INFLUENCE OF TRADITIONAL AND NON-TRADITIONAL ENTRIES ON FIGURE SKATING JUMPS

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The choice of performing jumps from traditional entries or nontraditional entries are left to the discretion of the skater. The purpose of this study was to examine the influence of non-traditional entries on the kinematics of two figure skating jumps using a simple quantitative tool available to coaches. It was hypotheisized that non-tradional entries would alter jump kinematics. Ten skilled figure skaters were videotaped while performing toe loops or salchows with both traditional and non-tradional entires. Kinematic variables were determined with Dartfish. Results indicated that non-traditional entries had significantly more jump height and ankle plantar flexion at landing in the toe loop, and signifcantly more horizontal displacment in the salchow. Coaches may wish to examine these subtlies to determine a skater's readiness to practice non-traditional entries.

KEY WORDS: angular position, Dartfish, jump height, linear displacement

INTRODUCTION: Jumping is a basic movement that children master fairly quickly as they grow (Haywood, 1993). Jumping is also a valuable skill in many sports such as gymnastics, track and field, and figure skating. The United States Figure Skating Association dictates that three of the required elements in the ladies short program be jump elements, and a maximum of seven of the required elements in the ladies long program also be jumps (USFSA, 2013). These requirements essentially make up more than half of the elements in both the ladies short and long programs. Since jumping is such an important factor in a figure skating program, a great deal of emphasis is placed on the skater's performance of their jump elements. Over the years, judges have also started to reward skaters for making a traditional jump more difficult. Skaters receive more points for a jump with a difficult entry than they would receive for the same jump with a traditional entry (USFSA, 2013). With the creative freedom that skaters have in determining their jump entry and the incentive of extra points, more often than not a skater will perform a more difficult version of a traditional jump by selecting a non-traditional entry to earn more points (USFSA, 2013). However, this trend may become a cause for concern if skaters are not proficient at their non-traditional jump entries, yet they include them in the program in hopes that they will earn extra points anyways. Thus the purpose of this study was to examine the influence of non-traditional entries on the kinematics of two figure skating jumps using a simple quantitative tool available to amatuer coaches. It was hypotheisized that non-traditonal entries would alter jump kinematics. Findings might help coaches examine readiness for non-traditonal entry attempts.

METHODS: Ten female figure skaters volunteered for the study. All skaters were able to perform both double salchows and double toe loops proficiently from a traditional take off and a non-traditional take off. Skaters, or their parent, signed a University approved consent form. Data collection took place at several skating rinks. Upon arrival at the rink, skaters completed a short demographic survey then placed joint markers on the lateral aspects of both legs at the hip, knee and ankle joints under the direction of the researcher. While skaters took 20 minutes to warm up, cameras were placed at mid ice in the hockey box to capture the toe loop trials (Cannon ZR960) and at the end of the ice rink to capture the salchow trials (Sony Cybershot DSC-S750). One skater performed a double salchow and a double toe loop in front of the cameras to verify that the field of view captured the entire jump. The spot on the ice where she initiated her jump was marked with permanent marker to show the other skaters where they should also initiate their jumps. Five trials of each skater's self-selected jump, double salchow or double toe loop with a traditional entry, were

filmed first, followed by five trials of the same jump with a non-traditional entry. In total one hundred trials were filmed. Trials that contained falls or step outs were excluded, leaving 43 trials for analysis (21 toe loops; 22 salchows). Data from both cameras were analyzed at 60 Hz using DartFish ProSuite (version 6.0). In each trial with both traditional and non-traditional entries, ankle, knee, and hip joint angles were determined at take-off and landing. Take-off position for the toe loop was defined as the last backward movement where both feet were still in contact with the ice and the take-off position for the salchow was defined as the last backward movement when the full blade was in contact with the ice. After calibration using each skater's height, maximum jump height, airtime, and horizontal displacement were also determined. Jump height was determined by subtracting the skater's height from her greatest vertical displacement from the surface of the ice. Horizontal displacement was calculated as the distance from the moment the skater's blade left the ice at take off to the moment the toe-pick first made contact with the ice at landing. Airtime was defined as the time between take-off and landing, when the skater's blade left the ice to when it first landed on the ice again. Paired samples t-tests compared the ankle, knee and hip angles at take-off and at landing, maximum jump height, airtime, and horizontal displacement between traditional and non-traditional entries for all jumps, just toe loops, and just salchows. Significance was set at .05 and a Bonferonni correction was used as needed.

