ORIGINAL ARTICLE

Decision-making style, aspiration level and resting autonomic indices in judo athletes: An exploratory psychophysiological profiling study

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ABSTRACT

Decision making is regarded as a determinant of combat-sport performance, but the dispositional and autonomic characteristics that accompany it in developing athletes are poorly described. This exploratory cross-sectional study profiled self-reported decision-making style, personality, cognitive errors, behaviourally measured aspiration level and resting heart rate variability in 118 male Armenian judo athletes aged 8–22 years. Psychological measures were applied to athletes aged 12 years and older (n = 72) and resting heart rate variability was recorded in 97 athletes. p values were adjusted for multiple testing (false discovery rate, FDR). Continuous decision-style scores were not associated with age or training experience, whereas lower intuition (more sensing) scores were associated with higher competitive level after adjustment for age and experience (OR = 0.38 per *SD*, p = .002). Intuitive athletes showed higher total spectral power than sensing athletes (Hedges' g = 0.86, FDR-adjusted p = .002, robust to leave-one-out analysis), but continuous intuition scores were unrelated to total power, so this preliminary finding rests on nine athletes with a clear sensing preference. Higher resting heart rate in feeling-oriented athletes (d = 0.74) and over-representation of thinking orientation among national-team members did not survive FDR correction. Among non-national-team athletes, aspiration level differed across competitive levels (η^2 = .43) and remained associated with level after adjustment for age and experience (OR = 5.37 per *SD*, 95% CI 2.22–13.00). After mutual adjustment, cognitive errors were associated with age and self-management, attachment and aspiration with training experience. These concurrent associations generate hypotheses for longitudinal research but do not support selection decisions.
Keywords: performance analysis, combat sports, heart rate variability, psychophysiology, personality, decision style.

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INTRODUCTION

In judo the outcome of a contest is frequently determined within seconds. The athlete must perceive the opponent's intention, evaluate several simultaneously available responses under physical load and emotional pressure, and commit to one of them without any possibility of revision. Physical and technical preparation in combat sports has been mapped in considerable detail, and several authors argue that the margin for further improvement along those dimensions is narrowing. By contrast, the dispositional and psychophysiological characteristics that accompany the act of choosing to remain comparatively uncharted, particularly in developing athletes.

Decision making in sport has been approached from ecological (Araújo et al., 2006), cognitive-modelling (Johnson, 2006) and time-pressure (Raab, 2002) perspectives. These frameworks provide a rich descriptive account of the situational and personal factors that accompany effective and ineffective choices, and comparisons of experts with novices have shown that decision differences increase specifically at the level of tactical-contextual adaptation (Berry et al., 2008; Gutiérrez-Díaz del Campo et al., 2011). What is far less clear is whether stable individual dispositions differentiate athletes within a competitive hierarchy, and whether such dispositions have measurable physiological correlates.

Two considerations make this question tractable. The first concerns the choice of dispositional variable. Broad personality domains have a well-documented but modest relationship with sporting performance, conscientiousness being the most consistent predictor (Piepiora, 2024; Zell & Lesick, 2021). A decision-style typology is conceptually closer to the decision act itself. The Myers-Briggs-based framework distinguishes four bipolar dimensions, of which the thinking-feeling dimension contrasts a logical-analytical approach to choice with an affective and value-based approach, and the sensing-intuition dimension contrasts reliance on concrete sensory information with reliance on inferred patterns. Typological classification into sixteen discrete types is psychometrically contested and dichotomising the bipolar dimensions discards within-group variability and treats athletes close to the cut-off as qualitatively different. The present study therefore analyses the dimensions as continuous scores and reports dichotomous comparisons only as secondary, exploratory analyses. It should also be emphasised that such an inventory captures a self-reported preference for approaching choices; it does not measure decision-making performance in actual judo situations.

The second consideration concerns the physiological level of description. According to the neurovisceral integration model, vagally mediated heart rate variability indexes the inhibitory control exerted by prefrontal structures over subcortical circuits and therefore reflects the functional integrity of the network supporting cognitive, affective and autonomic regulation (Schmaußer et al., 2024; Thayer et al., 2009, 2012). Heart rate variability has been directly associated with decision-making performance in healthy adults (Forte et al., 2021) and is increasingly used to guide and monitor training load (Düking et al., 2021; Javaloyes et al., 2019). In Baevsky's two-loop model, which underlies the variational pulsometry approach used in this study, a high regulatory stress index indicates a shift of cardiac control towards the central loop, that is, elevated regulatory tension (Baevsky & Chernikova, 2017). These models are used here to generate hypotheses about how dispositional preferences might relate to resting autonomic state, not to test the underlying mechanisms, which would require measures of executive control, autonomic reactivity and recovery.

A separate but practically important question concerns which psychological characteristics accompany competitive progression. Meta-analytic evidence indicates that pre-event self-efficacy is related to sporting performance, more strongly in elite than in sub-elite athletes (Lochbaum et al., 2023), while comparisons of

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Czech athletes at different levels found that goal setting, self-confidence and commitment differ by level but do not distinguish national from international competitors (Vičar, 2018). Aspiration level, measured behaviourally rather than by questionnaire, offers a less socially desirable index of the same construct.

The variables examined here also differ in temporal stability. Decision-style and personality questionnaire scores are intended to index relatively enduring dispositions; aspiration level reflects both dispositional and situational influences on self-appraisal; resting heart rate and heart rate variability are state-sensitive indices influenced by recent training load, sleep, emotional state and measurement conditions; and competitive level is a concurrent status indicator rather than a future outcome. Associations across these levels are therefore interpreted as concurrent correlates, not as evidence of coherent psychophysiological profiles or of predictive value.

The present exploratory study therefore had three aims: to examine whether decision-style dimensions were associated with age and training experience in a cross-sectional sample of judo athletes; to describe how the dimensions relate to self-report measures and to resting autonomic indices; and to describe which psychological and autonomic characteristics are associated with current competitive level after accounting for age and training experience. It was expected that decision-style dimensions would be weakly related to age and experience, and that thinking orientation and higher aspiration would be associated with higher competitive level. Given the exploratory design, all findings are interpreted as hypothesis-generating. No analysis was designated as confirmatory; *p* values were adjusted for multiple testing, and only effects surviving adjustment are described as robust within this sample.

MATERIAL AND METHODS

Participants

The sample comprised 118 male judo athletes aged 8–22 years (*M* = 13.2, *SD* = 3.7) with 1.0–16 years of training experience (*M* = 5.1, *SD* = 3.3), recruited from one judo club in Yerevan, Armenia, where they trained under five different coaches, and representing the full range of competitive experience from beginners to national-team members (Table 1). The club included athletes from beginner training groups to members of the Armenian national team; testing took place at two locations (see Procedures). Competitive level was assigned on objective competitive results: low level (*n* = 25), no medals or significant competitive achievements; intermediate level (*n* = 51), medals at national or international competitions; high level (*n* = 42), national-team members and athletes who had placed at the European Championship. Twenty-two athletes (18.6%) were national-team members.

Table 1. Characteristics of the sample.

Characteristic	Whole sample (*n* = 118)	8–11 years (*n* = 46)	12–22 years (*n* = 72)
Age, years (*M* ± *SD*)	13.2 ± 3.7	9.7 ± 1.1	15.5 ± 3.0
Training experience, years (*M* ± *SD*)	5.1 ± 3.3	2.9 ± 1.7	6.5 ± 3.5
Low competitive level, *n* (%)	25 (21.2)	14 (30.4)	11 (15.3)
Intermediate competitive level, *n* (%)	51 (43.2)	29 (63.0)	22 (30.6)
Highly competitive level, *n* (%)	42 (35.6)	3 (6.5)	39 (54.2)
National-team member, *n* (%)	22 (18.6)	0 (0.0)	22 (30.6)

Note. All participants were male.

