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Influence of Traditional and Nontraditional Entries on Figure Skating Jumps

BRYANNA NEVIUS

Introduction

Jumping is one of the first basic movements that one learns to perform as a child. The skill is mastered fairly quickly and as the child grows, it often becomes a valuable skill in many of the sports they participate in. Gymnastics, track and field, and figure skating are a few of the sports where jumping is not only a valuable skill, but also a required one. The United States Figure Skating Association states that three of the required elements in the ladies short program must be jump elements, and allows a maximum of seven jumps in the ladies long program (USFSA, 2013). The quantity of jumps equals more than half of the elements in both the ladies short and long programs. As jumping is such an important factor in the sport, a great deal of emphasis is placed on the skater's performance of jump elements. Over the years, judges have also started to reward skaters for making a traditional jump more difficult. In other words, skaters will receive more points for a jump with a difficult entry than they would receive for the same jump with a traditional entry.

With the creative freedom that skaters have in terms of their jump entries and with the extra points as incentive, more often than not, a skater will perform a more difficult version of a traditional jump by varying the entry. However, this trend may become a cause for concern if skaters are not proficient at their non-traditional jump entries, yet include them in the program in hopes of earning extra points. This begs the question of whether or not it is worth the extra points to include a non-traditional jump entry if the skater is more skilled at performing the same jump with a traditional entry.

The first jump examined in this study was the salchow. At its most basic level, it is characterized by its takeoff position, which is a backward inside edge. Once the skater is in the air, they complete one full rotation. With skill development the skater adds more rotations to complete jumps such as the double salchow, the triple salchow, and the quadruple salchow (Figure 1).

The toe loop is the second jump analyzed in this research study, and it is a toe jump as is stated in the name. The toe loop first takes off on two feet before it requires one foot. Essentially there is a transfer of weight that occurs from the back outside edge to the extended leg. As the skater glides on the backward outside edge, their weight is gradually transferred from that leg to the extended free leg with the toe pick in the ice. The skater will take off from the extended free leg with the toe pick in the ice, which differentiates this jump from the axel and the salchow (Figure 2).

Methods

Subjects: Ten female figure skaters from Massachusetts and Rhode Island volunteered for this study. All were able to perform both double salchows and double toe loops proficiently from both traditional takeoffs and a non-traditional take-off of their choice. The participants were chosen through communication with coaches and parents. Before data collection began, all participants, as well as the parents of participants under 18-years-old, were asked to sign a Bridgewater State University approved consent form stating that they agreed to be participants in this study.

Procedure

The data for this research were collected on three separate days in different locations, with different skaters. The same procedures were followed each day; however, the number of skaters filmed during each session differed. Ten skaters in total participated in the research study. Five skaters were filmed on the first day of data collection. Skaters arrived at the rink at approximately...
8:15 am and filled out a Bridgewater State University approved consent form as well as a demographic survey. After the paperwork was completed, the skaters, under my direction, placed joint markers on both sides of their legs at their hip, knee and ankle joints. At 8:50 am the skaters took the ice and they had 20 minutes to warm up before the filming began. During this time, I set up the necessary equipment, which included two tripods and two cameras. One camera was placed in the hockey box and one was placed on the ice near the Zamboni® door. After the cameras were placed, a subject performed a double salchow and a double toe loop in front of the cameras to confirm the accuracy of the camera's field of view. The subject also demonstrated to the others where to perform their jumps in relation to the camera. After the locations were confirmed, filming began and all five skaters performed five trials of the jump they had chosen (double salchow or double toe loop) with a traditional entry. Once the trials were completed, the skaters repeated five times with a non-traditional entry. During the filming of all the non-traditional entries, a third camera was used to capture the entire entry and take-off position. On the second day of filming a very similar procedure was followed; however, only one subject was filmed. The third day of filming was procedurally similar to the first and second days. Four skaters were filmed performing the jump of their choice for five trials with both traditional and non-traditional take-offs, and a third camera was used in these non-traditional trials as well.

Data Collection and Analysis
During the study a standard video-tape camera (Canon digital camera ZR960), as well as two digital cameras (Nikon Cool Pix S6100 and Sony Cybershot DSC-S750), were used to collect data from the skaters during their practice sessions. Once all of the data were collected, it was uploaded to the computer with DartFish software, and further analyzed. Using DartFish, each of the skater's trials, both traditional and non-traditional, were analyzed specifically in terms of the take-off angle of the ankle, knee, and hip joints (Figure 3), the maximum jump height, airtime, horizontal displacement, and the landing angle of the ankle, knee, and hip joints (Figure 4).

Take-off positions for the toe loop were defined as the last backward movement when 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. Jump height was found by measuring the highest point the skater reached in the air to the ice surface and subtracting her height from that value; horizontal displacement was defined 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 the take-off position and the landing position, approximating the moment the skater's blade left the ice to when it first landed on the ice again.

