Psychological Impact of Emotions on Chess Players' Performance

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Abstract

Participants played a chess game and reported their emotional state before making each move. We measured the quality of each move with the chess computer program Rybka 3.0. Participants also completed the PsychEval Personality Questionnaire (PEPQ), and we analyzed each move of the chess game and its associated state affect with respect to the PEPQ personality traits. It is hypothesized that state affect predicts performance during a chess game and is moderated by both playing strength and personality traits.

Figure 1. Former world champion Anatoly Karpov glowers at his long time rival, Garry Kasparov

Chess players have long known that competitive stress influences their performance. Calderwood, Klein, and Crandall (1988) found that amateur chess players made more mistakes during time pressure compared to chess masters. Time pressure is not the only stressor during a game, though; Schwarz et al (2002) observed players and assessed state affect after each move, finding that feelings of hopelessness and helplessness correlated with high heart rate variability. They did not, however, analyze chess performance with respect to state affect.

International Positive Affect Negative Affect Schedule Short Form

The International Positive Affect Negative Affect Schedule Short Form (I-PANAS-SF) is composed of two 5-item scales, "Positive Affect" and "Negative Affect" (Thompson 2007). A modified version was used in this study to measure state affect before each move. It was chosen for its speed of completion.

PsychEval Personality Questionnaire

The PsychEval Personality Questionnaire (PEPQ) assesses normal personality traits on 16 scales and pathology-oriented traits on 12 scales (Cattell 2003). It is published by the Institute for Personality and Ability Testing, Inc. (IPAT).

Rybka 3.0

With an estimated chess rating of over 3100 at full playing strength, Rybka 3.0 is stronger than any human grandmaster, and is widely considered the leading computer chess engine.

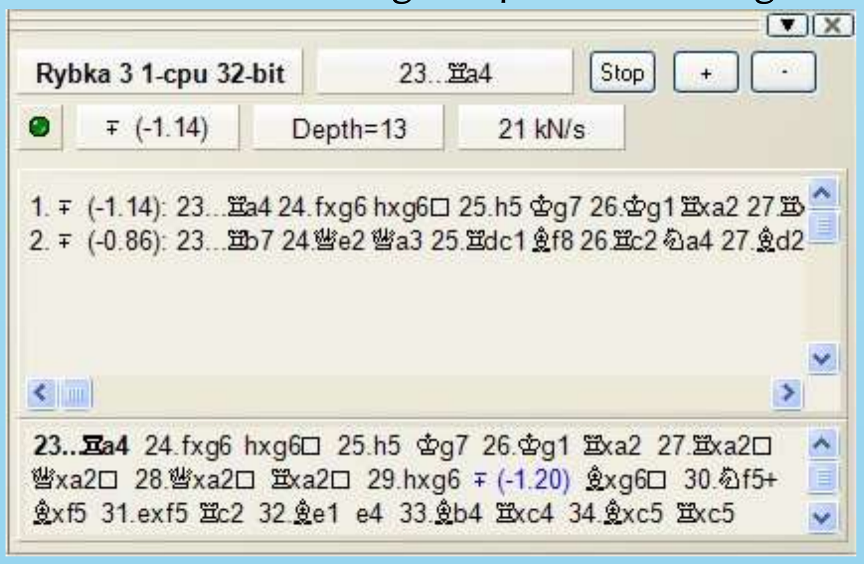

Figure 2. Rybka 3.0 analysis within ChessBase 10

Procedure

Subjects were required to a) have an established United States Chess Federation (USCF) rating b) have a current subscription to the Internet Chess Club (ICC) c) be over the age of 16. After completing informed consent, six participants with USCF ratings from 1050 to 1850 and were paired against opponents with ratings within 100 points. Games were played on ICC using with a time limit of 45 minutes for each side and a 45 second increment per move. To measure state affect before each move, participants completed the IPANAS-SF for the time period after their previous move and before making their current move, including the time spent during their opponent's turn. The 45 second increment provided enough time to comfortably complete the ten-item schedule. After finishing the game, participants completed and submitted their PEPQ answer sheet, game scoresheet, and I-PANAS-SF form.

The computer chess program Rybka 3.0 then analyzed the games using a a fixed search depth of 14-plies (7 moves for both sides). The difference between Rybka's evaluation (**$\Delta E = E_n - E_{n-1}$**) before and after move was used to measure perfomance. **$\Delta E > 0.0$** indicates that Rybka's evaluation immediately after a move was higher than immediately before the move, while **$\Delta E < 0.0$** indicates the converse.

Fixed-depth search, rather than Rybka's full variable-length search, was used to ensure reproducibility of evaluations across different computers with varying hardware specifications.