All psychological analyses were restricted to athletes aged 12 years and older (*n* = 72; *M* age = 15.5, *SD* = 3.0; *M* experience = 6.5, *SD* = 3.5 years), because the self-report instruments presuppose formal-operational reasoning, a stable self-concept and the capacity to appraise internal states reflectively, which are systematically established from approximately 12 years of age. Athletes aged 8–11 years (*n* = 46) were included in the description of the sample and in the analysis of age-related change in heart rate variability,

which carries no comparable psychometric constraint. Resting heart rate variability data were available for 97 athletes overall and for 51 athletes of the psychological subsample. Heart rate variability was not recorded for 21 national-team athletes tested at the "Olimpavan" complex, where the recording device was not available during their sessions; autonomic analyses therefore include only one national-team athlete. Aspiration level was not recorded for the 22 national-team athletes (see Procedures), so aspiration analyses are restricted to the 50 non-national-team athletes of the psychological subsample.

Inclusion required active engagement in judo training. Exclusion criteria were acute illness on the day of testing, consumption of caffeine or stimulants before testing, and any chronic condition or medication affecting the cardiovascular or central nervous system.

The study was observational and non-invasive, comprising standardised psychological questionnaires and a five-minute resting electrocardiographic recording; no clinical intervention was involved and no procedure carried physical risk. Data collection was carried out with the permission of the participating sports organisations. All participants and, in the case of participants under 18 years of age, their parents or legal guardians were informed about the nature and purpose of the procedures. Written informed consent was obtained from adult participants; for participants under 18 years, written consent was obtained from a parent or legal guardian together with the athlete's own assent. Recruitment was conducted by the researcher rather than by coaches, participation or refusal had no effect on training or team selection, individual results were not shared with coaches in identifiable form, and participants were identified by code only. Participants were free to withdraw at any time. The study protocol was approved by the Ethics Committee of the Psychologists' Union of Armenia (Certificate No. 10/26/0013). The study was conducted in accordance with the principles of the Declaration of Helsinki and complies with the current laws of the country in which it was performed.

Data on cortical activity during a laboratory decision task, obtained in a subgroup of these athletes, are reported separately and are not analysed here.

Measures

Decision-making style

Decision style was assessed with the Myers-Briggs-based Decision Style Inventory developed by Nutt (1979), a 32-item forced-choice questionnaire yielding a four-letter type and the four underlying bipolar dimensions: extraversion-introversion (E/I), sensing-intuition (S/N), thinking-feeling (T/F) and judging-perceiving (J/P). The Russian-language version adapted by N. B. Filinov-Chernyshev was translated into Armenian and back-translated into Russian, and discrepancies were resolved before administration; the inventory was administered in Armenian. Each dimension is scored by eight items, so the two pole scores sum to eight; the E, N, T and P scores (range 0–8) were used as continuous dimension scores. For secondary dichotomous analyses athletes were classified by the higher pole score, tied scores (4–4) being assigned to the E, N, T and P poles by the inventory key. Ties were frequent (E/I 17, S/N 19, T/F 24 and J/P 8 of 72 athletes), so dichotomous classifications are sensitive to the tie rule, which further motivates the continuous analysis. Because the frequency of individual types fell to one or two observations in several cells, the sixteen types are reported descriptively only; primary analyses used the continuous dimension scores, and comparisons of dichotomised poles are reported as secondary, exploratory analyses. The inventory measures self-reported preference and is not a measure of decision-making performance in judo.

Personality

Personality was measured with the Five-Factor Personality Questionnaire (5PFQ), which assesses five broad domains—extraversion, attachment, self-management, emotional stability and expressiveness—each

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composed of five subcomponents, yielding quantitative indices for twenty-five subfactors in addition to the five principal factors. The Armenian-language version adapted by the Laboratory of Experimental Psychology, Yerevan State University, was used. No published Armenian norms are available, so scores were analysed only as relative values within the sample. Internal consistency in the present sample, computed across the five facet scores of each factor, was α = .65 for extraversion, .73 for attachment, .87 for self-management, .61 for emotional stability and .76 for expressiveness.

Self-perception

Aspiration level was measured with the Schwarzlander motor test, in which the discrepancy between the athlete's predicted and actual performance across consecutive trials yields a quantitative index of aspiration. Because the index is derived from behaviour rather than from self-description, it is less exposed to social desirability than questionnaire measures of the same construct.

Cognitive control

Cognitive control was assessed with the Cognitive Errors in Sport questionnaire, a 27-item instrument yielding four scales. Situationality indicates whether cognitive errors arise predominantly in training (high score) or in competition (low score); awareness indicates difficulty in attending to the present moment, a high score characterising an athlete focused on past or future events; control indicates the level of metacognitive control, a high score reflecting low control; and the total score reflects the overall frequency of errors and, inversely, stress resistance.

Autonomic regulation

Autonomic regulation was assessed by heart rate variability using the Varicard 2.51 system, which implements Baevsky's variational pulsometry. A single 5-minute resting electrocardiographic recording was obtained in a seated position in the morning, before physical training, without orthostatic or active testing. Recording followed 10–15 minutes of seated rest in a quiet room, with spontaneous breathing, approximately 24 hours after the last training session. Respiration rate, sleep, hydration and fasting status were not recorded. Statistical and spectral analysis of the R-R interval series yielded heart rate, the standard deviation of normal-to-normal intervals (SDNN), the coefficient of variation, the stress index (SI), the centralisation index (IC), the relatively high-frequency (HF), low-frequency (LF) and very-low-frequency (VLF) components, and total power (TP). Relative HF is not equivalent to absolute vagally mediated HRV, and TP is a global variability measure; these indices are therefore interpreted as descriptors of resting state rather than as direct measures of regulatory capacity. Absolute HF power (ms^2) was derived as the product of total power and relative HF; RMSSD was not available in the device output.

Procedures

Data were collected at the ASIPCS "Sport EMI" scientific-research centre and the "Olimpavan" sport complex between July 2025 and May 2026. A complete assessment for one athlete took approximately 1–1.5 hours. Testing was conducted in quiet conditions with a fixed procedural order designed to progress from the least to the most demanding task and to prevent the resting autonomic recording from being contaminated by prior load: after instruction and consent the athlete underwent the resting heart rate variability recording, and the session concluded with the battery of psychological questionnaires. All testing was carried out by the same investigator. All athletes were tested within the same period of the season, which for high-level athletes coincided with competition preparation. National-team athletes were assessed during a training camp with limited available time, so the Schwarzlander test could not be administered to them; aspiration data are therefore missing for this entire subgroup for logistical reasons rather than at random.

Analysis

Analyses were carried out in SPSS 26. Distributional normality was checked with the Shapiro-Wilk test and homogeneity of variance with Levene's test. Because group sizes were unequal, all independent-samples *t* tests were computed with Welch's correction for unequal variances. Since *t* tests and analysis of variance are robust to departures from normality at these sample sizes, parametric procedures were retained as primary, but every comparison was verified in parallel with the corresponding non-parametric test (Mann-Whitney *U*, Kruskal-Wallis *H*); where the two disagreed, both are reported and the non-parametric result is given precedence for markedly skewed indices.

The relationship of decision style to competitive level, age group and national-team membership was tested with the chi-square statistic, and differences in age and training experience between the poles of each dimension with independent-samples *t* tests. Multivariate analysis of variance (Wilks' lambda) established which dimensions differentiated blocks of indicators, the blocks being cognitive-error scales, personality factors and autonomic indices. Where a multivariate effect was significant, individual indices were compared with independent-samples *t* tests. Because the J/P dimension was itself related to age and experience, all J/P comparisons were repeated with analysis of covariance using age and training experience as covariates. Associations of psychological indices with age and training experience were assessed with Pearson correlation, and differences between competitive levels with one-way analysis of variance and Tukey post hoc comparisons. The significance threshold was $p < .05$ and effect sizes were expressed as Cohen's *d*, interpreted as small (0.2), medium (0.5) and large (0.8).