Data were then analyzed with DartFish ProSuite V 6.0 and entered into Excel 2008. A series of 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. Entries for all jumps, just toe loops, and just salchows were compared and the significance level of .05 was adjusted using a Bonferonni correction. In total there were one hundred trials analyzed (ten trials per skater); however, some trials that were videotaped were excluded because of falls or step outs, leaving 43 trials for analysis.

Results
Subjects: The subjects, whose data can be seen in Table 1, consisted of ten female figure skaters who were able to perform either a double salchow or a double toe loop from both a traditional entry and a non-traditional entry of their choice.

<table>
<thead>
<tr>
<th>Table 1 Subject Demographics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs)</td>
</tr>
<tr>
<td>Mean</td>
</tr>
<tr>
<td>Standard Deviation</td>
</tr>
</tbody>
</table>

The subjects volunteered to participate in the study and they signed an informed consent form stating this agreement. Of
the ten skaters, one was at the pre-juvenile level, three were at the juvenile level, three were at the intermediate level, one had passed novice, and two were seniors. Nearly all of the subjects practiced all jumps from traditional entries (eight subjects), one subject practiced axel, double salchow, double flip and double lutz with traditional entries, and one subject practiced axel, double salchow, double toe loop, and double loop from traditional entries. In terms of jump performance with non-traditional take off positions, three skaters performed the axel, five skaters performed a double salchow, six skaters performed a double toe loop, four performed double loops, five performed double flips, and three performed double lutzs.

In the demographic survey skaters were asked when they felt comfortable practicing either the double salchow or double toe loop with a non-traditional take-off position. Six skaters said when they were consistent with landing the jump, two skaters responded always, one skater said one year prior, and one skater responded when she tested up to the level prior to her current placement.

Take-off Angles

The results of the jump take-off measurements analyzed with Dartfish are presented in Table 2. In overall jumps and in the toe loop and salchow, there were no significant differences between traditional and non-traditional entry take-off angles for the ankle, knee, or hip. There were, however, almost significant findings for the ankle and hip joints at takeoff. For the angle of the ankle at take-off the mean was 81.8 ± 11.3 degrees for traditional trials and 84.5 ± 7.8 degrees for non-traditional trials (p = .023); this shows slightly more plantar flexion in non-traditional trials. The hip joint angles at take-off for traditional trials were 127.4 ± 16.1 degrees and 132.3 ± 22.1 degrees or non-traditional trials (p = .028). This shows slightly more hip extension during non-traditional trials.

Flight

The results of the flight time measurements analyzed with Dartfish are presented in Table 3. In all jumps, the only significant difference during flight was the maximum jump height. The mean for the traditional jumps was .36 ± .14 m while the non-traditional mean was .44 m ± .15 m (p = .001).

Landing Angles

The results of landing angles analyzed with Dartfish are presented in Table 4. There were significant differences for the ankle angle at landing in all jumps where the mean for traditional trials was 85.7 ± 12.9 degrees and the mean for non-traditional trials was 90.5 ± 8.6 degrees (p = .001).

Discussion

The purpose of this study was to determine whether or not adding a non-traditional jump entry into a routine is beneficial to the skater or if there is more value in performing the same
jump with a traditional entry. Biomechanical effectiveness was examined by measuring the angles of joints at takeoff and landing, as well as measuring jump height, horizontal displacement, and flight time. It was hypothesized that non-traditional entries would change jump kinematics when compared to the same jumps performed from traditional entries.

**Take-off Position**

There were no significant differences found during the take-off portion of the jump for traditional and non-traditional jump entries. However, there were almost significant findings for the angle of the ankle at take-off, indicating more plantar flexion in non-traditional trials. This may indicate that during traditional take-off positions the skater has more time than in non-traditional trials to dorsiflex the ankle joints to prepare for the jump. Studies have shown that knee and other joint patterns contribute to a successful completion of the jump, and more successful landings (Johnson & King 2001), suggesting that the decrease in plantar flexion of the ankle joint in traditional jumps might allow for a more successful completion of that jump. It could also suggest that the skater is further along, timing wise, in their jump during non-traditional trials (i.e. the dorsiflexion of the ankle may be complete and is now plantar flexing).

During non-traditional trials of all jumps, there were also almost significant findings for the hip joint angle at take-off where there was more hip extension as compared to traditional trials. This hip extension during non-traditional trials of all of the jumps may indicate that the skater is able to flex the hip joint more during traditional trials. Like the ankle findings, more hip joint extension during non-traditional trials at take-off could also suggest that the skater has already flexed the hip and is now extending it. The hip flexion in traditional jumps may be a result of traditional constraints in terms of technique placed on the skater while performing the traditional entry. This change in the hip take-off angle could influence the landing.

**Flight**

When toe loop and salchow jump trials were combined, there were significant findings during flight as well. Maximum jump height was greater for non-traditional trials of all jumps when compared to traditional trials of all jumps. These findings indicate that greater jump height may be a by-product of performing jumps with a more difficult take-off position.

