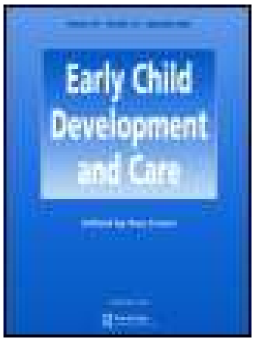

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Effects of creative dance on proprioception, rhythm and balance of preschool children

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ABSTRACT
The purpose of this study was to investigate the effects of creative dance on proprioception, rhythm and static balance in preschool children. The treatment group consisted of 32 preschool children which took part in a creative dance programme that lasted 2 months (twice a week), while the control group (30 preschool children) participated in an unstructured free-play setting. Prior to and after the intervention, children were assessed for proprioception (Active-Reproduction Test), rhythm (K-Rhythm Test) and balancing on one foot. The results showed that the treatment group performed significantly better on the proprioception and rhythm post-test measures compared to the control group. No significant differences were found for static balance. It may be concluded that creative dance can positively affect proprioception and rhythmic synchronization in preschool children. Considering the importance of these factors for children's motor development, it is suggested that creative dance should be included in early childhood curricula.

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Kinesthesis; sensorimotor synchronization; dancing; preschool

Introduction

Preschool teachers often observe children who appear to be unaware of their body position in relation to themselves and others. These children move in an uncoordinated manner during free play and often collide with objects and classmates. Such behaviour may be an indicator of poor proprioception (Kaufman & Schilling, 2007).

Proprioception is the conscious awareness of limb position and movement in space (Han, Waddington, Adams, Anson, & Liu, 2016). Even in the absence of vision, we are aware of our limb positions as well as their movement. Dancers, in order to define this sense, might be more accustomed to related terms such as kinesthesis or sense of movement (Batson, 2009). Currently, both proprioception and kinesthesis are used interchangeably as terms in the relevant literature (Han et al., 2016; Rosker & Sarabon, 2010).

According to Riemann and Lephart (2002), proprioception encompasses proprioceptive information, which is used by the higher nervous structure to produce sensations about the position or the movements of the limbs and the body. The specialized sensory receptors that transduce the mechanical events into neural signals and provide proprioceptive information are called mechanoreceptors. They are primarily found in muscles, tendons, ligaments, capsules and skin. The proprioceptive information is transmitted to the central nervous system for processing and ultimately results in the regulation of reflexes and motor control (Hewett, Paterno, & Myer, 2002).

Several studies revealed the importance of proprioception for coordinated movements, and many training programmes have been suggested for its improvement (Han, Waddington, Anson, & Adams,

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2015; Hewett et al., 2002). However, these programmes are not appropriate for young children because their main components are strong structured exercises and resistance training (Hewett et al., 2002). The most challenging part of strong structured programmes is keeping children's interest in taking part and continuing participation for a long time. To enhance children's motivation, it is important to give them the feeling of autonomic action and personal expression (Ryan & Deci, 2000).

Creative dance is a particular form of dance combining the mastery of movement with the artistry of expression (Gilbert, 2015). It supports autonomic action and encourages children to discover new ways of moving. Furthermore, the development of body awareness and movement are the main components of creative dance in preschool education (Stinson, 1988). Games such as 'mirroring' (partners mirror each other's movements), or moving in self-space (the space that a body takes up, also called Kinesphere), belong to the core content of every creative dance session (Brehm & McNett, 2007). Altogether, the tasks of creative dance require conscious awareness of body position and movement (Joyce, 1993). According to Ashton-Miller, Wojtys, Huston, and Fry-Welch (2001), directing attention to proprioceptive cues provides an opportunity to improve body awareness and movement. Therefore, creative dance might be an option to improve the proprioception of young children.

Several studies have reported that creative dance improves creativity (Garaigordobil & Berrueco, 2011), enhances social competence of preschool children (Lobo & Winsler, 2006; Williams, 1992), improves wellbeing (Ells et al., 2009), aerobic fitness (Quin, Frazer, & Redding, 2007) and contributes to a healthy weight maintenance of preschool girls (Gallotta, Baldari, & Guidetti, 2017). However, few studies have examined the effects of dance on proprioception. Specifically, Marmeleira et al. (2009) reported that creative dance improved the proprioception of elderly participants (63.6 ± 5.7 years). Moreover, it appears that no study has examined the effects of creative dance on children's proprioception. Therefore, the main purpose of this study was to investigate the effects of a creative dance programme, based on the concepts of Gilbert (2015), on proprioception in preschool children.

