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Original research

The influence of match characteristics and experience on decision-making performance in AFL umpires

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ABSTRACT

Objectives: The purpose of this study was to investigate the effects of match characteristics and elite level umpiring experience on the decision-making performance of umpires in the Australian Football League (AFL).
Design: Cross Sectional Study.
Methods: All decisions from the 2014 AFL home and away season made by 32 male AFL field umpires (age 33.1 ± 5.0 years, AFL umpire experience 122 ± 105 matches) were classified by a panel of four expert umpire coaches into correct, missed and unwarranted categories. The 8001 decisions were then further categorised based on the match time, score differential, field location, home ground advantage, match attendance and elite level umpiring experience. Chi-square with standardised residuals and two-way analysis of variance were used to analyse the data.
Results: Higher elite level umpiring experience and a larger score differential at the time of the decision resulted in improved decision-making accuracy. Home ground advantage, attendance and match time did not influence the decision-making performance of umpires. Impact averse decisions occurred in the back line of play, with umpires tending to be conservative with decisions that may impact the score.
Conclusions: Decisions that have an increased influence on an umpire's decision-making performance include score differential and elite umpiring experience. Implications on umpiring performance regarding the venue, attendance and the duration of a match were not apparent.

1. Introduction

The frequency of correct and incorrect decisions made in sport, often termed decision-making performance, is influenced by a complex mix of physical, social, psychological and environmental factors.[1] In team-based sports, decision-making involves athletes responding to stimuli that they perceive from the environment and producing the most appropriate movement or action response to accomplish a particular outcome.[2] A fundamental difference exists between players and umpires in the decision-making process of Australian football as umpiring decisions only encompass the identification of a rule violation according to the laws of the game, and does not include a performance based skill execution subsequent to the decision. Themes identified to relate to the umpire decision-making process of Australian football involve knowledge of gameplay, player intention during the match and the decision evaluation.[3]

An umpire, referee or official plays an integral role in almost all sports, as they uphold the laws of the game by adjudicating match play according to the laws. Several influences on decision-making performance have been identified in previous research. In Australian football, sub-elite umpires have a varied decision-making accuracy across the quarters of a match,[4] while elite umpires are consistent.[5] Although Australian football umpires of a sub-elite level have improved decision making accuracy and running performance with increasing experience, there is no correlation between the two variables at the sub-elite level.[6] At the elite level, movement patterns of an AFL umpire may influence decision-making performance, with increased running velocities prior to decisions having an association with incorrect adjudications.[7] The level of umpiring experience has been shown to affect decision-making performance in soccer[8–10] and in Australian football[11] but has not been investigated at the elite level of Australian football. Research that examined whether Australian Football League (AFL) umpires provide more favorable treatment (e.g. awarding free kicks) to a team from the same state as the umpire, has found evidence of decision bias.[12,13] Studies that have investigated the influence of home ground advantage on the decision-making performance of umpires

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have reported contrasting results, with both an effect[8,14,15] and no effect[16,17] reported. In addition, it has been shown that umpires in soccer tend to alter their decisions when the margin between the two playing teams is small[16–18] but no enquiries into Australian football have occurred.

The purpose of this research is to examine the decision-making performance of AFL umpires at the elite level, across an entire season, for all decision types. Smaller decision-making sample sizes have been used in previous research in AFL to provide a snapshot of the occurrences at the elite level[5,7] but none have investigated an entire home and away season of umpiring decisions. Using data collected from within the competition environment (i.e. actual match data) provides benefits over some video based methods[4,11,19] as it incorporates the native dynamic setting which characterises sports decisions.[20] A variety of factors that may affect AFL umpire decision-making performance were evaluated including: time point in the match, score differential, home ground advantage, field location of the decision, and level of umpiring experience.

2. Methods

The participants of the observational research comprised of 32 male AFL field umpires (age 33.1 ± 5.0 years; mean ± SD), who had varying levels of previous experience umpiring AFL matches (122 ± 105 matches). The data set comprised of all infringement decisions (n = 8001) made by umpires in the 2014 AFL season. The accuracy of each decision was assessed by the AFL Umpiring Department. Infringement decisions for all matches throughout the season (n = 198) were visually assessed by two designated umpire coaches. The designated coaches were selected from a panel of four AFL umpire coaches (AFL umpire experience = 294 ± 193 matches), including the AFL head umpire coach, for the decision classification process. Every decision was classified as correct, missed or unwarranted. Correct decisions were defined as an accurately made umpiring decision, missed decisions were defined as umpiring decisions that should have been made but were not awarded, and unwarranted decisions were defined as umpiring decisions that were made in a match but did not violate the laws of the game.