To address multiplicity, *p* values were adjusted with the Benjamini-Hochberg false-discovery-rate (FDR) procedure within seven families of tests: continuous decision-style scores in relation to age, experience, competitive level and national-team membership (16 tests); continuous scores in relation to psychological indices (48) and to autonomic indices (24); cognitive-error comparisons (12); autonomic comparisons (20); partial correlations with age and experience (24); and competitive-level comparisons (18). Adjusted and unadjusted values are reported together, and effects that did not survive adjustment are labelled exploratory. Continuous decision-style scores were related to other variables with Spearman correlations and, for national-team membership, Mann-Whitney tests with rank-biserial correlations and logistic regression adjusted for age and experience. Associations of psychological indices with age and training experience were examined with partial correlations, each controlling for the other variable. Associations with competitive level were examined with ordinal logistic regression of level on the standardised index, with and without age and training experience as covariates, and are expressed as odds ratios per standard deviation. For the sensing-intuition comparison, medians and interquartile ranges, bootstrap 95% confidence intervals (10,000 resamples), Hedges' *g*, a log-transformed analysis and a leave-one-out sensitivity analysis are reported. Because the relative HF, LF and VLF components sum to 100% and several indices overlap, the multivariate autonomic analysis was restricted to five indices (heart rate, ln SDNN, ln TP, HF % and ln SI); Box's *M* and partial eta squared are reported. Additional analyses were run in Python (SciPy 1.x, statsmodels). Because all athletes came from one club, clustering by organisation did not apply; clustering by coach (five coaches) was not modelled.

RESULTS

Distribution of decision-making styles

Thirteen of the sixteen possible types were represented in the psychological subsample. The distribution was markedly uneven: the three most frequent styles, corresponding to the INTJ (23.6%), ENTJ (15.3%) and INFJ (15.3%) types, together accounted for more than half of the subsample, while several styles were represented

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by a single athlete. This unevenness precluded direct statistical comparison of the sixteen styles and motivated the use of the four bipolar dimensions as the unit of analysis.

Introverted (62.5%), intuitive (77.8%), thinking (62.5%) and judging (76.4%) orientations predominated. Descriptive statistics for all psychological indices are given in Table 2.

Table 2. Descriptive statistics for psychological indices (n = 72).

Index	*M*	*SD*	*Mdn*	Min	Max	Shapiro-Wilk *p*
Cognitive errors						
Situationality (total)	14.1	4.4	13	6	23	< .001
Situationality (subscale 1)	6.3	2.3	6	2	11	.001
Situationality (subscale 2)	7.8	2.9	7	3	16	.005
Awareness	13.6	3.3	13	8	22	.007
Control	10.9	4.3	11	2	21	.016
Cognitive errors (total)	38.6	9.7	36	23	62	< .001
Personality factors (5PFQ)						
Extraversion	49.2	8.6	49.5	30	69	.704
Attachment	48.9	8.4	49.5	22	68	.152
Self-management	49.8	11.7	52	19	70	.031
Emotional stability	38.8	6.4	37.5	28	57	.004
Expressiveness	47.8	9.9	49.5	27	63	.008
Self-perception						
Aspiration level	84.6	16.7	89.3	38.6	100	< .001

Note. A high score on the cognitive-error scales denotes more frequent errors or poorer control.

Decision style, age and competitive level

Decision style was largely independent of age and training experience (Table 3). For the E/I, S/N and T/F dimensions no significant association was found with age group, chronological age or training experience. In this cross-sectional sample, therefore, these dimensions were not associated with maturation or accumulated experience; whether they are stable within individuals cannot be determined from the present design. Continuous dimension scores were likewise unrelated to age and training experience (all $|\rho| \leq .22$, all $p \geq .067$; Table 3).

Table 3. Continuous decision-style scores in relation to age, training experience and competitive status, and multivariate effects of the dichotomised dimensions on blocks of indicators (n = 72; autonomic block n = 51).

Dimension (score)	Tied scores, *n*	Age ρ (*p*; *p*FDR)	Experience ρ (*p*; *p*FDR)	Competitive level ρ (*p*; *p*FDR)	National team r_{rb} (*p*; *p*FDR)	MANOVA		
						Cognitive errors Λ (*p*)	Personality Λ (*p*)	Autonomic Λ (*p*)
Extraversion / Introversion (E/I)	17	.08 (.512; .683)	-.02 (.841; .935)	.00 (.972; .972)	-.12 (.415; .604)	0.851 (.027); η_p^2 = .15	0.948 (.613); η_p^2 = .05	0.943 (.738); η_p^2 = .06
Sensing / Intuition (S/N)	19	-.10 (.389; .604)	-.13 (.269; .538)	-.39 (< .001; .010)	-.26 (.079; .314)	0.893 (.104); η_p^2 = .11	0.877 (.114); η_p^2 = .12	0.730 (.012); η_p^2 = .27
Thinking / Feeling (T/F)	24	.18 (.125; .333)	.16 (.188; .430)	-.02 (.860; .935)	.34 (.019; .155)	0.970 (.722); η_p^2 = .03	0.959 (.731); η_p^2 = .04	0.856 (.205); η_p^2 = .14
Judging / Perceiving (J/P)	8	.22 (.067; .314)	.20 (.100; .320)	-.02 (.876; .935)	.14 (.329; .586)	0.837 (.017); η_p^2 = .16	0.893 (.176); η_p^2 = .11	0.966 (.900); η_p^2 = .03

Note. Continuous scores: E, N, T and P scores *(0–8).* ρ = *Spearman correlation;* r_{rb} = *rank-biserial correlation (positive = higher score in national-team members). pFDR = Benjamini-Hochberg adjusted p within the 16 tests of this table.* Λ = *Wilks' lambda;* η_p^2 = *partial eta squared. Cognitive-error block: Situationality subscales 1 and 2, awareness, control. Autonomic block: heart rate, ln SDNN, ln TP, HF (%), ln SI. Tied scores were classified as E, N, T and P by the inventory key.*

Continuous S/N scores were associated with competitive level: higher-level athletes had lower intuition, that is more sensing, scores (mean N score 5.5, 4.9 and 4.0 at the low, intermediate and high levels; $\rho = -.39$, $p < .001$, FDR-adjusted $p = .010$), and the association remained after adjustment for age and experience (OR = 0.38 per *SD*, 95% CI 0.20–0.71, $p = .002$). In the dichotomous analysis, 13 of the 16 sensing-oriented athletes were at the high level, $\chi^2(2, N = 72) = 6.87$, $p = .032$. The T/F dimension was related to national-team membership in the dichotomous analysis, $\chi^2(1, N = 72) = 3.93$, $p = .048$: 18 of 22 national-team athletes

(81.8%) had a thinking orientation, against 54.0% among club athletes. However, 24 of the 45 athletes classified as thinking had tied T and F scores; when ties were assigned to the feeling pole, the association disappeared (Fisher p = .408). Continuous T scores were higher in national-team members (4.6 ± 1.4 vs 3.7 ± 1.2; rank-biserial r = .34, p = .019), but this did not survive FDR correction (p = .155) or adjustment for age and experience (OR = 1.65 per point, 95% CI 0.96–2.85, p = .072). This association is therefore not robust and is treated as exploratory.

The only dimension related to maturation was J/P: perceiving-oriented athletes were older (17.1 ± 3.2 vs 15.0 ± 2.7 years, t = −2.71, p = .008) and more experienced (7.9 ± 4.0 vs 6.0 ± 3.2 years, t = −2.06, p = .043). All J/P comparisons were therefore repeated with age and experience as covariates.

Multivariate analyses of the dichotomised dimensions showed different patterns (Table 3). The cognitive-error block (Situationality subscales, awareness and control) was differentiated by E/I (Wilks' Λ = 0.851, F(4, 67) = 2.93, p = .027, partial η^2 = .15) and J/P (Λ = 0.837, F(4, 67) = 3.25, p = .017, partial η^2 = .16). In the reduced autonomic block, S/N was the only dimension with a multivariate effect (Λ = 0.730, F(5, 45) = 3.32, p = .012, partial η^2 = .27; Box's M p = .776), the other dimensions being non-significant (all $p \geq .205$). The personality block was differentiated by none of the dimensions (all $p \geq .114$), and T/F produced no multivariate effect on any block.