Another inherent element of creative dance is sensorimotor synchronization (SMS), which is defined as the coordination of rhythmic movement with an external rhythm (Repp & Su, 2013). Specialists from the dance and music fields might find the term 'rhythmic ability' more familiar (Côté-Laurence, 2000; Gilbert, 2015). Research has shown that professional dancers demonstrate better rhythmic synchronization than non-dancers (Bläsing et al., 2012; Miura, Fujii, Yamamoto, & Kudo, 2015). However, most of the investigations provide a correlational link between dance level and rhythmic synchronization rather than a causal effect (Karpati, Giacosa, Foster, Penhune, & Hyde, 2016; Miura et al., 2015). Therefore, the superior rhythmic ability of dancers could be inherently determined (natural talent) and/or attributed to the selection process by experienced dance instructors.

On the other side, modern music education uses clapping, walking and dancing movements in order to teach music skills (Goodkin, 2001). In this domain, a few related studies have reported improvements on children's rhythmic ability (High, 1994; Weikart, Schweinhart, & Larner, 1987; Zachopoulou et al., 2003). According to Zachopoulou et al. (2003), a music/movement programme based on the approach of Orff contributed to the enhancement of rhythmic ability in preschool children. The improvement of rhythm was attributed to movement activities similar to those used in creative dance. For example, the children were encouraged to synchronize body movements to the beat of musical selections containing different rhythms. Although rhythmical activities constitute a major part of creative dance lessons, there is no research to our knowledge on the effects of creative dance on children's rhythmic synchronization.

Besides proprioception and rhythm, balance is another important factor for the successful execution of dancing movements. Most of the movements and shapes performed in dance require a well-developed balance ability. Furthermore, balance is constantly exercised in creative dance lessons through specific games, e.g. 'in your self-space try balancing on five parts, three parts, two parts, then one part' (Gilbert, 2015). The few studies conducted so far revealed conflicting results. Boswell (1993), reported that creative dance improved balance of children with mental retardation. On the contrary, the studies of Wang (2004) and Gallotta et al. (2017) reported no significant effects of creative dance on children's balance. Balance is an important factor for the execution of daily physical activities and the contradictory findings in this area require further studies.

Creative dance is an integral part of early childhood education in many preschool programmes (Pollatou, Karadimou, & Gerodimos, 2005). However, little research has been done to identify the effectiveness of creative dance on the development of proprioception, rhythm and balance. Therefore, the purpose of the present study was to examine the effects of a creative dance programme on the development of proprioception, rhythm and balance in preschool children.

Methods

Participants

The sample for the study consisted of 62 children who attended a preschool centre in urban northern Greece (28 boys, 34 girls). The children were divided in four classes. Two of them were randomly selected for the treatment group and the other two served as the control group. The treatment group comprised 32 children (14 boys, 18 girls) with a mean age 64.46 ± 5.71 months (range 56.40–74.40 months). The control group consisted of 30 children (14 boys, 16 girls) with a mean age 62.36 ± 6.21 months (range 52.80–73.20 months). Sample size was determined using G*Power (version 3.1.7, F. Faul, University Kiel, Germany), setting a medium effect size at $f = 0.25$, alpha at 0.05, and power at 0.80, the required sample size is 34 (Faul, Erdfelder, Lang, & Buchner, 2007).

The research was conducted in accordance to the ethical guidelines of Aristotle University Thessaloniki, Greece. Informed consent was obtained from the guardian of the participants, and they could withdraw from the study at any time. Only children who were free of acute musculoskeletal injuries, did not have any previous dance or sport training, and had no diagnosed learning disabilities were included in the data analysis. No participant withdrew because of injury or any other adverse experience.

Procedure

The treatment group followed an 8-week creative dance programme, which occurred twice a week for 45 min. The focus of each lesson was one or two concepts from Gilbert (2015). The dance concepts included:

- body parts (head, arms, etc.), shapes (straight, symmetrical, etc.), relationships (body parts to body parts, body parts to objects, etc.);
- space (self-space/general space), size (big, medium, little), level (high, middle, low), direction (forward, backward, right, left, up, down, pathway) and focus;
- rhythm and speed (slow, medium, fast);
- force (energy, weight and flow);
- balance (on-balance, off-balance). For example, 'when the music stops, freeze in a one-legged balanced shape';
- choreographic forms (ABA, ABC, etc.).