If consensus was not reached between the two umpire coaches on the classification of a decision, the four coaches on the panel reviewed the decision in an attempt to come to an agreed consensus in a review meeting. In the review meeting all unclassified umpiring decisions were discussed and a unanimous response to the decision's classification was required to reach a consensus. If a consensus was not reached the head umpiring coach on the panel determined the final classification of the decision. This process represents the standard procedure followed by the AFL Umpiring Department in reviewing umpiring decision for the elite level of Australian football.

SportsCode video analysis (Version 8.7, Sportstec, New South Wales, Australia) and Champion Data's Coaches Information Analysis (Version 5.4.18, Champion Data Holdings, Melbourne, Australia) software programs were used to evaluate each decision, within four days of the completion of each match. The designated umpiring coaches used the official broadcast video and two additional camera angles (behind the goals and wide-angle side view) when classifying decisions.

Each match and decision was individually coded with the following factors that were associated with it:

- Umpire Experience — The total number of AFL matches adjudicated by the umpire prior to the 2014 season. Umpiring experience was categorised as; low <75 matches, moderate 75–150 matches, and high >150 matches.
- Home Ground Advantage — Categorised as 'both home ground' (at both team's home ground, i.e., in the case of a shared venue), 'intrastate home ground' (against a team from the same state that plays at an alternative ground), 'interstate home ground' (against a team from a different state).
- Attendance — The official attendance at the match, categorised as; small <25,000, medium 25,000–45,000 and large >45,000 spectators.
- Team the Decision is for — The team, home or away, as designated by the fixture, which receives the advantage from the adjudication.
- Match Time — The time point of the match that the decision was made, broken into two subcategories.
  - ○ Quarter — The quarter of the match in which the decision occurred.
  - ○ Quarter Segment — The first, second and third segment of each quarter of play, defined by the average length for all quarters for the 2014 AFL home and away season divided into thirds (0–10.4, >10.4–20.8, >20.8 min).
- Score Differential — The difference in the score between the two teams at the time of the decision, categorised as small ≤9, medium 10–18 and large >18 points (adapted from Ref. 21).
- Location of the Decision — The area of the field where the decision was made, in relation to the team that was infringed upon, categorised as forward, midfield or back.

All data was aggregated into counts of correct, missed, unwarranted and the total number of decisions for all categories of each factor investigated. The effect of these factors on decision-making performance was assessed using a Chi Square test for independence. Each factor was analysed against correct, missed and unwarranted decisions with unadjusted standardised residuals and Cramer's V values calculated for effect size. Expected equal distributions were applied to all variables except umpire experience, as there were an unequal number of umpires in each category. Umpire experience expected values were adjusted according to the distribution of umpires in each subcategory of low (n = 13), moderate (n = 8) and high (n = 11) level experience. Standardised residual significance was set at a magnitude of 1.96 with scores equal to or greater than being deemed significant due to it corresponding to values of less than five percent probability.[22]

Analysis of variance (ANOVA) tests were conducted to identify any main effects of variables and to identify any interacting effects with umpire experience using umpire error rates. To prepare the data for ANOVA, the frequency of correct, missed and unwarranted decisions was aggregated into error rates as percentages for each umpire with regards to each factor's subcategory. Error rates, were defined as the percentage of the total number of decisions that were missed and unwarranted. Mean and standard deviations, F ratios, p values, degrees of freedom and error degree of freedom values were calculated for main effects and interaction effects for all ANOVA's. Mean and 95% confidence intervals were calculated for low, moderate and highly experienced umpire categories.

For chi square and ANOVA analyses significant results were determined to be less than 0.05 and highly significant results being less than 0.001 for p values.[23] Data is presented as mean ± SD unless otherwise stated. All analyses were conducted in SPSS (Version 22, IBM, Foster City, California, United States of America).

