A NEW SOMATIC ENVIRONMENT: QUASI-QUANTITATIVE STUDY REVEALS WATER TRAINING AS AN EFFECTIVE METHOD TO INCREASE DANCER KINESTHETIC AWARENESS

Sarah W. Holmes

Kennesaw State University, United States

Email: sholme39@kennesaw.edu
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Abstract

Data from a two-year study suggest that water training has similar effects to a somatic practice. The nature of this study questioned an underlying assumption that dancers understood how to appropriately engage their external rotation. Principal Investigator (PI) hypothesized that working with water as a cross-training method would both strengthen and increase the range of motion of femoral external rotation. Subjects (university dancers) underwent pre- and post-testing measurements (passive and active external rotation and internal rotation). The study consisted of twice a week, 30 to 45-minute water conditioning classes, for six weeks. Programs assisting in angle analysis and determining statistical significance, included: *ImageJ*, Microsoft Excel, and the Statistical Package for the Social Sciences software (SPSS IMB version 24). Qualitative data were processed by an open source Python package, Natural Language Toolkit (NLTK) used specifically for text mining. The results reflected that quantitative measurement methods were not effective, indicating no statistical significance in increasing active or passive external rotation. PI observed an increase in perceived awareness of the subject's external rotation through a qualitative survey. This affirmed PI hypothesis that water training augments kinesthetic awareness in much the same way as a somatic practice. This study encourages the use of water training to develop a dancer's kinesthetic sensing by creating a positive learning experience that teaches body awareness in a new environment.

Keywords: dance, water conditioning, somatic practice, external rotation

After childbirth, I began to work out in the water, slowly developing a routine of exercises to get back in shape. It worked, and I not only regained my strength but my limberness also increased.

The dancers in the New York City Ballet were amazed at how quickly I was able to safely regain my strength and wanted to know my secret.
Allegra Kent (1976)

Introduction

Thomas Hanna first used the term "somatics" to describe the relationship between bodily awareness, biological function, and the environment (Hanna, 1976). This term evolved to encompass practices that better understood creating ease and efficiency in the body (Fitt, 1996). Dancers commonly practice methods such as Pilates, Feldenkrais, Cohen's Body-Mind Centering, Ideokinesis, Alexander Technique, Rolfing, Bartenieff Fundamentals, or Laban Movement Analysis to increase their kinesthetic potential (Bartenieff, 1980; Chmelar & Fitt, 1992; Fitt, 1996; Matt, 1992; Sweigard, 1974). This article explores the idea that somatic practice encompasses more environments than those aforementioned and specifically addresses the use of water as a new somatic environment. The physical benefits of water exercise to sustain and promote health, wellbeing and conditioning are well known (Buttelli, 2015; Goldstein, 2016; Pinto et al., 2015). Sebastian Kneipp's *My Water Cure*, published in 1893, examined the healing properties of water therapy and increased its presence in naturopathy (Locher & Pforr, 2007). In 1976, New York City ballet principal dancer Allegra Kent published *Allegra Kent's Water Beauty Book*, which outlined multiple water conditioning exercises. This text illustrated and described numerous movements that closely followed traditional ballet barre exercises and made them accessible to those without formal dance training. As highlighted above, Kent reports using these self-developed water exercises to help her return to dance after the birth of her children (Kent, 1976).

PI conversations with dancers revealed that while dancers intuitively understand the benefits of water training, many do not use it as an alternative method of conditioning for dance. Dancers have reported using water therapy to recover from injury (Sabo, 2013; Torres-Ronda & Alcázar, 2014), but eventually discontinue its use; perhaps viewing water conditioning primarily as a tool for recovery. Previous research has assessed different conditioning programs for dancers, yet none have assessed training techniques in a reduced gravity environment like water (Ramel et al., 1997; McMillan et al., 1998; Koutedakis, 2005; Pata et al., 2014; Sherman et al., 2014; Rodrigues-Krause et al., 2015). Furthering Kent's work, the present study attempted to quantify the physical benefits of water training. The present study examined the effects of water resistance training and illustrated its effectiveness of increasing the development of external rotation in dancers. As a precaution, PI hypothesized there would be no significant increase in subjects' external rotation following water training.