RESULTS: The skaters that completed the study had a mean age of 15.2 (3.7) years, were 1.5 (.09) m tall, weighed 447 (90.2) N and had 10.2 (3.6) years of skating experience. Comparison of the take-off angles for the hip, knee and ankle joints showed no significant differences between traditional and non-traditional entries (Table 1). Across all jumps, ankle (p=.023) and hip joint (p=.028) angles approached significance. At take-off the ankle was more plantarflexed and the hip was slighlty more extended for non-traditional entry trials compared to traditional entry trials (Table 1)

Table 1
Take-off Angles for Traditional (T) and Non-Traditional (NT) Entries

Jump	Ankle T	Ankle NT	Knee T	Knee NT	Hip T	Hip NT
Toe Loop	83.6±10.6	86.6±8.9	126.6±18.1	128.8±19.2	127.8±21.1	135.5±28.6
Salchow	79.8±12.0	82.5±6.1	125.9±5.8	122.7±7.83	126.9±8.1	129.2±13.5
All Jumps	81.8±11.3	84.5±7.8	126.3±13.6	125.7±14.7	127.4±16.1	132.3±22.1

Note: measures in degrees; Traditional=T; Non-Traditional=NT; Bonferroni Correction p=<.005

Across both jumps (p=.001) and for the toe loop (p=.0005) there was a difference in maximum jump height. Non-tradional entries showed significantly more height (Table 2). In the salchow, the non-traditional entry provided for significantly more (p=.001) horizontal displacement than the traditional entry (Table 2)

Table 2
Flight Characteristics for Traditional (T) and Non-Traditional (NT) Entries

Jump Type	Max Jump Height T (m)	Max Jump Height NT (m)	Airtime T (s)	Airtime NT (s)	Horizontal displacement T (m)	Horizontal displacement NT (m)
Toe Loop	0.33±.13*	.46±.171*	.62±.07	.63±.11	1.31±.53	1.04±.17
Salchow	.38±.14	.43±.117	.78±.12	.77±.09	1.56±.64*	1.83±.72*
All Jumps	.36±.14*	.44±.145*	.69±.12	.70±.12	1.43±.59	1.45±.66

*Significant difference p= <.005

At landing there were significant differences in the ankle angle across both jumps (p=.001) and for the toe loop (p=.001) (Table 3). Non-traditional trials showed greater plantar flexion at landing.

Table 3
Landing Angles for Traditional (T) and Non-Traditional (NT) Entries

Jump	Ankle T	Ankle NT	Knee T	Knee NT	Hip T	Hip NT
Toe Loop	83.9±12.5*	88.7±9.1*	135.1±6.3	135.8±7.9	129.5±14.4	136.1±14.7
Salchow	87.5±13.2	92.2±7.9	134.6±8.7	129.3±9.5	128.2±19.6	133.4±15.2
All Jumps	85.6±12.9*	90.5±8.6*	134.8±7.4	132.5±9.2	128.9±16.9	134.7±14.8

Note: All measures in degrees; Traditional=T Non-Traditional=NT; *= Significant difference at p=<.005.