3. Results

The 8001 decisions of the 2014 season analysis consisted of 6260 correct, 1162 missed and 579 unwarranted decisions, producing an error rate percentage of 21.8%. An average of 40 (±7) decisions were made each match. Umpires made more correct

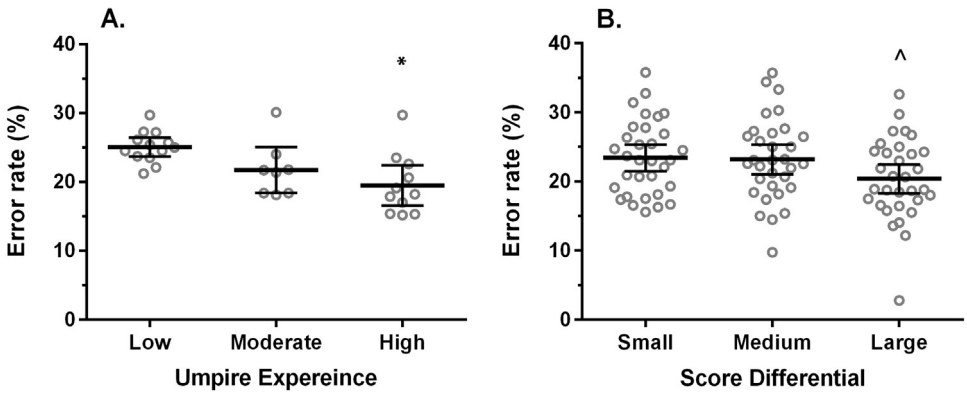

Fig. 1. (A) Mean ± 95% confidence intervals of error rate (%) for low (n = 13), moderate (n = 8) and highly (n = 11) experienced umpires with individual umpire error rates also displayed. (B) Mean ± 95% confidence intervals of error rate (%) for small (n = 32), medium (n = 32) and large (n = 32) score differentials with individual umpire error rates (%). *Significantly ($p < 0.05$) different compared to umpires of low experience. Ŝignificantly ($p < 0.001$) different compared to small score differential.

Table 1
Proportions of decisions for decision classifications, match characteristics and umpire experience in AFL Umpires with standardised residuals. Frequencies (Standardised Residual); n, number of subjects; X^2, Chi Square result; df, degrees of freedom; V, Cramer's V value.

Variable	Sub category	Chi square independence	Correct	Missed	Unwarranted	Error rate
Score differential	Small margin	$X^2 = 6.7$	2302 (−0.6)	447 (0.7)	230 (1.0)	22.7%
	Medium margin	df = 4	1366 (−0.4)	273 (1.0)	128 (0.0)	22.7%
	Large margin	p = 0.150	2592 (0.9)	442 (−1.4)	221 (−0.9)	20.4%
		V = 0.021				
Umpire experience	Low experience (n = 13)	$X^2 = 30.41$	2266 (−1.8)	499[a] (3.0)	241 (1.6)	24.6%
	Medium experience (n = 8)	df = 4	1631 (0.0)	291 (−0.7)	161 (0.8)	21.7%
	High experience (n = 11)	p < 0.001	2363 (1.8)	372[a] (−2.5)	177[a] (−2.3)	18.9%
		V = 0.044*				
Area of decision	Back line	$X^2 = 17.24$	955 (0.4)	140[a] (−2.6)	108[a] (2.2)	20.6%
	Midfield	df = 4	4228 (0.0)	796 (0.4)	384 (−0.4)	21.8%
	Forward line	p = 0.002	1077 (0.3)	226 (1.7)	87 (−1.4)	22.5%
		V = 0.033*				

[a] Denotes statistically significant standardised residual score (standardised residual magnitude >1.96).
* Denotes statistically significant result ($p < 0.05$).

decisions (32 ± 7) than missed decisions (6 ± 2) and unwarranted decisions (3 ± 2) as well as more missed decisions than unwarranted decisions ($p < 0.001$). Individual umpire error rates averaged 22.3% (±4.2%), ranging from 15.2% to 30.1% (Fig. 1).

The proportion of the number of decisions for each independent variable was shown to be highly significant ($p < 0.001$), with a disproportionate number of decisions occurring for each independent factor's subcategories. The expected proportions for correct, missed and unwarranted decisions were significantly different for the zone of the decision, umpire experience and the category of the decision ($p < 0.05$) with very weak effect sizes for all variables indicated by small Cramer's V scores ($V < 0.1$).