Materials and Methods

Following approval by a research ethics committee, PI initiated the study to understand the effectiveness of water training on university-level ballet and modern dancers. The dependent variables were passive and active external rotation of the hip. The entire subject group (n=8) consisted of seven female dancers (FM=7) and one male dancer (M=1). Measurement data were combined due to the limited number of subjects. The control group (CON = 2) consisted of one male and one female dancer. The control group, by volunteer, did not participate in water classes but continued their regular dance schedules. Subjects were university students between 18 and 25 years of age, recruited from all levels of ballet and modern technique classes. All subjects maintained their dance and rehearsal schedules throughout the study. Subjects reported spending an average of 11.90 hours per week dancing, comprised of technique classes (ballet, modern, jazz) and rehearsals. Of this, subjects reported on average 4.04 hours per week in modern technique (level undefined) compared to 2.79 hours per week in ballet (level undefined). The control group averaged 2.33 hours per week dancing. Regarding supplementary cross-training, subjects reported spending 3.15 hours per week on cardiovascular exercise; .60 hours per week taking yoga classes; .50 hours per week in Pilates classes; and .80 hours per week weight training.

Water-training was held twice a week, for 30 to 45 minutes each session, for six weeks. The subjects practiced the same beginning and intermediate-level ballet exercises. Subjects were submerged between the xiphoid process and shoulders, as this translated to 60%-85% of off-loaded body weight (Torres-Ronda & Alcazar, 2014). Pre- and post-training measurements included passive external rotation, passive internal rotation, active external rotation, and tibial external rotation. Subjects lay prone on the table, where PI measured passive internal and external rotation (Grossman, 2003). The active external rotation was measured through photograph capture of subjects standing first position on Rotator Discs (Grossman, 2003; Harmon-Matthews et al., 2016). PI measured and defined "total active external rotation" as the angle created (and measured by *ImageJ* software) by subjects' right and left leg femoral external rotation in a standing first position. The tibial external rotation was measured using an adapted "footprint" method (Figure 2). Subjects sat in a chair, knee flexed at 90°, patella in the frontal plane, and feet placed on the floor. PI traced the placement of the foot on butcher paper and measured the resulting angle (created by the vector of the second toe to the middle calcaneus and 90°) to find tibial rotation (Hazelwood et al., 2007). Tools for measurement included: Prestige Medical Goniometer and two Rotator Discs (Balanced Body, Inc. Sacramento, California, 9 inches in diameter).

Programs assisting in angle analysis and determining statistical significance included: *ImageJ* software, Microsoft Excel, and the Statistical Package for the Social Sciences software (SPSS IMB version 24). The level of statistical significance was $p < .05$. Qualitative data were processed by an open source Python package, Natural Language Toolkit (NLTK) used specifically for text mining. Objective of the sentiment analysis was to determine if survey respondents' sentiment changes over the progression of survey questions. Using a submergible Samsung camera, subjects were video recorded and shown their working process after the study.

The exercises included in the six-week water training class were:

- Pliés in first position.
- Battemant Tendu en croix.
- Dégagé en croix.

- Développé en croix.
- Grand battemant en croix.
- Releve in first position.
- Passé balance.
- Romb de jambe.
- Grande romb de jambe. (Low and just below 90 degrees.)
- Romb de jamb en l'air en dedans and en dehors.
- "Jumps" in first position.
- "Jumps" in second position.
- Ballet port de bras