DISCUSSION: The purpose of this study was to examine the influence of non-traditional entries on the kinematics of two figure jumps using a simple quantitative tool available to amatuer coaches. As hypotheisized non-tradional entries altered jump kinematics.
There were no statistically significant differences between traditional and non-traditional entries in the ankle, knee and hip joint angles at take-off, but across both jumps non-traditional jump entries tended to produce slightly more plantar flexion and hip extension. These tendencies could indicate that with non-traditional entries skaters are slightly further along in the jumping motion at takeoff, executing the extension phase of the jump already, or perhaps skaters took less time to perform the preparatory flexion motions associated with jumping. Traditional entries may constrain the take-off position, thus the skater‘s preparation for and execution of the jump. The knee and other joints contribute to successful completion of the jump and the success of the landing (Johnson & King 2001), thus these tendencies should be further investigated to determine how they might influence other aspects of the jump and the skater’s readiness for non-traditional entries.
Comparison of flight parameters indicated that, especially for the toe loop, maximum jump height was greater with a non-traditional as opposed to a traditional entry. For the salchow, the non-traditional entry provided for greater horizontal displacement than the traditional entry. The non-traditional entry may have allowed skaters to emphasize technique differences in these jumps. To perform a toe loop from either a traditional and a non-traditional entry, the skater applies most of their weight on their favored leg and places the toe-pick of their free leg into the ice, which helps to propel them into the air. Use of the toe pick slows the horizontal aspect of the jump and permits increased vertical motion (King, 2000). The salchow is an edge jump, thus the toe-pick is not utilized at all during take-off, which allows for more horizontal movement (King, 2000). In each jump the increases could be due to lack of technical limitations associated with the traditional take-off position (USFSA, 2013). Non-traditional entries may be more effective at providing for greater height in the toe loop and greater horizontal distance for edge jumps. If coaches can detect these subtle differences with a simple quanititative tool, they could make more informed decisions about skaters‘ readiness for non-traditional entires.
During the landing phase the ankle showed greater plantar flexion during nontraditional entries when compared to traditional entries, especially for the toe loop jumps. Increased plantarflexion could be related to the increased jump height associated with toe loops done with non-traditional entries. Also skaters may not be as far into the lower extremity flexion sequence associated with landing if they jumped higher. Non-traditional entries seem to allow a less structured technique throughout the jump because skaters do not have to start in a specific take-off position. Landing a jump is very important to the skater, thus the mechanics of the landing should be carefully considered as non-traditional entries are attempted.

CONCLUSION: The purpose of this study was to examine the influence of non-traditional entries on the kinematics of two figure skating jumps using a simple quantitative tool available to coaches. Results indicated that non-traditional entries had significantly more jump height and ankle plantar flexion at landing in the toe loop, and signifcantly more horizontal displacement in the salchow. Detecting these increases in jump height and horizontal displacment may be important for coaches as they could influence a skater’s

readiness to focus their practice on non-traditional entries. These differences could make the entire jump, take-off through landing, more difficult to control, or they could give a skater an opportunity to add complexity to their jump. Coaches may wish to examine these subtle jump characteristic differences with a simple video analysis tool to determine a skater's readiness to practice non-traditional entries. The findings of this research could be further supported through a larger sample size as well as through acquiring the score given to the jump from an accredited figure skating judge. This would allow further insight into which jump take-off is more effective at earning more points from the perspective of the skater and the coach.

REFERENCES:

Haywood, Kathleen M. (1993).*Life span motor development*. (2nd ed.). Champaign, IL: Human Kinetics. p. 135.

Johnson, M., & King, D. L. (2001). *A kinematic analysis between triple and quadruple revolutions figure skating jump*. University of California San Diego, CA: American Society of Biomechanics. Retrieved from http://www.asbweb.org/conferences/2001/pdf/063.pdf

King, D. L. (2000). Jumping in Figure Skating. *Biomechanics in Sport*, *9*, 312-325.

United States Figures Skating Association. (2013, May 10). *Technical Info: Singles/Pairs*. Colorado Springs, CO: United Skates Figure Skating Association. Retrieved from http://www.usfsa.org/New_Judging.asp?id=355

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