Umpires with low experience missed significantly more decisions than expected while highly experienced umpires made fewer mistakes than expected (standardised residual >|1.96|, Table 1). Less missed decisions and more unwarranted decisions were made in the back line field of play than predicted (standardised residual >|1.96|, Table 1).

While a significant difference was not evident between the subcategories of score differential ($p = 0.15$, Table 1) a main effect for score differential was present ($F(2, 87) = 3.78$, $p < 0.05$), with small margins having a 3.1% (±1.3%) higher percentage of incorrect decisions made when compared to large margins ($p < 0.05$, Fig. 1). The difference in medium margins and large margins approached significance ($p = 0.074$) with medium margins trending towards a higher error rate (2.9 ± 1.3%).

A main effect was found for umpire experience ($F(2, 87) = 13.11$, $p < 0.001$) with umpires of low experience having a 6.2% (±1.2%) increase in error rate when compared to highly experienced umpires ($p < 0.001$, Fig. 1). Comparisons between low and medium experienced umpires ($p = 0.054$), and medium and highly experienced umpires ($p = 0.074$) were approaching significance with increases in experience producing a non-significant decrease in error rate. No other main effects or interactions with umpire experience were recorded ($p > 0.05$).

4. Discussion

Umpires made more missed decisions than unwarranted decisions, which is consistent with previous literature.[5,7] The overall error rate of 21.8%, or a decision-making accuracy of 78.2%, for the 2014 AFL regular season yielded a reduced decision-making accuracy when compared to the 84–87% reported by Elsworthy et al.[5,7] The same process of using elite umpire coaches to classify AFL umpiring decisions was used by Elsworthy et al.[5,7] making discrepancies a likely result of seasonal variations or a reflection of differences in sample size and sampling frequency within the season. The present analysis includes all 8001 decisions made during the 2014 AFL home and away season, compared with only 884 and 448 from the previous studies.[5,7]

The score differential between two teams does not affect the number of correct, missed or unwarranted decisions individually but it does affect the error rate of the umpiring group. The amalgamation of missed and unwarranted decisions as incorrect decisions highlights that as the score differential increases, umpire's decision-making accuracy improves. Score differential also affects soccer referees in close matches as they alter the amount of injury time they award depending on the score margin

of the match.[16–18] The potential causes of these effects could be a result of the impact aversion phenomena and the effects of anxiety on decision-making performance.[24,25] Impact aversion, a preference towards the result that will have the least influence on the match, which has been previously identified in baseball, may play a role in umpiring decisions of close matches.[24,25] Anxiety has been shown to promote a risk adverse tendency in decision-making, consistent with impact aversion,[26] while increases in anxiety have been shown to effect cognitive flexibility performance in soccer and baseball,[27] providing a potential explanation for the increases in decision-making errors. Also the style of play in AFL matches could influence the ability of umpires to make correct decisions as the style of play in AFL matches changes when the margin is close.[21] As this aspect is uncontrollable, a greater focus may be addressing high levels of anxiety.

Consistent with previous literature, a larger number of decisions were made in the midfield of play when compared to the two end zones.[5] Incorrect decisions made in the backline favour the corresponding defending team due to a less than expected number of missed decisions and larger than expected number of unwarranted decisions made. Again, it can be suggested that AFL umpires have an impact aversion, or in this case a score aversion bias, potentially preventing a team from a scoring opportunity by avoiding making decisions that could impact the scoreboard. The effects of scoring aversion may be amplified at the higher levels of competition, as elite ice hockey referees appear to have a larger fear of mistakes than referees adjudicating lower tiered competitions.[28] The elite level umpire may therefore be more susceptible to the effects of anxiety and scoring aversion in matches.