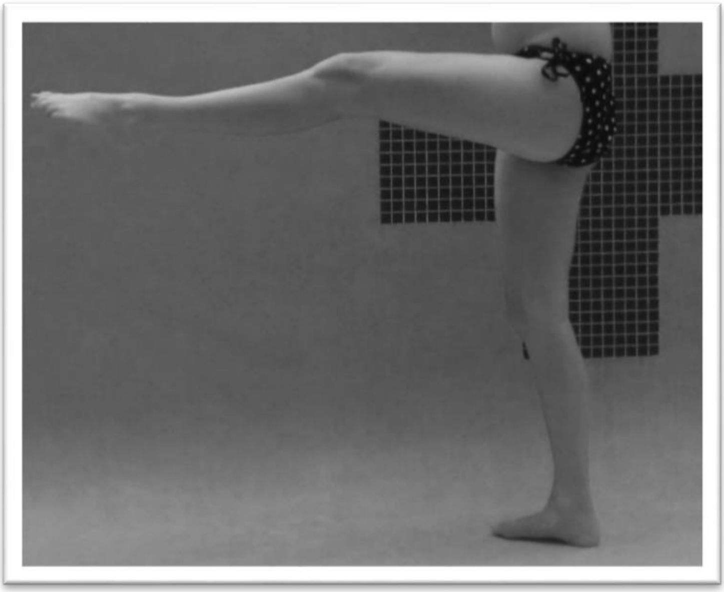

Figure 1: Battement devant, beginning level subject. Image from author's personal collection.

Results

Raw data were input and processed by the SPSS (v. 24) to find statistical significance in passive and active external rotation measurements. The null hypothesis maintained that there would be no statistical significant difference between pre- and post-tests for all measurements. The Related-Samples Wilcoxon Signed Rank Test found no statistically significance ($p < .05$) supporting the null hypothesis between pre- and post-test data for passive and active turnout measurements. While statistically insignificant, the PI observed an increasingly active and passive external rotation measurement (Table 1). While all changes detected were due to chance, PI observed the most noticeable change in the subjects' average degree of pre- and post-test measurements of active turnout: 105.81˚ ±SD 8.42˚ pre-test and 109.53˚ ±SD 9.86˚ post-test. The percent of passive external rotation used by active external rotation was 86.92% pre-test and 90.97% post-test; or a 4.05% gain of active external rotation.

Table 1: Data of passive and active external rotation measurements.

Subject*	Pre-Test Passive Ext. Rotation	Tibial Ext. Rotation	Pre-Test Total Passive Rotation†	Pre-Test Total Passive Rotation‡	Pre-Test Total Active TO	Post-Test Passive Ext. Rotation	Post-Test Total Passive Rotation	Post-Test Total Active TO	Post-Test Total Passive Rotation
1	36.67	27.43	64.10	128.19	111.73	37.00	64.43	119.65	128.86
2	30.00	30.11	60.11	120.21	111.67	30.30	60.44	108.42	120.88
4	43.67	33.34	77.01	154.02	101.56	39.70	73.03	101.16	146.06
5	38.67	11.05	49.71	99.43	113.26	35.70	46.71	124.99	93.43
6	43.33	11.94	55.28	110.55	110.43	36.30	48.28	106.89	96.55
7	27.33	16.01	43.34	86.68	87.61	39.00	55.01	94.86	110.01
9	41.00	28.52	69.52	139.03	105.35	31.00	59.52	114.84	119.03
10	35.67	32.19	67.85	135.71	104.85	42.00	74.19	105.41	148.37
Average ≈	*37.04*	*23.82*	*60.87*	*121.73*	*105.81*	*36.38*	*60.20*	*109.53*	*120.40*
±SD ≈	*5.95*	*9.26*	*11.07*	*22.14*	*8.42*	*4.07*	*10.21*	*9.86*	*20.42*

*Subjects three and eight were control group subjects, data not included. See Table 2.

† In both pre- and post-test measurements of passive external femoral rotation and tibial external rotation the right leg was used. In the pre- and post-test measurements of active turnout, both right and left legs were used.

‡ Total passive external rotation value was calculated by adding tibial external rotation with passive femoral external rotation measurements. This number was multiplied by two.

Table 2: Data of passive and active external rotation measurements, control subjects.