Each lesson consisted of the following parts: warm up (2–3 min aerobic activity games), exploring the concept (understanding, finding different ways to move that fulfil the concept), developing skills (applying, learning dance steps and practising them in movement combinations), creating (dance improvisation) and cooling down (good-bye dance). During the same period, the control group participated in an unstructured free-play setting, with emphasis on fundamental movement skills.

Measurement instruments

Before and after the intervention, three tests were administered to measure the children's proprioception, rhythm and static balance.

Proprioception test: Active-Reproduction Test

The experimental set up that was used for the measurement of proprioception has been described previously, and has been shown to be sensitive and produce reproducible results (Fridén, Roberts, Zätterström, Lindstrand, & Moritz, 1996; Roberts, Fridén, Zätterström, Lindstrand, & Moritz, 1999). The apparatus consists of a platform placed on the floor and a paddle that could rotate in either direction like the hand of a clock (Figure 1). The participant lies on the side, with the lower extended leg placed on the paddle. The knee joint is positioned in the rotatory axis of the paddle, and the lower limb is fixed with straps. Pillows are placed under the head and the contralateral limb. With this arrangement, visual control of the leg on the paddle is eliminated.

The axis of an electro-goniometer was placed on the rotation point of the paddle (0.02° measurement accuracy, Vernier, http://www.vernier.com). The angle of the goniometer was visualized on a monitor as a numerical angle and recorded via LoggerLite191 software with a sampling frequency of 100 Hz.

The starting join position of the knee was 30° (Figure 1). The examiner flexed the leg 30° at a speed of about 10°/s. Upon reaching the final position (60°), the leg was held still for 5 s and the participant was asked to remember the position (target angle). Then, the leg was returned to the starting position (30°) with the same speed by the examiner. Afterwards, the participant was asked to flex the knee to the target angle (60°) using his/her own muscle force. When the participant believed that the target angle was reached, he/she notified the examiner and the angle was recorded (the estimated angle). The absolute deviation between the estimated angle and the target angle (60°) was registered. After a practice trial, the children performed three trials. The mean absolute deviation from the three trials was calculated and used for statistical analysis (Fridén et al., 1996).

To increase the children's interest in the task, it was presented as a game called 'going driving to a friend's house'. The starting point (30°) was the 'home' and the target point (60°) was 'the friend's house' (Opila-Lehman, Short, & Trombly, 1985). To avoid distractions, the test was conducted in a quiet room by the same examiner using the same instructions. Only dominant legs were tested. The test 'Kicking a ball' was used for determination of the dominant leg (Gabbard & Hart, 1996).

The reliability of the test was determined by the test–retest method in a pilot study with 18 preschool children. The group was retested one week after the initial test, and the intraclass reliability

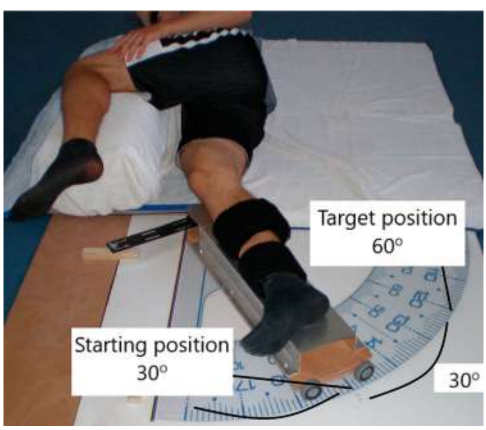

Figure 1. Proprioception test. The person is a model who did not participate in the study.

coefficient was satisfactory (ICC = 0.75). The children that took part in the test–retest measurements were not included in the main study.

Rhythm Test

The measurement of rhythmic synchronization was conducted with the K-Rhythm Test, which consists of a software program and two forceplates connected to a computer (KINVENT, http://www.k-invent.com). The participant was asked to walk in place on the two forceplates in synchrony with the steady beat produced from the software (metronome).

The software captures both the time of the metronome onset (beat) and the participant's corresponding foot contact on the forceplate (sampling frequency 100 Hz). The rhythmic accuracy (or asynchrony) is the absolute temporal difference between the beat and the corresponding participant's foot contact (Figure 2) (Elliott, Welchman, & Wing, 2009). The mean of the absolute differences was used for statistical analysis (Bailey & Penhune, 2010).

Prior to measurement, participants were acquainted with the apparatus (walking in place on the forceplates). In accordance to the 'High/Scope Beat Competence Analysis Test', children were asked to step in time on the steady beat of two tempi: 132 and 120 beats/min (Weikart et al., 1987). The fast tempo was executed first, followed by the slow one (Weikart et al., 1987).