Decision-making performance improved as the level of experience attained by the umpire increased, with more missed decisions being made by umpires of low experience and less incorrect decisions being made by highly experienced umpires. Elite level umpires are expected to have an improved decision-making performance than their sub-elite counterparts,[8,9,11] with differences now evident between experience levels within elite umpires in AFL. The increase in incidence of missed decisions made by umpires of low experience may be a result of tentative thoughts in adjudicating decisions as umpires of low experience miss more decisions. Consistent with schema theory,[29] highly experienced AFL umpires may have potential scenarios prepared in their memory that allows them to assess scenarios and make decisions more quickly through identifying cues.[30] Larkin et al.[3] has identified that Australian football umpires apply heuristics within a match to complete their decision-making process. Whether umpires of less elite experience have developed this process or if it is a case of greater anxiety affecting the decision-making process is still unknown.

While the number of decisions made was reduced in the final quarter and quarter segment of matches, there were no changes in umpire's decision-making accuracy across matches. Elsworthy et al.[5] also found a consistent decision-making accuracy yet reported a uniform distribution of umpiring decisions across elite AFL matches. As decision-making accuracy is not influenced across a match it may suggest that the style of play of elite Australian football may be less conducive to decisions in the final portions of a game as the number of decisions made is reduced. In contrast Larkin et al.[4] found an improved decision-making accuracy in the final term of sub-elite umpires which may further highlight the disparity between elite and sub-elite AFL umpires. Larkin et al.[4] used a scenario based video test to assess intra match decision-making compared to decision-making in the field of play which may account for the differences in results.

Home ground advantage and match attendance did not affect the decision-making performance of umpires, nor did umpire experience interact with these variables to influence decision-making performance. Research in elite soccer has also found that a team's home ground advantage and the attendance alone does not influence umpiring decisions[16,17] although the phenomenon has been observed in basketball,[14] Muay Thai[15] and sub-elite soccer using a visual scenario test.[8] The findings from Dohmen[16] and Scoppa[17] may further support the notion that the proximity of the crowd to the field of play, and umpire, may be a more important factor for influencing umpiring decision-making compared to the size of the crowd.[17] Differences may be attributed to Australian football grounds having different characteristics in terms of field size, proximity to the play and mixed supporter bases attending AFL games.

The home team received more infringement decisions which supports previous findings in the AFL.[12,13] As no differences in the accuracy of those decisions occurred between home and away teams, the increased frequency of decisions for the home team is justified. As the findings by Mohr and Larsen[12] and Watson[13] did not distinguish if infringement decisions were warranted, it can be suggested that other factors are at play for why home teams receive more infringement decisions.

5. Conclusion

Increases in an AFL umpire's level of elite umpiring experience and a large score differential between two teams reduced the error rate associated with umpiring decisions. The presence of a home ground advantage, the size of the crowd and the time point within the match had no effect on an umpire's ability to adjudicate infringement decisions. Some score aversion is evident in the backline zone of play, with umpires tending to make more missed and less unwarranted decisions that favour the defending team.

Practical applications

- In an attempt to combat or limit the effects of score differential on the decision-making performance of umpires, developing anxiety management practices and incorporating high anxiety situations within training may be beneficial. By preparing umpires to cope with heightened anxiety levels within competitive situations, umpires may be able to limit the effects of anxiety and potential score aversion.
- The increased error rate of inexperienced umpires, caused by a larger number of missed decisions, may be attenuated by teaming inexperienced umpires with those of a high level of elite experience as they miss less decisions.
- For the umpire selection and reviewing process, consideration of the match characteristics of a decision, such as the score differential, needs to be taken into account when comparing to other performances.
- In regards to the scoring aversion occurrence in a team's backline of play, educating the umpiring cohort on the presence of this phenomenon may be an initial approach.

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References

1. Araujo D, Davids K, Hristovski R. The ecological dynamics of decision making in sport. *Psychol Sport Exerc* 2006; 7(6):653–676.
2. O'Connor D, Larkin P. Decision making for rugby, in *Science of Sport: Rugby*, Till K, Jones B, editors, Marlborough, Crowood Press, 2015, p. 102–112.
3. Larkin P, Mesagno C, Berry J et al. Exploration of the perceptual-cognitive processes that contribute to in-game decision-making of Australian football umpires. *Int J Sport and Exerc Psychol* 2016:1–13.