Decision style and cognitive errors

Extraverted athletes scored significantly higher than introverted athletes on the first Situationality subscale (7.26 ± 2.47 vs 5.71 ± 1.96, t = 2.77, p = .008, d = 0.71), on awareness (14.67 ± 3.54 vs 12.91 ± 3.00, t = 2.15, p = .036, d = 0.55) and on the total cognitive-error score (41.70 ± 10.11 vs 36.71 ± 9.13, t = 2.10, p = .040, d = 0.53), all three confirmed non-parametrically (Table 4). Because a high awareness score denotes difficulty in attending to the present moment, this pattern indicates that extraverted athletes more frequently encounter errors of attentional disengagement. The difference survived control for age and experience, analysis of covariance for the first Situationality subscale yielding p = .012. After FDR correction, only the first Situationality subscale remained significant (p = .035; awareness and total score p = .061).

Table 4. Cognitive-error scales at the poles of the extraversion-introversion and judging-perceiving dimensions (n = 72).

Scale	Extravert (n = 27)	Introvert (n = 45)	t	p	pFDR	d	
Situationality (total)	15.11 ± 4.73	13.47 ± 4.13	1.5	.141	.154	.38	
Situationality (subscale 1)	7.26 ± 2.47	5.71 ± 1.96	2.77	.008	.035	.71	
Situationality (subscale 2)	7.85 ± 2.94	7.76 ± 2.92	0.13	.893	.893	.03	
Awareness	14.67 ± 3.54	12.91 ± 3.00	2.15	.036	.061	.55	
Control	11.93 ± 4.21	10.33 ± 4.27	1.55	.128	.153	.38	
Cognitive errors (total)	41.70 ± 10.11	36.71 ± 9.13	2.1	.040	.061	.53	
Scale	**Judging (n = 55)**	**Perceiving (n = 17)**	t	p	pFDR	d	p (ANCOVA)
Situationality (total)	13.15 ± 3.78	17.12 ± 5.02	−3.01	.006	.035	−.97	.002
Situationality (subscale 1)	5.91 ± 2.08	7.53 ± 2.50	−2.42	.024	.049	−.74	.051
Situationality (subscale 2)	7.24 ± 2.45	9.59 ± 3.59	−2.53	.020	.049	−.85	.001
Awareness	13.20 ± 3.29	14.76 ± 3.13	−1.78	.086	.115	−.48	.464
Control	10.20 ± 3.87	13.29 ± 4.83	−2.41	.024	.049	−.75	.032
Cognitive errors (total)	36.55 ± 8.26	45.18 ± 11.42	−2.89	.009	.035	−.95	.007

Note. Values are M ± SD. Welch t test. pFDR = Benjamini-Hochberg adjusted p across the 12 tests of this table. ANCOVA covariates: age and training experience.

The J/P dimension produced the largest effects in this domain. Perceiving-oriented athletes had a substantially higher total cognitive-error score than judging-oriented athletes (45.18 ± 11.42 vs 36.55 ± 8.26, t = −2.89, p = .009, d = −0.95), with differences in the same direction on both situationality subscales and on the control scale. Analysis of covariance showed that these differences are not age artefacts: total situationality (p = .002), the second situationality subscale (p = .001), control (p = .032) and the total score (p = .007) all remained significant after adjustment for age and experience. The single exception was

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awareness, for which the effect disappeared after adjustment (p = .464) while the effect of age became significant (p < .001); that particular difference is therefore developmental rather than stylistic. All four J/P differences that were significant before correction remained significant after FDR correction (p = .035–.049).

Decision style and autonomic regulation

The S/N dimension was the only one to produce a significant multivariate effect on the autonomic block (Table 5). The largest difference concerned total spectral power, which was more than twice as high in intuitive as in sensing athletes (3272.0 ± 2252.9 vs 1456.3 ± 801.4 ms squared, t = 4.14, p < .001, d = 0.87). The relatively high-frequency component (38.8 ± 12.4 vs 30.4 ± 9.9%, p = .045, d = 0.70) and heart rate (84.4 ± 10.7 vs 94.7 ± 10.4 beats per minute, p = .020, d = −0.97) differed in the same direction. Because these comparisons rest on only nine sensing athletes, a single resting recording and highly unequal groups, they are reported as preliminary. Median total power was 3064 ms² (IQR 1751–4154) in intuitive and 1980 ms² (IQR 807–2095) in sensing athletes (Mann-Whitney p = .004). The mean difference was 1816 ms² (bootstrap 95% CI 1020–2650; Hedges' g = 0.86, 95% CI 0.56–1.33), and it remained significant after FDR correction (p = .002), after log transformation (p = .010), after adjustment for age and experience (p = .002) and in every leave-one-out analysis (maximum p < .001). Derived absolute HF power showed the same pattern (1223 ± 817 vs 460 ± 314 ms², FDR-adjusted p = .001), whereas the differences in heart rate (p = .098) and relative HF (p = .179) did not survive FDR correction (Table 5, Figure 1). However, continuous intuition scores were not correlated with total power (ρ = .11, p = .455; Table S1), indicating that the difference was concentrated in the nine athletes with a clear sensing preference rather than forming a gradient along the dimension.

Table 5. Resting autonomic indices at the poles of the sensing-intuition and thinking-feeling dimensions (n = 51).

Index	Pole A *M* ± *SD*	Pole A *Mdn* [IQR]	Pole B *M* ± *SD*	Pole B *Mdn* [IQR]	*t*	*p*	*p*FDR	*d*	*U*-test *p*
Sensing-intuition (S/N): Intuitive (*n* = 42) vs Sensing (*n* = 9)									
Heart rate (beats/min)	84 ± 11	84 [75–93]	95 ± 10	93 [85–95]	−2.69	.020	.098	−.97	.026
SDNN (ms)	58.6 ± 24.3	55.2 [37.8–73.3]	48.0 ± 20.9	40.4 [36.6–57.3]	1.34	.204	.374	.45	.203
Coefficient of variation (%)	7.9 ± 2.7	7.7 [5.8–9.8]	7.5 ± 3.2	5.7 [5.4–8.1]	0.43	.674	.842	.18	.317
Stress index, SI	127 ± 165	70 [32–178]	267 ± 300	158 [73–357]	−1.36	.206	.374	−.73	.159
Centralisation index, IC	1.9 ± 1.1	1.6 [1.1–2.4]	2.7 ± 1.4	2.2 [1.6–3.3]	−1.6	.140	.374	−.71	.071
HF (%)	38.8 ± 12.4	39.0 [30.2–46.6]	30.4 ± 9.9	31.3 [23.5–39.1]	2.2	.045	.179	.70	.066
LF (%)	44.2 ± 10.6	44.3 [36.6–51.2]	47.5 ± 9.4	49.4 [39.5–54.9]	−0.94	.367	.598	−.32	.505
VLF (%)	17.0 ± 7.3	16.6 [11.2–21.1]	22.1 ± 9.5	21.4 [16.2–22.0]	−1.51	.162	.374	−.66	.122
Total power, TP (ms²)	3272 ± 2253	3064 [1751–4154]	1456 ± 801	1980 [807–2095]	4.14	< .001	.002	.87	.004
HF, absolute (ms², derived)	1223 ± 817	992 [617–1637]	460 ± 314	463 [162–774]	4.66	< .001	< .001	1.01	.003
Thinking-feeling (T/F): Feeling (*n* = 23) vs Thinking (*n* = 28)									
Heart rate (beats/min)	91 ± 11	93 [84–96]	83 ± 10	83 [75–92]	2.61	.012	.083	.74	.016
SDNN (ms)	51.9 ± 26.0	48.0 [35.8–60.5]	60.7 ± 21.7	61.3 [42.3–76.4]	−1.29	.203	.374	−.37	.066
Coefficient of variation (%)	7.5 ± 3.0	6.7 [5.5–8.4]	8.2 ± 2.6	8.1 [6.0–10.0]	−0.82	.418	.598	−.23	.145
Stress index, SI	215 ± 265	117 [34–266]	99 ± 100	56 [32–103]	1.99	.057	.189	.60	.222
Centralisation index, IC	2.0 ± 1.3	1.9 [1.1–2.4]	2.1 ± 1.1	1.6 [1.4–2.3]	−0.15	.884	.926	−.04	.762
HF (%)	38.6 ± 14.4	34.2 [29.6–47.8]	36.3 ± 10.5	38.2 [30.4–42.5]	0.64	.524	.698	.19	.726
LF (%)	43.4 ± 11.1	44.9 [35.5–51.7]	45.9 ± 9.9	44.3 [40.1–52.1]	−0.85	.400	.598	−.24	.538
VLF (%)	18.0 ± 7.4	17.6 [13.0–21.6]	17.8 ± 8.4	17.0 [11.3–21.2]	0.09	.926	.926	.03	.726
Total power, TP (ms²)	2837 ± 2587	2193 [1202–3318]	3046 ± 1825	2868 [1679–4282]	−0.33	.746	.857	−.09	.349
HF, absolute (ms², derived)	1052 ± 815	873 [409–1414]	1118 ± 813	815 [598–1340]	−0.29	.772	.857	−.08	.842