Subject Control Group	Pre-Test Passive Ext. Rotation	Tibial Ext. Rotation	Pre-Test Total Passive Rotation†	Pre-Test Total Passive Rotation‡	Pre-Test Total Active TO	Post-Test Passive Ext. Rotation	Post-Test Total Passive Rotation	Post-Test Total Active TO	Post-Test Total Passive Rotation
3	22.00	37.79	59.79	119.59	116.31	36.80	74.63	119.41	149.25
8	42.67	21.99	64.65	129.30	108.83	39.00	60.99	113.44	121.97
Average ≈	*32.34*	*29.89*	*62.22*	*124.45*	*112.57*	*37.90*	*67.81*	*116.43*	*135.61*
±SD ≈	*14.62*	*11.17*	*3.44*	*6.87*	*5.29*	*1.56*	*9.64*	*4.22*	*19.29*

Meaningful and Useful Qualitative Results:

- "…I have an easier time standing on one leg for extended combinations like long promenades and adagios. I think this may be because I have almost figured out how to support myself in the water and this has translated to the classroom...".
- "I have always been told to keep my pelvis down but have never known what it really felt like until working in the pool. It allowed me to feel which muscles I needed to use to keep it in alignment."
- "Not being able to see myself helped me work on my turnout. I was able to find what was natural for me and not just worry about forcing it to achieve a 'look' of turnout."
- "I used the first two sessions to learn how to move more efficiently, … the last few weeks it became more of a resistance tool."
- "…working in the water allowed me to notice my full range of motion without dealing with the weight of my leg…the weight of my leg wasn't inhibiting the rotation."
- "I had more time to think through my alignment and technique… because I wasn't as focused on keeping myself upright."
- "I was able to use internal thoughts and feeling instead of worrying about what I looked like in the mirror compared to other dancers."
- "I think it really has been an advantage for me because it's really important to be able to actually feel what it's like to do movements correctly rather than just seeing what they look like. Everyone's body is different and I think this class helps the process of improving your personal goals with your body."
- "I have been able to use what I learned in this class and been able to apply it in my ballet class and other technique classes. What I have noticed most is my flexibility increase in my développé. I think it's because now I am more aware of what muscles need to be used to properly access the movement."
- "**…**I think that my strength and flexibility (equally) are affected. I say this because in ballet I have noticed that I can hold my leg up longer and higher. Also, it has helped me to be able to stand in a 'true 5th position.' Being able to feel my muscles engaging in the pool has helped me figure out how to engage them better outside of the pool."

A Sentiment Analysis report, compiled by The Kennesaw State University Center for Statistics and Analytical Services, analyzed qualitative data with the following objective: Determine if survey respondents' sentiment changes over the progression of survey questions (Zhou, 2016). Findings from the Sentiment Analysis report indicated a "positive" subject attitude. The Sentiment Analysis assessed the "attitude" (or sentiment) of each survey respondent using a hierarchical text classification process and provided evidence regarding a subject's attitude in terms of positive, negative, or neutral sentiment (Zhou, 2016). Results concluded there were three positive subjects, two neutral subjects, and two negative subjects. Analysis considered the subjects' concerns by calculating the top ten frequencies of the following keywords (after the text was cleaned of stop words such as: of, is, are): awareness, leg, increased, alignment, strength, joint, body, extension, movement, and tone. The most prominent descriptive words, as indicated by the text frequency, were: awareness, leg, and increased. The Sentiment Analysis report stated, "overall, the qualitative data is showing a positive attitude, the respondents are satisfied with the study: the students appear to increase awareness of his/her leg or the strength of body extension" (Zhou, 2016).