The children executed 16 steps in synchrony to the beat of the metronome. The test was conducted in a quiet room, and the intensity of the acoustic stimulus was set individually at a level declared comfortable by the child.

Asynchrony is the absolute temporal difference between the beat and the corresponding participant's foot contact (Figure 2) (Elliott et al., 2009). Exactly this is measured by the K-Rhythm Test (face validity). Many studies regarding rhythmic synchronization use similar computer programs, where participants tap on footpads (Rosenblum & Regev, 2013), or on the mouse button of a computer (Bailey & Penhune, 2010).

Furthermore, the distinguishing validation for the age factor was examined in a pilot study with 68 children (5–8 years old, Table 1). The ANOVA results showed that older children had better rhythmic synchronization than younger ones ($F = 6.68$, $p = .001$, $\eta^2 = 0.23$).

Post hoc Bonferroni analyses indicated that each age group was significantly better than age groups more than a year younger. Specifically, 7 and 8 years old children were significantly better compared to 5 years old, and age group 8 was significantly better compared to 6 years old. These results are in agreement with those of a similar computer-based measurement, the Interactive Metronome (Kuhlman & Schweinhart, 1999).

The reliability of the test was determined by the test–retest method in a pilot study with 23 preschool children. The group was retested one week after the initial test, and the intraclass reliability coefficient was satisfactory (ICC = 0.71). The participants in the reliability and validity measurements were not included in the main study.

Static balance

The test of balancing on one foot was used for assessing static balance (Bös et al., 2004). The participants balanced on a bar 3 cm wide and 5 cm high. They are asked to stand on their dominant leg for 60 s with their eyes open. The free leg had to be kept in the air like a stork. During the test, each

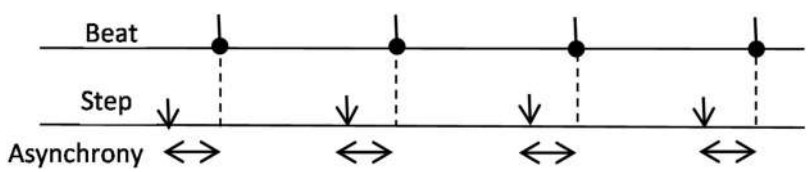

Figure 2. Asynchrony represents the temporal absolute difference between beat and the corresponding foot contact.

Table 1. Rhythmic synchronization by age group.

Age	*N*	*M* ± SD
5	16	176.49 ± 30.36
6	14	165.34 ± 33.28
7	20	141.77 ± 33.92[a]
8	18	131.27 ± 34.11[a,b]

Note: *N* = number of participants.
[a] Significant difference of the groups 7 and 8 compared to group 5 ($p < .05$).
[b] Significant difference between age groups 8 and 6 ($p < .05$).

ground contact with the free leg was recorded as a penalty point. At 30 points, the test was discontinued. Total points were summed and used for data analysis. The fewer ground contacts, the better the participant's balance. The test shows good reliability ($r \geq 0.70$) and validity (Bös et al., 2004).

Statistical analyses

To investigate differences between the two groups (treatment and control group), data were analysed using one-way Analysis of Variance (ANOVA) for repeated measures. *Post hoc* analyses were conducted using Bonferroni pairwise comparisons. All statistical analyses were conducted using SPSS (version 20), and significance was set at $p \leq .05$.

Results

Descriptive statistics of the dependent variables are presented in Table 2.

Proprioception

The repeated measures ANOVA indicated a significant interaction effect between group (treatment, control) and time of measurement (pre-post), ($F_{1,60} = 14.475$, $p = .002$, partial eta squared $\eta_p^2 = 0.147$). At the beginning of the intervention, there were no significant differences between the two groups (treatment, control) ($t = 0.40$, $p = .68$). At the end of the intervention, Bonferroni correction revealed that the treatment group was significantly better than the control group ($t = 3.69$, $p = .001$, 95% CI [3.656, 1.157], Cohen's $d = 0.99$).

Rhythm

The repeated measures ANOVA showed a significant interaction effect of group (treatment, control) and time of measurement (pre-post) ($F_{1,60} = 10.190$, $p = .002$, partial eta squared $\eta_p^2 = 0.145$). At the beginning of the intervention, there were no significant differences between the two groups (treatment, control, $t = 0.68$, $p = .49$). At the end of the intervention, Bonferroni correction revealed that the treatment group was significantly better than the control group ($t = 2.29$, $p = .026$, 95% CI [0.015, 0.001], Cohen's $d = 0.614$).