*Note. Pole A / Pole B as in section headers. Welch t test. pFDR = Benjamini-Hochberg adjusted p across the 20 tests of this table. Absolute HF = TP × HF(%)/100. Sensitivity analyses for TP (*S/N*): mean difference 1816 ms², bootstrap 95% CI 1020 to 2650; Hedges g = 0.86 (95% CI 0.56 to 1.33); ln-transformed t test p = .010; leave-one-out p range < .001 to < .001; adjusted for age and experience p = .002. Continuous* N score *vs TP:* ρ = *.11, p = .455.*

At the psychological level the picture is inverted. Sensing-oriented athletes rated themselves as more emotionally stable (42.2 ± 6.1 vs 37.9 ± 6.1, p = .021, d = −0.70) and had a markedly higher aspiration level (94.1 ± 9.2 vs 82.6 ± 17.3, p = .010, d = −0.71). Continuous intuition scores correlated negatively with emotional stability (ρ = −.27, p = .020), but this did not survive FDR correction (p = .168; Table S2). Sensing-oriented athletes thus combined higher self-rated stability and aspiration with lower resting total power. This

apparent discrepancy between self-appraisal and resting autonomic state is presented as a hypothesis for replication rather than as an established profile.

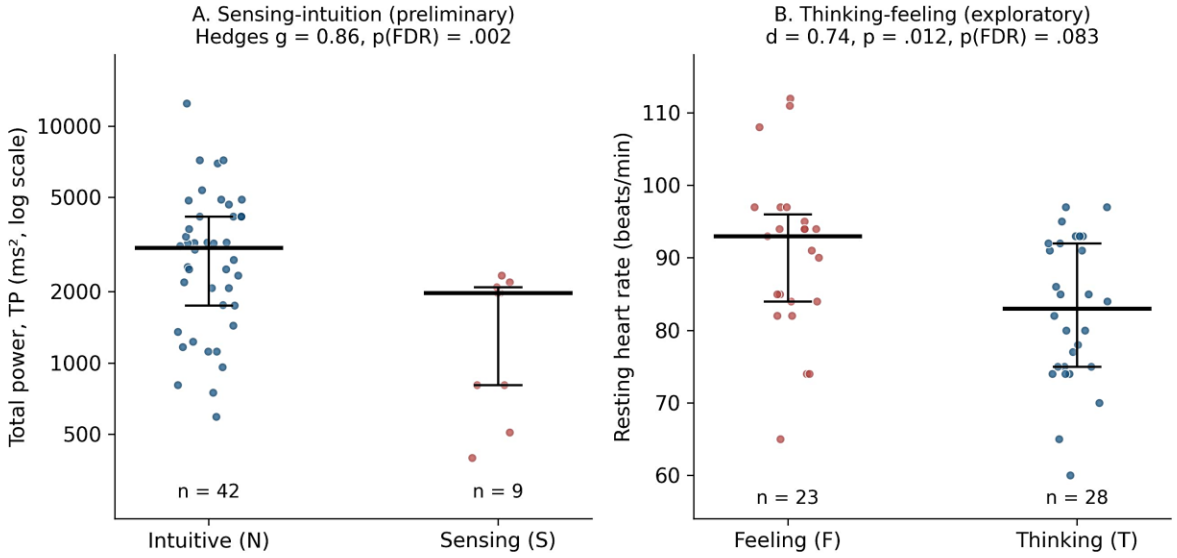

Figure 1. Resting total spectral power in sensing- and intuition-oriented judo athletes.

Table S1. Spearman correlations of continuous decision-style scores with resting autonomic indices (*n* = 51).

Score	Index	*n*	ρ	*p*	*p*FDR
E score	Heart rate	51	.04	.769	.769
E score	SDNN	51	-.08	.586	.740
E score	Stress index	51	-.09	.552	.740
E score	HF (%)	51	-.18	.197	.676
E score	Total power	51	-.13	.382	.740
E score	HF (ms², derived)	51	-.15	.297	.740
N score	Heart rate	51	-.11	.459	.740
N score	SDNN	51	.17	.240	.721
N score	Stress index	51	-.09	.547	.740
N score	HF (%)	51	.31	.029	.485
N score	Total power	51	.11	.455	.740
N score	HF (ms², derived)	51	.19	.171	.676
T score	Heart rate	51	-.29	.040	.485
T score	SDNN	51	.21	.147	.676
T score	Stress index	51	-.13	.352	.740
T score	HF (%)	51	-.10	.476	.740
T score	Total power	51	.05	.734	.766
T score	HF (ms², derived)	51	-.06	.666	.748
P score	Heart rate	51	.07	.601	.740
P score	SDNN	51	-.11	.439	.740
P score	Stress index	51	-.06	.686	.748
P score	HF (%)	51	-.07	.617	.740
P score	Total power	51	.21	.144	.676
P score	HF (ms², derived)	51	.19	.176	.676

Note. pFDR = Benjamini-Hochberg adjusted p across the 24 tests.

The T/F dimension, which showed no multivariate effect on self-report measures, was associated with a difference in resting heart rate. Among the 51 athletes with autonomic data (thinking, *n* = 28; feeling, *n* = 23), feeling-oriented athletes had a significantly higher resting heart rate than thinking-oriented athletes (90.5 ± 11.4 vs 82.6 ± 10.0 beats per minute, *t* = 2.61, *p* = .012, *d* = 0.74), confirmed non-parametrically (*p* = .016). The stress index differed in the same direction (215.4 ± 265.0 vs 99.1 ± 100.3, *t* = 1.99, *p* = .057, *d* = 0.60); given the extreme positive skew of this index and the discrepant non-parametric result (*p* = .222), this

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difference is reported as a trend rather than as an established effect. The heart rate difference did not survive FDR correction (p = .083), although it persisted after adjustment for age and experience (p = .014); continuous T scores showed a weak negative correlation with heart rate (ρ = −.29, p = .040, FDR-adjusted p = .485). The T/F finding is therefore exploratory.

Table S2. Spearman correlations of continuous decision-style scores with psychological indices (n = 72; aspiration n = 50).

Score	Index	*n*	ρ	*p*	*p*FDR
E score	Situationality (total)	72	.21	.084	.334
E score	Situationality (subscale 1)	72	.30	.012	.145
E score	Situationality (subscale 2)	72	.07	.554	.834
E score	Awareness	72	.19	.108	.369
E score	Control	72	.26	.025	.168
E score	Cognitive errors (total)	72	.29	.012	.145
E score	Extraversion	72	.01	.964	.965
E score	Attachment	72	-.16	.178	.495
E score	Self-management	72	-.08	.527	.834
E score	Emotional stability	72	-.08	.483	.834
E score	Expressiveness	72	-.07	.556	.834
E score	Aspiration level	50	-.07	.648	.900
N score	Situationality (total)	72	-.16	.176	.495
N score	Situationality (subscale 1)	72	-.24	.046	.221
N score	Situationality (subscale 2)	72	-.11	.364	.797
N score	Awareness	72	-.05	.657	.900
N score	Control	72	-.26	.025	.168
N score	Cognitive errors (total)	72	-.23	.053	.229
N score	Extraversion	72	.08	.507	.834
N score	Attachment	72	.08	.486	.834
N score	Self-management	72	-.03	.775	.954
N score	Emotional stability	72	-.27	.020	.168
N score	Expressiveness	72	.05	.695	.912
N score	Aspiration level	50	-.13	.360	.797
T score	Situationality (total)	72	.02	.884	.965
T score	Situationality (subscale 1)	72	.06	.624	.900
T score	Situationality (subscale 2)	72	-.02	.890	.965
T score	Awareness	72	.09	.442	.834
T score	Control	72	-.02	.858	.965
T score	Cognitive errors (total)	72	.01	.950	.965
T score	Extraversion	72	.05	.703	.912
T score	Attachment	72	.02	.869	.965
T score	Self-management	72	.14	.244	.615
T score	Emotional stability	72	-.08	.499	.834
T score	Expressiveness	72	.01	.959	.965
T score	Aspiration level	50	-.24	.097	.359
P score	Situationality (total)	72	.35	.003	.141
P score	Situationality (subscale 1)	72	.25	.031	.168
P score	Situationality (subscale 2)	72	.30	.012	.145
P score	Awareness	72	.11	.365	.797
P score	Control	72	.18	.126	.404
P score	Cognitive errors (total)	72	.25	.031	.168
P score	Extraversion	72	.01	.965	.965
P score	Attachment	72	.04	.745	.941
P score	Self-management	72	.10	.420	.834
P score	Emotional stability	72	.16	.186	.495
P score	Expressiveness	72	-.08	.501	.834
P score	Aspiration level	50	.01	.920	.965