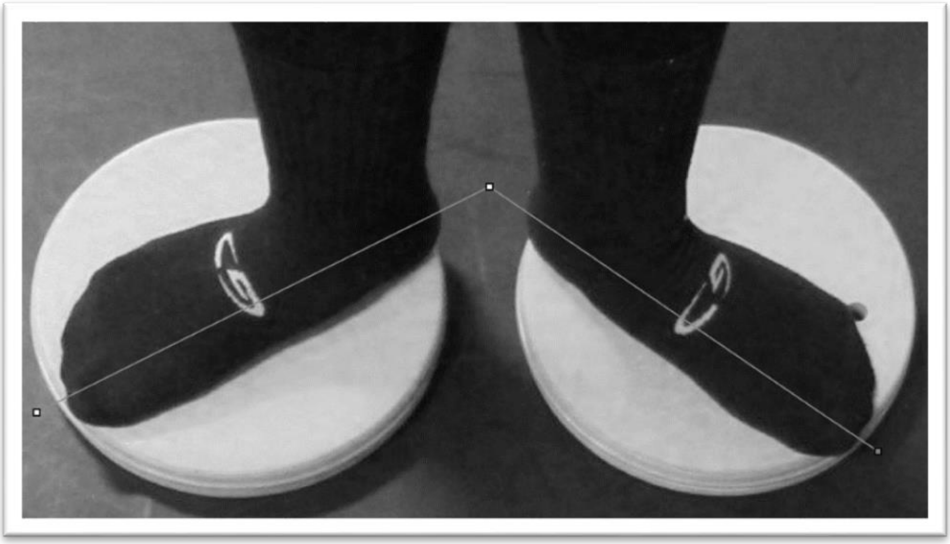

Figure 2: Measurement of subject active external rotation, post-test, 119.650 degrees, *ImageJ* software. Photo from author's personal collection.

Discussion

This segment examines the essential finding from the present study with those cited in the literature, as well the limitations of the present study. While physical elements like balance and flexibility contribute to greater hip and leg range of motion in *grand romb de jambe*, the underlying presumption is that these biomechanics are correctly initiated (Wilson & Kwon, 2007). Further, while some pelvic mobility is needed to facilitate greater and safer range of motion in the hip (Kwon et al., 2007; Bronner & Ojofeitimi, 2011), underwater video of the subjects revealed that beginning-level dancers initiated movement from the hip rather than brushing through the foot (encouraging pelvic stability and femoral external rotation). Merkensteijn and Quin (2015) stated "the complexity involved in achieving a 'technically correct' turnout demonstrates how important it is for dance teachers to have knowledge of anatomical constraints and limitations" (p. 59). If utilized properly, water classes can provide educators with a platform for teaching proper turnout through the use of a water-based somatic environment. More to the point, dancers could, in cooperation with their teachers' guidance, carefully evaluate whether this particular "somatic" practice helps their development.

Pata et al. (2014) examined land-based exercise practices that increased a dancer's strength and their ability to access their external rotation. While their results are promising, the directional pull of gravity was the major assistor for these land-based exercises. The reduced-gravity water environment promotes buoyancy and encourages hip/femur mobility. Torres-Ronda and Alcazar (2014) reported "…performing a training program in water can lead to significant improvements not only in strength and muscle power in both the upper and lower extremities, but also in … flexibility, and body composition…" (p. 240). PI aimed to condition dancers in the development and control of external rotation required for the artistic expression of ballet and modern dance. Koutedakis et al. (2005) stated "any change in the traditional training regimens must be approached cautiously to insure that the aesthetic content of the dance always remains at the highest possible level" (p. 32). This implies that conditioning programs should not impugn a dancer's level of technical proficiency. This is a key reason why PI used commonly performed ballet exercises, rather than water-based resistance exercises (Buttelli et al., 2015).

After reviewing Chatfield and Champion (2008), there were no complementary comparisons of external rotation measurements due to sample size, gender, level, and age range. From studies that were similar (three out of the seventeen reviewed), the average of subjects' external rotation measurements (for one hip) post-study were in the lower-range than others at 36.38˚. The significance of this physical result is compelling since it opens broader questions regarding quality and equity of training *before* students enter university-level dance, as well as to what capacity educators can shape a student's technique after they have begun university or college-level training.

Torres-Ronda and Alcazar (2014) reported that water training programs can improve strength and muscle power (p. 239). If perceived strength and flexibility are inversely related but directly correlated (i.e., an increase in flexibility leads to a decrease in stability; stability in this scenario could be perceived as "strength"), then the data suggest that the subjects' strength increased. The control group experienced the opposite outcome, relative to each subject, in each scenario. If an outcome of decreased passive external rotation indicates an increase in strength, then researchers might anticipate a decrease in both passive external and internal rotation. However, in this scenario, only three out of eight subjects experienced this result. If an outcome of increased passive external rotation indicates an increase in flexibility, then researchers might anticipate increases in both passive external and internal rotation. Yet again, in this scenario, only two out of eight subjects experienced this result. Noted before, the PI observed an increase in both active and passive external rotation, suggesting a possible increase in hip (acetabular/femoral) flexibility *and* strength. Control group subjects experienced the direct opposite results relative to the study group. The percent of active external rotation gained through the acquisition of more passive external rotation in pre-test versus post-tests, while minimal, may indicate that subjects utilized more of their passive external rotation (Deighan, 2005).