Table 2. Proprioception (degrees), rhythm (msec) and balance (contacts) of the treatment and control groups from pre- and post-tests.

	Treatment group		Control group	
	Pre	Post	Pre	Post
Proprioception	6.90 ± 3.23	4.40 ± 2.34*	6.60 ± 2.75	6.81 ± 2.57
Rhythm	142.36 ± 22.49	124.30 ± 30.11*	138.06 ± 26.58	141.17 ± 27.75
Balance	19.78 ± 6.33	18.18 ± 7.05	19.5 ± 5.64	18.80 ± 6.13

*Significant difference between the two groups ($p < .05$).

Balance

The repeated measures ANOVA indicated no significant interaction effect between group (treatment, control) and time of measurement (pre, post) ($F_{1,60} = 0.363$, $p = .549$, partial eta squared $\eta_p^2 = 0.006$). Furthermore, there were no significant effects of group (treatment, control) ($F_{1,60} = 0.013$, $p = .908$, partial eta squared $\eta_p^2 = 0.001$) or time of measurement (pre-post) ($F_{1,60} = 2.389$, $p = .127$, partial eta squared $\eta_p^2 = 0.038$).

Discussion

The specific of creative dance compared to other dance forms is its child-centred character (Joyce, 1993). In contrast to other dance forms, creative dance encourages children to express their thoughts and feelings with basic motor skills (locomotor and non-locomotor movements), and not with specific dance steps, such as in ballet steps (Brehm & McNett, 2007). According to the results of the study, a creative dance programme based on the concepts of Gilbert (2015) may enhance children's proprioception and rhythm, but not balance.

Dance performance relies heavily on body awareness and movement in space (Batson, 2009). One of the most important elements in dance is to be aware of what the body does in movement, e.g. what action is going on and what body shapes are made. Consequently, many dance teachers claim that dance training may play a role in the development of children's proprioception (Gilbert, 2015; Stinson, 1988). However, there is no empirical evidence of creative dance enhancing children's proprioception. The results of the present study showed that a creative dance programme may have a positive contribution to the development of proprioception. This finding is encouraging considering the importance of proprioception for movement coordination and motor learning (Wong, Kistemaker, Chin, & Gribble, 2012).

The findings of the present study are in agreement with those of Marmeleira et al. (2009), who reported that creative dance improved the proprioception of elderly participants (63.6 ± 5.7 years) compared to a respective control group (65.3 ± 7.6 years). However, due to the older sample, it is difficult to compare the results of Marmeleira et al. (2009) to the current study. It is well documented that proprioception decreases with age due to changes in joint morphology associated with aging (Adamo, Martin, & Brown, 2007). Furthermore, proprioception is altered throughout the lifespan by a variety of other factors, including postural habit, menstruation, musculoskeletal injury and movement training (Ribeiro & Oliveira, 2007). These factors make it problematic to compare the results of the present study to those of Marmeleira et al. (2009). Therefore, further research is needed in order to verify the findings of the present study.

Several studies have shown that professional dancers demonstrate increased accuracy in position-matching (proprioception) compared to untrained controls (Kiefer et al., 2013; Ramsay & Riddoch, 2001). However, it is not known whether professional dancers' superior ability is inherently determined, or whether it is the result from extensive training (Han et al., 2015). The participants in the present study were untrained preschool children. The better results in the treatment group compared to the control could be an indication that proprioception may be trained.

According to the review of Ribeiro and Oliveira (2007), the exact mechanism by which training may improve proprioception remains unclear. It is hypothesized that training induces adaptations in the peripheral and central components of proprioception. At the peripheral level, proprioception is based on neural input from mechanoreceptors. The major mechanoreceptor involved in proprioception is the muscle spindle (Riemann & Lephart, 2002). There is evidence that training induces morphological adaptations in the muscle spindle, which may decrease the stretch reflex response and increase the amplitude (Ribeiro & Oliveira, 2007). The central component of proprioception involves feedback loops that transmit information between and within sensory and motor areas (Riemann & Lephart, 2002). It is possible that dance induces plastic changes, such as increased strength of synaptic connections and/or structural changes in the organization of connections among neurons.

Furthermore, regular dance training may increase cortical representation of the joints resulting in enhanced joint proprioception (Bläsing et al., 2012).