Note. pFDR = Benjamini-Hochberg adjusted p across the 48 tests.

This effect was specific rather than global. None of the remaining seven autonomic indices differed significantly between the poles of the T/F dimension: SDNN (51.9 ± 26.0 vs 60.7 ± 21.7 ms, p = .203, d = −0.37), the coefficient of variation (p = .418), the centralisation index (p = .884), the relative high-frequency (p = .524), low-frequency (p = .400) and very-low-frequency (p = .926) components, and total power (2837.0 ± 2586.7 vs 3045.8 ± 1824.8 ms squared, p = .746). Only SDNN showed a weak tendency in the expected direction on the non-parametric test (p = .066). The T/F difference was therefore limited to resting heart rate and did not extend to heart rate variability indices.

A control analysis across all athletes with autonomic data (n = 97) indicated that heart rate variability indices were largely unrelated to age in this sample, making maturation an unlikely explanation for the style-related differences, although age was not formally controlled in those comparisons. Eight of nine heart rate variability indices did not differ between the 8–11, 12–14 and 15–22 year age groups. The single significant difference concerned the relatively low-frequency component, which increased with age from 39.3 ± 9.1% to 44.7 ± 9.8% and 44.8 ± 11.4% (F = 3.66, p = .029), consistent with the maturation of sympathetic and baroreflex regulation. Total power, SDNN, the stress index and the parasympathetic component showed no age-related change, closely reproducing the pattern reported in large developmental samples in which supine parasympathetic indices are practically independent of age while the low-frequency to high-frequency relationship increases (Harteveld et al., 2021; Helánová et al., 2024).

Dissociation of age and training experience

Bivariate correlations showed different patterns for chronological age and accumulated training experience (Table 6). All cognitive-error scales correlated positively with age - awareness r = .43, p < .001; total score r = .32, p = .006; first situationality subscale r = .32, p = .007; control r = .26, p = .025 - but none correlated with training experience. The reverse held for personality: self-management showed its strongest association with training experience (r = .46, p < .001) rather than with age, and attachment (r = .26, p = .030) and extraversion (r = .25, p = .035) likewise correlated with experience alone. Aspiration level correlated with experience (r = .30, p = .032) but not with age (r = .03, p = .863). Because age and training experience are themselves correlated, these bivariate associations do not isolate independent contributions. Age and experience correlated strongly (r = .71). When both were entered together, awareness (partial r = .41), total cognitive errors (.34), the first situationality subscale (.31) and control (.30) remained associated with age (FDR-adjusted p = .006–.041) but not with experience, while self-management (partial r = .43), aspiration level (.36) and attachment (.32) remained associated with experience (FDR-adjusted p = .005–.041) but not with age. Extraversion did not survive adjustment (partial r = .22, p = .072; Table 6).

Table 6. Bivariate and partial correlations of psychological indices with age and training experience (n = 72; aspiration n = 50).

Index	*n*	*r* (age)	*p*	*r* (experience)	*p*		
Situationality (total)	72	.13	.266	.03	.805		
Situationality (subscale 1)	72	.32	.007	.15	.222		
Situationality (subscale 2)	72	-.05	.696	-.07	.564		
Awareness	72	.43	< .001	.20	.085		
Control	72	.26	.025	.08	.514		
Cognitive errors (total)	72	.32	.006	.12	.327		
Extraversion	72	.14	.248	.25	.035		
Attachment	72	.04	.723	.26	.030		
Self-management	72	.24	.046	.46	< .001		
Emotional stability	72	.13	.271	.14	.228		
Expressiveness	72	-.15	.201	.05	.693		
Aspiration level	50	.03	.863	.30	.032		
Index	***n***	**partial *r* (age | experience)**	***p***	***p*FDR**	**partial *r* (experience | age)**	***p***	***p*FDR**
Situationality (total)	72	.16	.188	.301	-.09	.449	.567
Situationality (subscale 1)	72	.31	.010	.041	-.12	.335	.447
Situationality (subscale 2)	72	.00	.983	.983	-.05	.674	.735
Awareness	72	.41	< .001	.006	-.15	.215	.323
Control	72	.30	.012	.041	-.16	.185	.301
Cognitive errors (total)	72	.34	.004	.031	-.16	.176	.301
Extraversion	72	-.05	.653	.735	.22	.072	.172
Attachment	72	-.20	.092	.200	.32	.007	.040
Self-management	72	-.14	.235	.332	.43	< .001	.005
Emotional stability	72	.04	.724	.755	.07	.546	.656
Expressiveness	72	-.26	.027	.081	.22	.064	.170
Aspiration level	50	-.20	.171	.301	.36	.012	.041

Note. Partial correlations control for the other variable (age and experience correlate r = .71). pFDR = Benjamini-Hochberg adjusted p across the 24 partial-correlation tests.

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Competitive level

Among athletes for whom it was recorded (non-national-team athletes, n = 50), aspiration level differed across competitive levels (F(2, 47) = 17.73, p < .001, η^2 = .43), all three Tukey pairwise comparisons being significant: low versus intermediate (p = .001), intermediate versus high (p = .024) and low versus high (p < .001). Means increased consistently from 66.5 ± 19.2 at the low level (n = 11) to 84.8 ± 12.0 at the intermediate level (n = 22) and 96.2 ± 8.2 at the high level (n = 17), as shown in Figure 2 and Table 7. Because aspiration was not recorded for the 22 national-team athletes, the high-level group for this variable comprised high-level club athletes only, and the result does not extend to the full competitive hierarchy. Mean differences were 18.3 points (low vs intermediate, 95% CI 6.8–29.8), 11.4 (intermediate vs high, 1.3–21.5) and 29.7 (low vs high, 17.6–41.8). The association persisted after adjustment for age and experience (ANCOVA F(2, 45) = 13.42, p < .001; ordinal regression OR = 5.37 per SD, 95% CI 2.22–13.00, FDR-adjusted p = .004). Nine of the 17 high-level athletes reached the maximum score of 100, indicating a ceiling effect.

Table 7. Psychological and autonomic indices by competitive level, unadjusted and adjusted for age and training experience (n = 72 unless stated).

