Biomechanics in Throwing a Curling Stone

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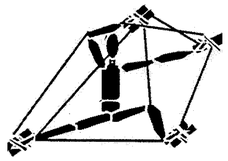
Curling and Coordination: What effect does experience have on curling stone throwing mechanics?

Changes in Fluidity with Experience

An increase in experience in new movement skills reduces "freezing out" and creates a release of degrees of freedom (Bernstein, 1967; Turvey, 1990)

- Freezing out involves keeping the joint angles or entire body "rigidly, spastically fixed"
- An example of a joint angle is the composite angle between the shoulder, elbow, and wrist
- With more experience comes the unlocking of joints and an almost single, coordinated system



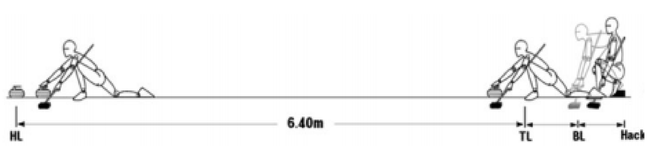
Comparisons to Pistol Shooting and Skiing Studies

Coordination of joint angles with experience has been observed in pistol shooting (Arutyunyan, Gurfinkel, & Mirskii, 1968) and skiing (Vereijken, 1997)

- Novices keep their arm joints tightly fixed, whereas experts refrain from locking, which allows for more fluid pistol movement.
- During a study investigating a pistol shooting task, the researchers noticed an increase in joint movements resulted in less spatial variability of shots
- Vereijken (1997) ran participants in a skiing research study in which novices displayed more rigid movement, but became more coordinated with increased experience.

Biomechanical assessment of the Sliding Motion of Curling Delivery

- A study by Yoo, Kim, and Park (2012) measured and compared the sliding motion in curlers with varying levels of experience
- They measured different lower body joint angles to determine differences in technical characteristics of the sliding motion
- Results of the study showed elite curlers sliding further than subelite curlers, on average
- There is a lack of curling research comparing throwing mechanics in novice and elite curlers



Method

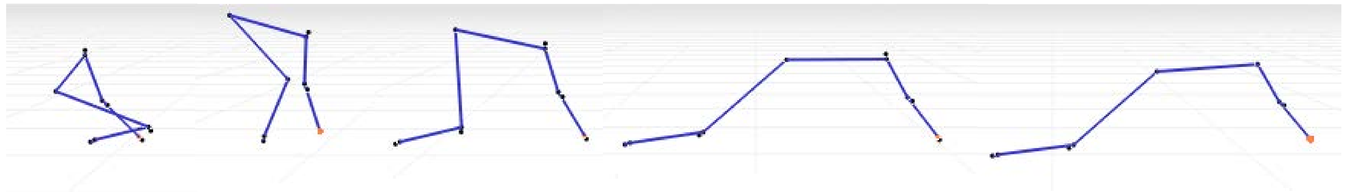
- Experience: 2-3 years to Olympic level

	Shot	
Turn	Hit	Draw
Counter-Clockwise	Hit Counter-Clockwise	Draw Counter-Clockwise
Clockwise	Hit Clockwise	Draw Clockwise

Note. 2 trials for each condition

- Movement recorded using a motion tracker (Optotrak Certus)
  - Infrared emitters attached to right side of body
    - Shoulder, elbow, and wrist of arm
    - Hip, knee, and ankle of leg
- Dependent variables
  - Difference in hip and ankle height during the throw
  - Hip height start of the throw
  - Fishtailing

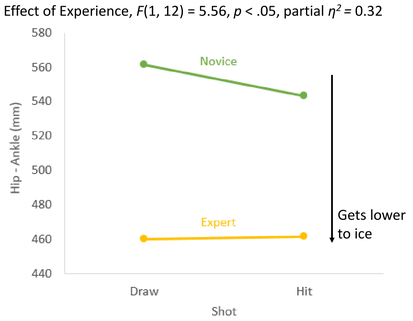
The Curling Slide



Results

Shot x Experience interaction, $F(1, 12) = 4.40$, $p = .058$, *partial* $\eta^2 = 0.27$

Main Effect of Experience, $F(1, 12) = 5.56$, $p < .05$, partial $\eta^2 = 0.32$



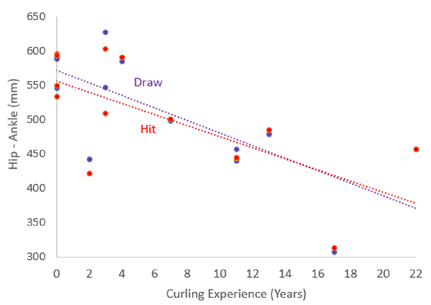


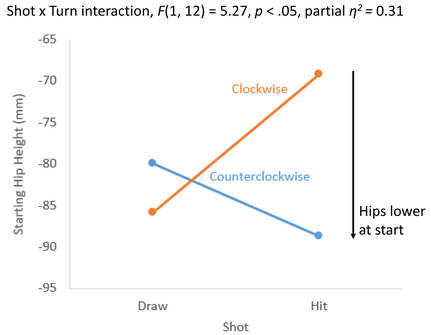
Table 1

Separate Simple Linear Regression Analyses for Draw and Hit Shots Predicting Hip – Ankle (mm) from Curling Experience (Years)

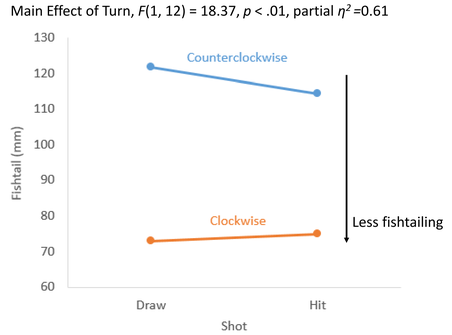
	Curling Experience (Draws Thrown)		Curling Experience (Hits Thrown)	
Variable	*b*	95% CI	*b*	95% CI
Constant	571.02**	[521.53, 620.50]	556.25**	[505.49, 607.02]
Hip – Ankle	-9.07*	[-14.27, -3.88]	-8.09*	[-13.41, -2.76]
R^2	0.55		0.69	
F	14.50*		10.94*	

Note. $N = 14$. *CI* = 95%
*$p < .01$. **$p < .001$.

Shot x Turn interaction, $F(1, 12) = 5.27$, $p < .05$, partial $\eta^2 = 0.31$



Main Effect of Turn, $F(1, 12) = 18.37$, $p < .01$, partial $\eta^2 = 0.61$



Conclusions

- We predicted that curlers with more experience would demonstrate a lower hip to ankle ratio.
- Our results show that experts demonstrate a lower hip to ankle ratio than novices, but for novices, hit shots are lower than draw shots.
- We found that starting hip height was higher for hit shots than draw shots
- Starting hip height is higher for counter-clockwise hit shots than clockwise hit shots.
- Curlers demonstrated a fish-tail movement more predominantly with the counter-clockwise throwing motion.

Future Directions

Results of this study can be used to develop a better long-term technique in curlers still learning the game and for more experienced curlers who are looking to make improvements to their already existing game. Coaches can use the results of the study to create more specific techniques for increasing fluidity.

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