Except dance training, age appears to also be associated with the development of proprioception. Laszlo and Baivstow (1980), reported that there is a developmental trend in proprioception in 5–12-year-old children. However, some of the 5- and 7-year-olds performed as well as adults (Laszlo & Baivstow, 1980). Therefore, future work should examine whether dance may increase the rate and the magnitude of the developmental trend of children's proprioception.

Rhythm

The capacity to synchronize a motor pattern to a rhythmic stimulus is a crucial aspect in any dance performance. In practice, it refers to either the synchronization of one's movements to those of another dance partner or to the beat of music. The results of the present study showed that creative dance has a positive effect on children's synchronization to external rhythmic stimuli. It is difficult to compare the study's result with relevant literature, since, to our knowledge, there have not been other investigations with creative dance. However, previous studies have demonstrated the role of music/movement approaches in the improvement of rhythmic synchronization. For instance, Zachopoulou et al. (2003) examined the effects of a music/movement programme based on the approach of Orff on rhythm in preschool children. A large part of their programme included improvisation and creative activities similar to creative dance. For example, children were encouraged to express their ideas and emotions through body and limb movements in synchrony to the beat of music. However, the Orff approach is a method of music education, and a large part includes playing music with percussion instruments (tambourines, maracas, woodblocks, etc.). Therefore, comparison of the current study's results with those of Zachopoulou et al. (2003) should be treated with caution. As this study is the first study to examine the effects of creative dance on synchronization, there is a need for further research to verify the findings.

Several studies have shown that professional dancers perform better rhythm than novice controls (Bläsing et al., 2012; Miura et al., 2015). However, how the motor system produces synchronized movements is still poorly understood (Miura et al., 2015). One of the major theoretical approaches to synchronization is the Dynamical Systems Approach (DSA) (Kelso, 1995). According to the DSA, motor systems show a pre-existing, self-organizing tendency in motion pattern formation during rhythmic activities, which can be altered by practice (Miura et al., 2015). Results indicated that the motor system matches certain movement patterns to certain external rhythms for optimal synchronization without specific commands within the nervous system (Miura, Kudo, & Nakazawa, 2013). Based on relevant studies, the review by Miura et al. (2015) concluded that movement experiences requiring spatiotemporal acuity, such as dance movements, seem to enhance rhythmic synchronization.

Balance

Balance is essential for successful completion of dance movements, and several studies have revealed better balance skills in professional dancers compared to no dancers (Gerbino, Griffin, & Zurakowski, 2007). However, the results of the present study showed no significant differences between the intervention and the control group. Moreover, Wang (2004) and Gallotta et al. (2017) reported that a creative dance programme did not significantly improve children's balance ability. The creative dance activities of the current study required balance on different body parts, e.g. moving in space and stopping in balanced positions using different body shapes (Gilbert, 2015). It seems that such activities are not sufficient to produce significant improvements in children's balance. Apparently, there is a need for further studies on the effects of creative dance on children's balance.

Limitations and conclusion

The limitations of this study include the fact that the motivation and concentration of the participants were not under experimental control. It was assumed that the very nature of the creative dance activities (e.g. animal imitation and creative movement in synchrony with the music), would keep children motivated and attentive.

Another limitation of the study is the way in which rhythmic synchronization is measured, that is the absolute temporal difference between the beat and the corresponding participant's foot contact, and the mean of the absolute differences was used to statistical analysis. Nevertheless, according to Dynamical Systems Theory, musical rhythmic entrainment is an active, self-sustained, periodic oscillation at multiple time scales, enabling the listener to use predictive timing to maintain a stable pattern and synchronize movements at metrical levels (Kelso, 1995). Therefore, it is suggested that future studies should use nonlinear measures taken from time series analysis, in order to study rhythmic synchronization.

The present study showed that creative dance may have a significant impact on children's proprioception and rhythm, but not on static balance. Removing creative dance from preschool education could be detrimental to many children's motor development. Therefore, the present study suggests that creative dance should be supported and not excluded from preschool education.

Disclosure statement

No potential conflict of interest was reported by the authors.

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References

Adamo, D. E., Martin, B. J., & Brown, S. H. (2007). Age-related differences in upper limb proprioceptive acuity. *Perceptual and Motor Skills*, *104*, 1297–1309.

Ashton-Miller, J. A., Wojtys, E. M., Huston, L. J., & Fry-Welch, D. (2001). Can proprioception really be improved by exercises? *Knee Surgery, Sports Traumatology, Arthroscopy*, *9*, 128–136.

