi.10.1080/14647893.2014.930819.

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