Principal Components Analysis of I-PANAS-SF scales

Before conducting a principal components analysis, the I-PANAS-SF items "Upset" and "Hostile" were excluded because responses for those items were not normally distributed. Varimax rotation revealed a two-component structure roughly corresponding with that of Thompson's (2007). Therefore, we followed Thompson's example and named the two components "Positive Affect" and "Negative Affect." The *Negative Affect* component differed from Thompson, however, in that *Inspired* had a negative loading less than -0.300.

Table 1. Total Variance Explained

Component	Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %
Positive Affect	3.738	46.724	46.724
Negative Affect	2.049	25.619	72.343

N = 107
Principal Components Analysis
Varimax with Kaiser Normalization

Table 2. Rotated Component Matrix

I-PANAS-SF item	Component	
	Positive Affect	Negative Affect
Ashamed	-.094	**.669**
Nervous	.193	**.803**
Afraid	-.145	**.847**
Alert	**.932**	.149
Inspired	**.753**	**-.387**
Determined	**.882**	-.240
Attentive	**.914**	.059
Active	**.787**	.054

Item loadings above 0.30 are highlighted

Linear Mixed Model Analysis

Since consecutive positions occurring during a chess game are not independent, a linear regression was inappropriate. A linear mixed model was chosen because it supports the analysis of correlated data. In this model, moves were repeating data grouped by subject with a first-order autocorrelation covariance structure. USCF Rating was modeled as a both a fixed effect and a random effect, *Positive Affect and Negative Affect* were fixed effects, and **ΔE** was the dependent variable. Results are shown in Table 3.

Table 3. Estimates of Linear Mixed Model Fixed Effects

Parameter	Estimate	t	Sig.
Intercept	-2.214206	-8.575	.000
USCFRating	.001169	6.252	.000
PositiveAffect	1.159153	4.776	.000
NegativeAffect	.054537	.183	.856
USCFRating * PositiveAffect	-.000675	-3.639	.001
USCFRating * NegativeAffect	-.000149	-.607	.546
PositiveAffect * NegativeAffect	.153340	.303	.763
USCFRating * PositiveAffect * NegativeAffect	-.000184	-.416	.679

$p < 0.05$ highlighted. 6 groups, N=107.

Next, PEPQ personality traits were included in the model as fixed effects. However, no PEPQ trait was a significant predictor, although *Depressive Features* approached significance (p=0.082).

Finally, a linear mixed model including each of the I-PANAS-SF adjectives was analyzed. No individual item was a significant predictor.

Data Exclusion

• The first 5 moves were excluded because players rely on a series of pre-memorized moves called an *opening*.

• When allowed to search a variable number of moves, Rybka's estimated rating is 3100. However, a fixed search depth of 14 plies limits Rybka's ability to accurately assess some positions because important moves may be beyond its "move horizon." Since it is unlikely that players would perform better than Rybka at full strength,, moves with **$\Delta E > 0.10$** were excluded.

• Finally, Rybka 3.0 assigns a score of negative infinity or positive infinity when checkmate can be forced, making computation of **ΔE** impossible. Moves with these evaluations were excluded to simplify analyses.

Results

• ***United States Chess Federation (USCF) Rating* was a significant predictor of performance.**

• ***Positive Affect* was also a significant predictor of performance.**

• ***Alert* and *Attentive* alone did not predict performance.** One could argue that the improved performance resulting from the Positive Affect component is primarily the items *Alert* and *Attentive.* When analyzed in the linear mixed model, though, *Attentive* and *Alert* were not individually significant predictors of performance. Only the entire *Positive Affect* component was significant.

• ***Negative Affect* was not a significant predictor of performance.** This indicates that reduced *Positive Affect*, rather than *Negative Affect*, inhibited chess performance.

• **Stronger players performed better than weaker players under reduced *Positive Affect*.** A negative interaction between *USCF Rating* and *Positive Affect* indicates that as playing strength increases, the degree of *Positive Affect*'s influence decreases.

• **PEPQ traits had no significant effects.** While the PEPQ trait *Depressive Features* had an effect approaching significance (p=0.082), the small size is too small to draw conclusions about moderating effects of PEPQ scales.

Discussion

• Positive affect has been linked to increased cognitive flexibility in medical diagnoses, industrial negotiations, intuitive judgments, decision making, and creative problem solving tasks.

• Rowe, Hirsh and Anderson (2007) found that positive affect increased the breadth of attentional selection in both a remote association task and an Eriksen flanker task compared to negative and neutral affects. They did not, however, find that negative affect decreased attentional selection.

• *Negative Affect* had no significant impact on performance in this study, similar to Rowe, Hirsh, and Anderson's (2007) inability to correlate negative mood with reduced attentional selection.

• Although the games were unrated and not played in a formal tournament setting, emotions significantly impacted chess performance, showing that Internet chess games can be used to study the relationship between state affect and performance.

References

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