While the quantitative results of this study are not statistically significant, the qualitative results are substantively interesting. Due to the scarcity of viable quantitative data, the PI of the present study maintains that the benefits of water conditioning contribute to dancer health through its *perceived* result rather than *actual* result. Subjects communicated improved bodily awareness, the realization of greater turnout, and perceived ease of lower limb movement and hip strength. Although not quantitatively correlated, this training may contribute to a lower likelihood of injury, since lower-body injuries are often associated with poor turnout in dancers (Merkensteijn and Quin, 2015, p. 57). Qualitative results such as those previously listed, suggest that subjects' awareness of their technique increased in the water, perhaps due to the time they had to kinesthetically sense movements in their body. Likewise, subjects noticed the benefits of working in the water, namely using it as a resistance tool while simultaneously trying to learn how to work through the water more efficiently.

Interestingly, other students outside of the study seemed to notice technical improvement of the study's subjects. While anecdotal, one subject reported, "[my classmate] noticed that I was having an easier time with *al le second* promenades, particularly *en de hors*. My standing leg wasn't as wobbly and remained more turned out, and my working leg was higher (but still in the correct alignment)." Kent (1976) echoed this sentiment in the beginning of this article, stating "the dancers with the company were amazed at how quickly I was able to come back and wanted to know my secret" (p. x). It appears that water conditioning has an impact on a dancer's performance and physicality so much so that it is noticeable.

Water training seems to encourage a dancer's awareness of her or his external rotation. Without a more substantive exploration of this subject, legitimizing the adoption of this type of somatic training into a dance department's coursework might be difficult.

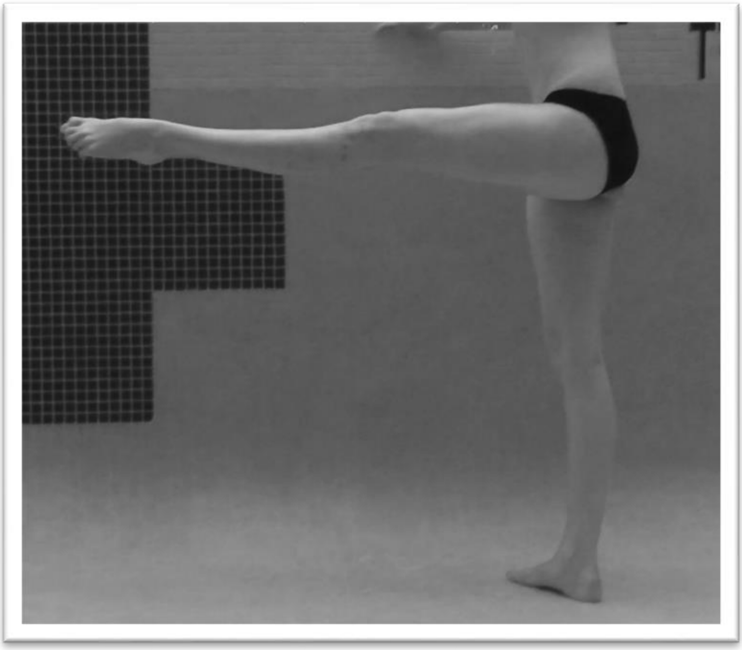

Figure 3. Battement devant, intermediate level subject. Image from author's personal collection.

Limitations

A clear drawback of this study was the limited number of subjects, especially in context with the quantitative results of the control group. Any generalizations of these results on a larger population size is discouraged. Additionally, the heterogeneity of dance backgrounds (i.e., ballet, modern, jazz) and the various technical abilities of subjects (beginning to advanced) impacted the overall consistency of the data. Additionally, PI understand there are multiple ways to measure external rotation (Grossman et al., 2008) and there is unreliability in the measurement techniques used in this study by the PI and student research assistants, both of which create potential difficulties in data reliability and analysis. Especially faulty was PI technique used in the "footprint" technique. To this end, a more standardized method of measurement technique is needed. Moreover, there is the risk of faulty technique when measuring active and passive turn out (Grossman et al., 2008).