4. Larkin P, O'Brien B, Mesagno C et al. Assessment of decision-making performance and in-game physical exertion of Australian football umpires. *J Sports Sci* 2014; 32(15):1446–1453.
5. Elsworthy N, Burke D, Scott BR et al. Physical and decision-making demands of Australian football umpires during competitive matches. *J Strength Cond Res* 2014; 28(12):3502–3507.
6. Paradis K, Larkin P, O'Connor D. The effects of physical exertion on decision-making performance of Australian football umpires. *J Sports Sci* 2016; 34(16):1535–1541.
7. Elsworthy N, Burke D, Dascombe B. Factors relating to the decision-making performance of Australian football officials. *Int J Perform Anal Sport* 2014; 14(2):401–410.
8. Nevill AM, Balmer NJ, Williams AM. The influence of crowd noise and experience upon refereeing decisions in football. *Psychol Sport Exerc* 2002; 3(4):261–272.
9. Weston M, Bird S, Helsen W et al. The effect of match standard and referee experience on the objective and subjective match workload of English Premier League referees. *J Sci Med Sport* 2006; 9(3):256–262.
10. Catteeuw P, Helsen W, Gilis B et al. Decision-making skills, role specificity, and deliberate practice in association football refereeing. *J Sports Sci* 2009; 27(11):1125–1136.
11. Larkin P, Berry J, Dawson B et al. Perceptual and decision-making skills of Australian football umpires. *Int J Perform Anal Sport* 2011; 11(3):427–437.
12. Mohr PB, Larsen K. Ingroup favoritism in umpiring decisions in Australian football. *J Soc Psychol* 1998; 138(4):495–504.
13. Watson J. Australian Football League: "home advantage", "umpire bias" or both? *SBM* 2013; 3(3):176–188.
14. Anderson KJ, Pierce DA. Officiating bias: the effect of foul differential on foul calls in NCAA basketball. *J Sports Sci* 2009; 27(7):687–694.
15. Myers T, Balmer N. The impact of crowd noise on officiating in muay thai: achieving external validity in an experimental setting. *Front Psychol* 2012; 3:346.
16. Dohmen TJ. The influence of social forces: evidence from the behavior of football referees. *Econ Inq* 2008; 46(3):411–424.
17. Scoppa V. Are subjective evaluations biased by social factors or connections? An econometric analysis of soccer referee decisions. *Empir Econ* 2008; 35(1):123–140.
18. Garicano L, Palacios-Huerta I, Prendergast C. Favoritism under social pressure. *Rev Econ Stat* 2005; 87(2):208–216.
19. Larkin P, Mesagno C, Berry J et al. Development of a valid and reliable video-based decision-making test for Australian football umpires. *J Sci Med Sport* 2014; 17(5):552–555.
20. Johnson JG. Cognitive modeling of decision making in sports. *Psychol Sport Exerc* 2006; 7(6):631–652.
21. Sullivan C, Bilsborough JC, Cianciosi M et al. Match score affects activity profile and skill performance in professional Australian Football players. *J Sci Med Sport* 2014; 17(3):326–331.
22. Durrheim K, Tredoux C. *Numbers, Hypotheses & Conclusions: A Course in Statistics for the Social Sciences*, UCT Press, 2004.
23. Hatcher L. *Step-by-Step Basic Statistics Using SAS: Student Guide*, SAS Institute, 2003.
24. Green E, Daniels DP. *Can Decision Biases Increase with the Stakes? Field Evidence of Impact Aversion*, Stanford University, 2014.
25. MacMahon C, Starkes JL. Contextual influences on baseball ball-strike decisions in umpires, players, and controls. *J Sports Sci* 2008; 26(7):751–760.
26. Hartley CA, Phelps EA. Anxiety and decision-making. *Biol Psychiatry* 2012; 72(2):113–118.
27. Han DH, Park HW, Kee BS et al. Performance enhancement with low stress and anxiety modulated by cognitive flexibility. *Psychiatry Investig* 2011; 8(3):221–226.
28. Dorsch KD, Paskevich DM. Stressful experiences among six certification levels of ice hockey officials. *Psychol Sport Exerc* 2007; 8(4):585–593.
29. Sherwood DE, Lee TD. Schema theory: critical review and implications for the role of cognition in a new theory of motor learning. *Res Q Exerc Sport* 2003; 74(4):376–382.
30. McLennan J, Omodei MM. The role of prepriming in recognition-primed decisionmaking. *Percept Mot Skills* 1996; 82(3):1059–1069.