Index	Low *M*	Intermediate *M*	High *M*	*F*	*p*
Situationality (total)	17.5	13.3	13.5	4.41	.016
Situationality (subscale 1)	8.3	5.5	6.2	6.55	.002
Situationality (subscale 2)	9.3	7.9	7.3	1.97	.148
Awareness	14.8	12.0	14.1	3.88	.025
Control	12.2	10.0	11.1	1.08	.344
Cognitive errors (total)	44.5	35.3	38.7	3.53	.035
Extraversion	44.3	48.5	51.1	2.94	.059
Attachment	42.3	49.8	50.3	4.5	.015
Self-management	44.3	47.6	52.7	2.96	.059
Emotional stability	39.4	35.8	40.4	3.97	.023
Expressiveness	38.4	51.3	48.5	7.64	.001
Aspiration level (n = 11/22/17; non-national-team athletes only)	66.5	84.8	96.2	17.73	< .001
Heart rate (n = 51)	85.4	84.3	89.0	0.9	.411
SDNN (n = 51)	57.2	60.4	52.0	0.6	.552
Stress index, SI (n = 51)	41.2	147.8	223.6	3.11	.054
HF % (n = 51)	35.9	40.2	34.7	1.09	.343
Total power (n = 51)	3009.4	3218.9	2589.6	0.41	.668
HF absolute (n = 51)	1037.1	1247.4	924.9	0.81	.449

Index	*p*FDR	η^2	Kruskal-Wallis *p*	Adjusted OR per *SD* [95% CI]	*p* (adjusted)	*p*FDR (adjusted)
Situationality (total)	.057	.11	.026	0.53 [0.31–0.90]	.020	.144
Situationality (subscale 1)	.015	.16	.008	0.54 [0.32–0.92]	.024	.144
Situationality (subscale 2)	.222	.05	.148	0.60 [0.35–1.03]	.062	.224
Awareness	.065	.10	.023	0.99 [0.56–1.76]	.973	.973
Control	.443	.03	.101	0.94 [0.56–1.57]	.808	.855
Cognitive errors (total)	.078	.09	.009	0.72 [0.42–1.23]	.227	.340
Extraversion	.097	.08	.055	1.45 [0.83–2.52]	.190	.340
Attachment	.057	.12	.043	1.45 [0.87–2.44]	.157	.340
Self-management	.097	.08	.023	1.09 [0.62–1.93]	.767	.855
Emotional stability	.065	.10	.008	1.44 [0.82–2.53]	.201	.340
Expressiveness	.009	.18	.005	1.59 [0.93–2.72]	.091	.272
Aspiration level (n = 11/22/17; non-national-team athletes only)	< .001	.43	< .001	5.37 [2.22–13.00]	< .001	.004
Heart rate (n = 51)	.494	.04	.358	1.49 [0.85–2.61]	.159	.340
SDNN (n = 51)	.584	.02	.208	0.70 [0.40–1.23]	.213	.340
Stress index, SI (n = 51)	.097	.11	< .001	2.22 [1.07–4.62]	.033	.149
HF % (n = 51)	.443	.04	.364	0.91 [0.54–1.55]	.736	.855
Total power (n = 51)	.668	.02	.173	0.79 [0.46–1.35]	.385	.534
HF absolute (n = 51)	.505	.03	.198	0.83 [0.48–1.42]	.490	.630

Note. Adjusted OR *from ordinal logistic regression of competitive level (low < intermediate < high) on the standardised index, age and training experience. pFDR = Benjamini-Hochberg adjusted p across the 18 indices. Aspiration level was not recorded for the 22 national-team athletes; Tukey 95% CIs for aspiration differences: low-intermediate 18.3 (6.8–29.8), intermediate-high 11.4 (1.3–21.5), low-high 29.7 (17.6–41.8).*

Among personality factors the largest difference concerned expressiveness (F = 7.64, p = .001), which was substantially lower in low-level athletes (38.4 ± 10.7) than in intermediate (51.3 ± 8.9, p < .001) and high-

level athletes (48.5 ± 8.7, p = .005), with no difference between the latter two (p = .481). Attachment showed the same pattern (F = 4.50, p = .015; low versus intermediate p = .035, low versus high p = .012, intermediate versus high p = .966). In the domain of cognitive errors, low-level athletes had the highest situationality (8.3 ± 2.6 vs 5.5 ± 2.2 and 6.2 ± 1.9, F = 6.55, p = .002) and the highest total error score (44.5 ± 9.6, F = 3.53, p = .035; low versus intermediate p = .026). Both personality effects therefore reflect a difference between the lowest level and the two higher levels rather than a gradient across all three, which further distinguishes them from aspiration level. After FDR correction, expressiveness (p = .009) and the first situationality subscale (p = .015) remained significant, but none of the personality or cognitive-error differences remained significant after adjustment for age and experience (all FDR-adjusted $p \geq .144$; Table 7).

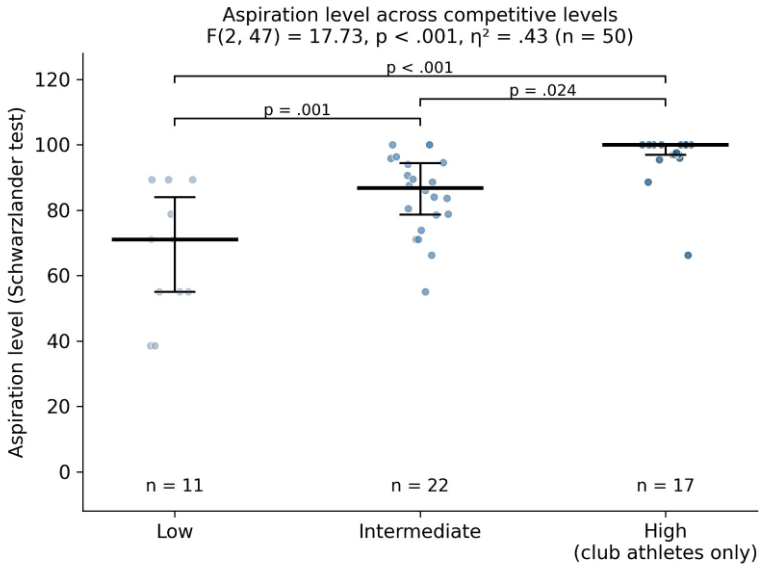

Figure 2. Aspiration level across competitive levels in non-national-team judo athletes.

Self-management and extraversion showed a consistent upward trend across levels that reached significance only in the non-parametric test for self-management (Kruskal-Wallis p = .023).

Among autonomic indices the stress index deserves particular attention. Analysis of variance gave a borderline result (p = .054) while the non-parametric test was strongly significant (p < .001); given the extreme asymmetry of the distribution the non-parametric result is taken as the basis. Importantly, the direction of the effect ran counter to the initial hypothesis: the stress index increased consistently with competitive level, from 41.2 ± 56.7 at the low level to 147.8 ± 201.4 at the intermediate level and 223.6 ± 227.0 at the high level, the only significant pairwise contrast being low versus high (p = .042). Competitive level was strongly related to age and training experience (Table 1), so the competitive-level comparisons in this section are unadjusted. After adjustment, a higher stress index remained associated with higher competitive level (OR = 2.22 per *SD*, 95% CI 1.07–4.63, p = .033), but this did not survive FDR correction (p = .149).

DISCUSSION

This exploratory study yielded four observations that may guide future work: continuous decision-style scores were not associated with age or experience in this cross-sectional sample; the dimensions showed heterogeneous associations with self-report and resting cardiovascular measures, only some of which

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survived correction for multiple testing; sensing-oriented preference was more frequent at higher competitive levels; and, among non-national-team athletes, behaviourally measured aspiration level differed across competitive levels independently of age and experience. None of these findings establishes temporal stability, mechanism or predictive value.

The finding that E/I, S/N and T/F are unrelated to age and training experience is consistent with, but does not demonstrate, a dispositional reading of decision style; within-person stability can only be tested by repeated assessment of the same athletes. The finding contrasts with developmental data on sport decision making, which show that expert-novice differences narrow at the level of skill selection but widen at the level of tactical-contextual adaptation (Gutiérrez-Díaz del Campo et al., 2011). The apparent contradiction resolves if decision style, as a dispositional mode of approaching choice, is distinguished from decision-making capacity as a trainable skill. The present results concern the former; the developmental literature concerns the latter. This distinction also marks a construct gap: the inventory captures self-reported preference, and no perceptual-choice task, tactical accuracy measure, response time, competitive decision outcome or coach rating was included. The functional relevance of these styles for decision making in judo therefore remains untested, and future studies should combine dispositional scores with representative judo decision tasks.