There were significant findings during flight, particularly in the toe loop. There was a significant difference in jump height as the non-traditional trials were higher than the traditional entry trials. There were also significant findings in the salchow trials as well; the non-traditional horizontal entry provided for greater displacement than the traditional entry.

The significant findings for jump height during all jumps are most likely influenced by the significant findings for maximum jump height during toe-loop trials. Both the toe loop trials and the all jump findings show significant differences in maximum jump height. This could suggest a relationship between jump height and the technique associated with the toe loop jumps, especially during non-traditional trials. To perform a toe loop from both a traditional and a non-traditional take-off position, 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. This movement essentially slows the horizontal portion of the jump in order to increase the vertical movement of the jump, which could cause the increased jump height in the toe-loop verses the salchow. The increased jump height in the toe loop during non-traditional entries could be related to a lack of the technical limitations associated with the traditional take-off position.

The significant findings in the salchow trials for horizontal displacement were also likely caused by the jump’s specific technique. The salchow is an edge jump, meaning that the toe-pick is not utilized at all during take-off, which allows for more horizontal movement versus jumps that utilize the toe pick, such as the toe loop. Due to this variation in jumping technique, the horizontal speed of the salchow was not decreased as it was in toe loop trials, perhaps allowing for an increase in horizontal displacement with a non-traditional entry. Non-traditional entries may be more effective at creating a greater horizontal distance for edge jumps.

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

Note: All measures in degrees; Traditional=T Non-Traditional=NT*= Significant difference at p=<.005
Landing Position
During the landing portion of the jump, there were significant differences in all jumps for the ankle angle, which showed greater plantar flexion during nontraditional entries when compared to traditional entries. There were also significant differences for the angle of the ankle joint during toe loop trials, which also showed greater plantar flexion at landing from non-traditional entries compared to traditional entries.

The increased plantar flexion at the ankle in all jumps during non-traditional trials is most likely due to the increased plantar flexion in the toe loop. This may indicate that the significant difference in the angle of the ankle during the toe loop and all jumps may be caused by the significant height difference found in the toe loop and all jumps. These two jump characteristics may be related to each other, suggesting that the increased height during non-traditional trials may allow for the ankle to plantar flex in an effort to stabilize the landing portion of the jump. In addition to the jump height, jump timing may also be related to the increased plantar flexion. The non-traditional jumps seem to have a less structured technique throughout the jump because they do not have to start with a specific take-off position as traditional jumps must. This may permit the jump to attain a larger maximum height, and consequently greater plantar flexion at the landing.

Summary and Recommendations
The purpose of this study was to determine whether or not adding a non-traditional jump entry into a routine is beneficial to the skater or if there is more value in performing the same jump with a traditional entry. In order to earn more points during competition, many skaters and their coaches implement non-traditional take-off positions and in increased difficulty into the jump. The opportunity to earn extra points is appealing when as little as one tenth of a point can define how well an athlete performs. However, it was hypothesized that non-traditional entries would change jump kinematics when compared to the same jumps performed from traditional entries.

Significant differences were found in all jumps for jump height, horizontal displacement and the angle of the ankle during landing, with nontraditional trials greater for all three aspects of the jump. Differences were expected between traditional versus non-traditional versions of the same jumps, however these specific differences were not anticipated. While unanticipated, the differences highlight the fact that non-traditional jump entries do cause differences in the jump when compared to the traditional entry of the same jump. Increased plantar flexion during the landing is most likely caused by the increase in jump height during non-traditional trials. This increase in jump height may cause more difficulties in terms of the amount of control the skater has over the jump versus the amount of control they have over the traditional version. Increased horizontal displacement during non-traditional trials may have the same effect.

These particular findings do seem to support the hypothesis; nontraditional jump entries did cause a change in the jump kinematics when compared to traditional entries of the same jumps. Almost significant findings were seen during take-off when measuring the angle of the ankle and hip. The angles of both hip and ankle increased almost significantly during the take-off portion of non-traditional trials. This suggests that during traditional trials, skaters had more confined take-off positions; their hip and knee joints were flexed more, allowing them to prepare for the jump differently as compared to non-traditional trials.

The findings of this study could be further supported through a larger sample size as well as the acquisition of jump scores 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. In addition to the previous improvements, future research should be directed towards studying different aspects of jump difficulty other than take-off positions to gain a better understanding of traditional versus non-traditional jumps as a whole.

References


[Image of painting]. United States of America; iceskate.net. Retrieved November 20, 2013, from iceskate.net


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**About the Author**

Bryanna Nevius is a graduating senior majoring in Physical Education, with a concentration in Exercise Science, and minoring in Management. In the spring of 2014, she received an ATP research grant which allowed her to complete her honors thesis under the guidance of her mentor, Dr. Pamela J Russell (Movement Arts, Health Promotion & Leisure Studies). She plans on pursuing a career in Sports Medicine following the completion of her undergraduate work in the spring of 2015.