Bailey, J. A., & Penhune, V. B. (2010). Rhythm synchronization performance and auditory working memory in early-and late-trained musicians. *Experimental Brain Research*, *204*, 91–101.

Batson, G. (2009). Update on proprioception: Considerations for dance education. *Journal of Dance Medicine & Science*, *13*, 35–41.

Bläsing, B., Calvo-Merino, B., Cross, E. S., Jola, C., Honisch, J., & Stevens, C. J. (2012). Neurocognitive control in dance perception and performance. *Acta Psychologica*, *139*, 300–308.

Boswell, B. (1993). Effects of movement sequences and creative dance on balance of children with mental retardation. *Perceptual and Motor Skills*, *77*, 1290–1290.

Bös, K., Bappert, S., Tittlbach, S., & Woll, A. (2004). Karlsruhe's motoric screening for nursery school children (KMS 3–6). *Sportunterricht*, *53*, 79–87.

Brehm, M. A., & McNett, L. (2007). *Creative dance for learning: The kinesthetic link*. New York: McGraw-Hill.
Côté-Laurence, P. (2000). The role of rhythm in ballet training. *Research in Dance Education*, *1*, 173–191.
Elliott, M. T., Welchman, A. E., & Wing, A. M. (2009). MatTAP: A MATLAB toolbox for the control and analysis of movement synchronisation experiments. *Journal of Neuroscience Methods*, *177*, 250–257.
Ells, L., Ogilvie, J., Kurtz, R., Temply, J., Moore, H., McLure, S., … Shucksmith, J. (2009). *North East dance & health project: An evaluation of a creative dance programme in preschool children*. Stockton on Tees: North East Public Health Authority.
Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G*power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, *39*, 175–191.
Fridén, T., Roberts, D., Zätterström, R., Lindstrand, A., & Moritz, U. (1996). Proprioception in the nearly extended knee. *Knee Surgery, Sports Traumatology, Arthroscopy*, *4*, 217–224.
Gabbard, C., & Hart, S. (1996). A question of foot dominance. *The Journal of General Psychology*, *123*, 289–296.
Gallotta, M. C., Baldari, C., & Guidetti, L. (2017). Motor proficiency and physical activity in preschool girls: A preliminary study. *Early Child Development and Care*, *4*, 1–11.
Garaigordobil, M., & Berrueco, L. (2011). Effects of a play program on creative thinking of preschool children. *The Spanish Journal of Psychology*, *14*, 608–618.
Gerbino, P. G., Griffin, E. D., & Zurakowski, D. (2007). Comparison of standing balance between female collegiate dancers and soccer players. *Gait & Posture*, *26*, 501–507.
Gilbert, A. G. (2015). *Creative dance for all ages* (2nd ed.). Champaign, IL: Human Kinetics.
Goodkin, D. (2001). Orff-Schulwerk in the new millennium. *Music Educators Journal*, *88*, 17–23.
Han, J., Waddington, G., Adams, R., Anson, J., & Liu, Y. (2016). Assessing proprioception: A critical review of methods. *Journal of Sport and Health Science*, *5*, 80–90.
Han, J., Waddington, G., Anson, J., & Adams, R. (2015). Level of competitive success achieved by elite athletes and multi-joint proprioceptive ability. *Journal of Science and Medicine in Sport*, *18*, 77–81.
Hewett, T. E., Paterno, M. V., & Myer, G. D. (2002). Strategies for enhancing proprioception and neuromuscular control of the knee. *Clinical Orthopaedics and Related Research*, *402*, 76–94.
High, L. (1994). Effects of selected rhythmic teaching strategies on beat-performance skills of kindergarten children. *Southeastern Journal of Music Education*, *5*, 117–128.
Joyce, M. (1993). *First steps in teaching creative dance to children*. Mountain View, CA: Mayfield.
Karpati, F. J., Giacosa, C., Foster, N. E., Penhune, V. B., & Hyde, K. L. (2016). Sensorimotor integration is enhanced in dancers and musicians. *Experimental Brain Research*, *234*, 893–903.
Kaufman, L. B., & Schilling, D. L. (2007). Implementation of a strength training program for a 5-year-old child with poor body awareness and developmental coordination disorder. *Physical Therapy*, *87*, 455–467.
Kelso, J. (1995). *Dynamic patterns: The self-organization of brain and behavior*. Cambridge: MIT press.
Kiefer, A. W., Riley, M. A., Shockley, K., Sitton, C. A., Hewett, T. E., Cummins-Sebree, S., & Haas, J. G. (2013). Lower-limb proprioceptive awareness in professional ballet dancers. *Journal of Dance Medicine & Science*, *17*, 126–132.
Kuhlman, K., & Schweinhart, L. J. (1999). *Timing in child development*. Ypsilanti, MI: I-lighlScope Educational Research Foundation.
Laszlo, J., & Baivstow, P. (1980). The measurement of kinaesthetic sensitivity in children and adults. *Developmental Medicine & Child Neurology*, *22*, 454–464.
Lobo, Y. B., & Winsler, A. (2006). The effects of a creative dance and movement program on the social competence of head start preschoolers. *Social Development*, *15*, 501–519.
Marmeleira, J., Pereira, C., Cruz-Ferreira, A., Fretes, V., Pisco, R., & Fernandes, O. M. (2009). Creative dance can enhance proprioception in older adults. *Journal of Sports Medicine and Physical Fitness*, *49*, 480–485.
Miura, A., Fujii, S., Yamamoto, Y., & Kudo, K. (2015). Motor control of rhythmic dance from a dynamical systems perspective: A review. *Journal of Dance Medicine & Science*, *19*, 11–21.
Miura, A., Kudo, K., & Nakazawa, K. (2013). Action–perception coordination dynamics of whole-body rhythmic movement in stance: A comparison study of street dancers and non-dancers. *Neuroscience Letters*, *544*, 157–162.
Opila-Lehman, J., Short, M. A., & Trombly, C. A. (1985). Kinesthetic recall of children with athetoid and spastic cerebral palsy and of non-handicapped children. *Developmental Medicine & Child Neurology*, *27*, 223–230.
Pollatou, E., Karadimou, K., & Gerodimos, V. (2005). Gender differences in musical aptitude, rhythmic ability and motor performance in preschool children. *Early Child Development and Care*, *175*, 361–369.
Quin, E., Frazer, L., & Redding, E. (2007). The health benefits of creative dance: Improving children's physical and psychological wellbeing. *Education and Health*, *25*, 31–33.
Ramsay, J. R., & Riddoch, M. J. (2001). Position-matching in the upper limb: Professional ballet dancers perform with outstanding accuracy. *Clinical Rehabilitation*, *15*, 324–330.
Repp, B. H., & Su, Y.-H. (2013). Sensorimotor synchronization: A review of recent research (2006–2012). *Psychonomic Bulletin & Review*, *20*, 403–452.
Ribeiro, F., & Oliveira, J. (2007). Aging effects on joint proprioception: The role of physical activity in proprioception preservation. *European Review of Aging and Physical Activity*, *4*, 71–76.
Riemann, B. L., & Lephart, S. M. (2002). The sensorimotor system, part I: The physiologic basis of functional joint stability. *Journal of Athletic Training*, *37*, 71–79.