The thinking-feeling dimension showed no association with the self-report blocks, whereas, before correction for multiple testing, feeling-oriented athletes had a resting heart rate about eight beats per minute higher than thinking-oriented athletes. This difference was confined to heart rate: the stress index reached only trend level and the remaining heart rate variability indices did not differ. The finding therefore indicates a difference in resting chronotropic level rather than a distinct autonomic-regulation profile, and, because it did not survive FDR correction, it requires replication with multiple convergent autonomic indicators. The over-representation of thinking orientation among national-team members was likewise not robust: it depended on the assignment of tied scores and did not survive correction or adjustment. It does, however, illustrate that physiological measures may capture group differences that are not visible in questionnaire data.

The neurovisceral integration model, according to which vagally mediated heart rate variability reflects prefrontal inhibitory control over subcortical structures (Thayer et al., 2009, 2012), offers one framework for generating hypotheses about such a difference. However, the present study did not measure executive control, vagal reactivity, recovery from stress or decision performance, and resting heart rate is not a specific index of vagal function. The model is therefore used to motivate future tests, for example a judo-specific stress task with baseline, reactivity and recovery phases, rather than as confirmation of the proposed mechanism.

The S/N findings suggest a distinct and testable hypothesis. Sensing-oriented athletes rated themselves as more emotionally stable and set higher aspirations yet showed lower total spectral power and a higher resting heart rate, raising the possibility that self-appraisal and resting autonomic state may diverge in some athletes. Although the total-power difference was robust to correction and to leave-one-out analysis, continuous intuition scores were unrelated to total power, so the effect may reflect a small group with a pronounced sensing preference, a non-linear relation, or chance. It should not be read as evidence that subjective well-being conceals reduced adaptive reserve. Total power is a global variability measure sensitive to respiration, recent load, sleep and emotional state, relative HF is not equivalent to absolute vagally mediated HRV, and the comparison rested on nine sensing athletes and a single recording. Replication in a larger and more balanced sample, with repeated recordings, absolute HF power, RMSSD and controlled respiration, is required.

The association between more sensing-oriented scores and higher competitive level was the most robust decision-style finding, persisting with continuous scores, after FDR correction and after adjustment for age and experience. It is compatible with the view that reliance on concrete, immediately available information is adaptive in a fast combat sport, but also with selection, coaching or competitive experience shaping self-description. Because sensing-oriented athletes were concentrated at the high level, their autonomic profile may also partly reflect the training phase in which high-level athletes were tested.

The different correlates of age and training experience persisted when both variables were entered together, which strengthens the dissociation but does not explain it. The age-related increase in reported cognitive errors may reflect more accurate self-observation in older athletes, or the more complex competitive demands and greater performance pressure they face; the present data cannot distinguish between these accounts. Likewise, the association of self-management, attachment and aspiration with training experience is compatible both with a training effect and with selection and retention, whereby athletes with these characteristics remain in judo longer. All of these associations are concurrent and should not be interpreted as developmental or causal.

Aspiration level was the variable most clearly associated with competitive level among the athletes in whom it was measured, and the association persisted after adjustment for age and experience. This extends meta-analytic evidence that pre-event self-efficacy relates to performance more strongly in elite than in sub-elite athletes (Lochbaum et al., 2023) and departs from findings that goal setting and self-confidence fail to distinguish national from international competitors (Vičar, 2018). Two explanations are plausible. The Schwarzlander procedure measures aspiration behaviourally rather than by questionnaire, reducing social-desirability influence; and judo, as an individual martial art, attributes competitive outcome directly to the athlete, which may sharpen the relationship between self-perception and level. Importantly, this result applies only to the non-national-team subsample, because aspiration was not recorded in national-team athletes, and the high-level group showed a ceiling effect. Aspiration level and sensing orientation should therefore be regarded as candidate correlates of current competitive status, not as screening indicators of competitive potential; their predictive value would need to be tested prospectively, controlling for age, experience, training environment and baseline performance.

The increase of the stress index with competitive level contradicted the initial hypothesis and requires careful interpretation. Three explanations are plausible and not mutually exclusive. First and most likely, the measurement context: high-level athletes were assessed during intensive competitive preparation, when training load and competitive expectation elevate sympathetic tone even at rest. Second, a resting index does not capture regulatory flexibility, that is, the capacity to respond to load and recover, which is a more sensitive marker of sporting adaptation and the basis of heart rate variability-guided training approaches (Javaloyes et al., 2019; Düking et al., 2021). Third, the competitive-level groups differed in age, and the stress index rises naturally with age. Distinguishing these explanations requires repeated measurement at different phases of the training macrocycle, which lies beyond the scope of this study and is formulated here as a direction for further work.

Practical implications should be stated cautiously. On the basis of the present evidence, dichotomous decision-style classifications and aspiration scores should not be used for screening, selection or training prescription, particularly in minors. A more defensible, applied message is that multimethod assessment may reveal discrepancies between self-report and current physiological state, which can prompt individual, contextual and non-selective follow-up by qualified practitioners.

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Several limitations qualify these conclusions. First, the design is cross-sectional: it cannot establish within-person stability, causal direction or predictive value. Second, the sample was exclusively male, Armenian and drawn from one national sporting system, and the decision-style and personality instruments were used in Armenian translations without local norms, so transferability to other populations is uncertain. Third, subgroups were unequal, most notably sensing-oriented athletes with autonomic data (n = 9). Fourth, aspiration level was missing for all national-team athletes, a non-random gap that restricts the aspiration findings to club-level athletes; heart rate variability was likewise missing for 21 of the 22 national-team athletes, so the autonomic findings do not extend to the highest competitive group; and the Schwarzlander index showed a ceiling effect at the high level. Fifth, autonomic assessment relied on a single seated 5-minute recording without control of respiration, sleep, hydration or recent emotional state, used relative rather than absolute spectral indices, and captured resting state rather than regulatory flexibility. Sixth, competitive level was confounded with age, training experience and training phase. Seventh, a large number of tests was performed, and effects that do not survive correction should be treated as exploratory. Eighth, the decision-style inventory produced many tied scores, dichotomous findings differed from continuous ones, and it does not measure decision performance in judo. Finally, all testing was carried out by one investigator who was not blind to competitive level.

CONCLUSIONS

In this exploratory cross-sectional study of male judo athletes, continuous decision-style scores were not associated with age or training experience. Whether these dimensions are stable within individuals requires longitudinal testing.

The decision-style dimensions showed heterogeneous associations with other measures. Judging-perceiving and, more weakly, extraversion-introversion were associated with cognitive-error scores after correction for multiple testing. Intuitive athletes had higher total spectral power than sensing athletes, but this preliminary finding rested on nine athletes and was not reproduced with continuous scores, and the higher resting heart rate of feeling-oriented athletes did not survive correction. These findings illustrate the value of combining self-report with physiological measures but do not establish distinct autonomic profiles.

More sensing-oriented scores and, among non-national-team athletes, higher aspiration level were associated with higher competitive level independently of age and experience, whereas the over-representation of thinking orientation among national-team members was not robust. These are candidate correlates of current competitive status, not indicators of competitive potential, and should not be used to select young athletes. After mutual adjustment, cognitive errors were associated with age and self-management, attachment and aspiration with training experience; whether the latter reflects training effects or selection remains to be determined.

AUTHOR CONTRIBUTIONS

All authors meet the criteria for authorship in accordance with established ethical guidelines. Contributions are specified according to the CRediT (Contributor Roles Taxonomy) as follows:

Conceptualisation: Gayane Lalayan, Lusine Stepanyan. Methodology: Gayane Lalayan, Lusine Stepanyan. Formal analysis: Gayane Lalayan. Investigation: Gayane Lalayan. Data curation: Gayane Lalayan. Writing – original draft: Gayane Lalayan. Writing – review & editing: Gayane Lalayan, Lusine Stepanyan. Supervision: Lusine Stepanyan.

All authors have critically reviewed and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

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CONFLICT OF INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this manuscript.

AI USE DISCLOSURE

In accordance with current publishing ethics and transparency recommendations, artificial intelligence (AI) tools were used solely to assist with translation and language editing, with the aim of improving clarity and readability. No AI tools were used in the generation of scientific content, including the study design, data collection, analysis, interpretation of results, or the formulation of conclusions. The authors retain full responsibility for the content of the manuscript and confirm its originality, integrity, and accuracy.

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