The PI acknowledges that there could be an emotional aspect to achieving greater turn out, along with a physical privilege that external rotation may possess. As one subject reflected, "most of the girls were turning out too much….," pointing to a clear need for the PI to provide greater technical guidance during the water training classes. For safety, the PI advised subjects to work in an abbreviated turnout, but did not adequately enforce this recommendation. The correction and guidance of subjects' external rotation was limited to class times when the PI was in the pool. Subjects' continuous need and desire to reach and move beyond their maximum external rotation speaks to a more troubling notion of perfectionism. Another limitation of the study was the temperature of the pool. Some subjects found the cooler water challenging and this may have hindered their movement freedom. Notwithstanding these limitations, the data gathered seem to suggest that water training can positively influence a dancer's knowledge and perception of their turnout.

A number of unanswered questions surfaced from this study. One, in particular, garnered the PI's attention: Would subjects' awareness of muscular sensing in grand battement devant *terra firma* change due to the use of floatation equipment like "water wings" in the water-based environment? Would the adoption of this tool encourage freedom in hip movement through leg extension or facilitate equally dynamic closure to fifth? According to Kent, the use of devices such as water wings should be permitted for advanced students with awareness and control of external rotation. (A. Kent, personal communication, October 10, 2016.)

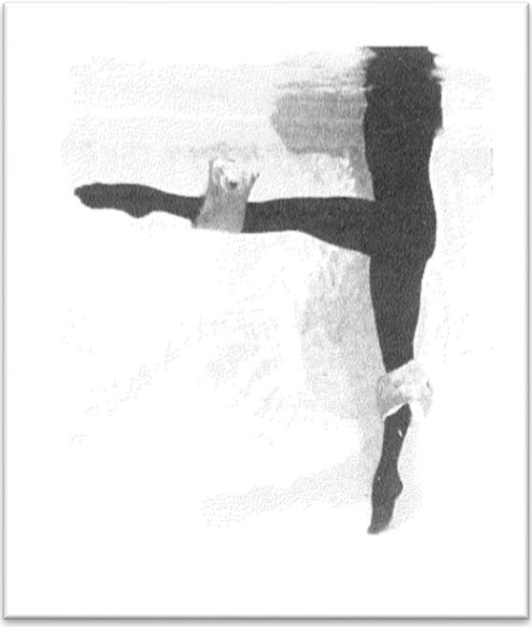

Figure 4: Allegra Kent, demonstrating "Front Leg Kick" exercise with water wings (Kent 1976). Permission to use photo obtained from the author.

Conclusion

The qualitative responses from this study revealed that dancers benefited from their water training. Subject observations revealed an enhanced awareness of their external rotation outside of traditional land-based training. Subjects' comments bare a strong resemblance to those found in somatic-based studies (Barr, 1996). As Figures 1, 3 and 4 illustrate, all levels of dancers can benefit from the buoyancy and resistance that water training provides. Based on these findings, it is important that dancers understand how to properly facilitate external rotation. Especially as they transition into university or college-level programs that privilege techniques requiring external rotation. From PI discussions with community studio owners and dance teachers, more often than not, young dancers do not understand how to properly engage their external rotation. Kent suggested that water training is an effective method to teach beginning college-age dancers about proper placement (A. Kent, personal communication, October 10, 2016.) Pool classes can be used to teach students about their physical potential and help them connect with the muscle groups needed to facilitate proper external rotation (Grossman et al., 2005). This discovery process, as indicated from the subjects' qualitative responses, may be more difficult to sense in land-based instruction. This study suggests that water training is a productive supplement to traditional dance pedagogy and an effective conditioning practice for dancers to maintain their fitness outside of the classroom. When transitioning into their professional careers as dancers, future professionals can use water-training as a supplemental and cost-effective alternative to strength training forms like Pilates or Gyrotonic®.

Acknowledgments

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