Roberts, D., Fridén, T., Zätterström, R., Lindstrand, A., & Moritz, U. (1999). Proprioception in people with anterior cruciate ligament-deficient knees: Comparison of symptomatic and asymptomatic patients. *Journal of Orthopaedic & Sports Physical Therapy*, *29*, 587–594.

Rosenblum, S., & Regev, N. (2013). Timing abilities among children with developmental coordination disorders (DCD) in comparison to children with typical development. *Research in Developmental Disabilities*, *34*, 218–227.

Rosker, J., & Sarabon, N. (2010). Kinaesthesia and methods for its assessment: Literature review. *Sport Science Review*, *19*, 165–208.

Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist*, *55*, 68–78.

Stinson, S. (1988). *Dance for young children. Finding the magic in movement*. Reston, VA: Publications Department, AAHPERD.

Wang, J. H.-T. (2004). A study on gross motor skills of preschool children. *Journal of Research in Childhood Education*, *19*, 32–43.

Weikart, P. S., Schweinhart, L. J., & Larner, M. (1987). Movement curriculum improves children's rhythmic competence. *HighScope ReSource*, *6*, 8–10.

Williams, G. M. (1992). Developing communication through movement and dance. *Early Child Development and Care*, *81*, 109–115.

Wong, J. D., Kistemaker, D. A., Chin, A., & Gribble, P. L. (2012). Can proprioceptive training improve motor learning? *Journal of Neurophysiology*, *108*, 3313–3321.

Zachopoulou, E., Derri, V., Chatzopoulos, D., & Ellinoudis, T. (2003). Application of Orff and Dalcroze activities in preschool children: Do they affect the level of rhythmic ability? *Physical Educator*, *60*, 50–56.