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Examining How Constraints Influence NCAA Division II Athlete's Physical Performance

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***Abstract*—**This quantitative quasi-experimental research investigated disparities in mean and median performance among millennial soccer players. According to research, the fear of failure causes millennials to struggle with difficult jobs. The application of specified limitations has been found to increase individual productivity. The study utilized the constraint-based model of novelty (C-BMN) framework and the game performance assessment instrument (GPAI) to assess data concerning constraint-type and its impact on the productivity of 18 soccer players. Individual components cooperation and trapping had statistical significance throughout the intervention, while positioning, passing, and dribbling did not. The GPAI was statistically significant between the control and both restriction types. A two-way mixed ANOVA revealed no significant interaction between limitations and temperaments, however only 72% of individuals completed the temperament exam.

***Keywords*—**Constraints, temperament, physical performance, GPAI.

I. Introduction

THIS research aims to aid coaches in optimizing practice performance by matching the appropriate constraint with their temperament. This research focuses on millennial student-athletes, who were born between 1982 and 2004 [20]. Millennials grew up in an environment where they continually feared failure, and as a result, they have difficulty with complex tasks [1]. These experiences have an effect on the capacity of Millennials to synthesize and apply their knowledge in novel contexts [5]. Understanding how an individual approaches a problem from a motivational perspective (temperament) might aid in the development of tactics to enhance their performance [9]. This research aimed to aid soccer and other coaches in developing practice regimens that are adapted to the temperament of their players.

II. Methods

This study used a convenience sample of 25 males from a mid-west collegiate Division II soccer team. 19 men chose to participate, including eight seniors (42.1%), two juniors (10.5%), four sophomores (21.1%), and five freshmen (26.3%). This study used a modified Game Performance Assessment Instrument [7] to assess participants' soccer abilities [3]. The updated rubric measures each of the five criteria: Teamwork & Supporting Behavior, Position or Direction, Trapping, Dribbling, and Passing. After assessing the specific criteria, participants were given a total score by aggregating the five sub-components. The Personality Plus Test [6] utilized in this research was developed by Florence Littauer. The exam comprises of 40 questions divided into four columns where you circle the adjective that best defines you. After the exam, the answers are copied to a sheet and the columns are appended. The most popular column determines temperament: sanguine, choleric, melancholy, or phlegmatic.

Data were scored by the soccer head coach using the Game Performance Assessment Instrument [7]. The GPAI is a multifaceted rubric that assesses individual performance components and overall performance [7]. Research shows that this instrument is effective in assessing and improving soccer players in-game performance [3].

The following overarching question evolved from the study's purpose: Do designed constraints affect the performance of NCAA Division II soccer players mediating through temperament?

RQ1. Will there be a statistical difference between the means of the rubric scores of the input-constraint, output-constraint, and the control in terms of performance of National Collegiate Athletic Association (NCAA) Division II soccer players?

- $H_0$1: No difference exists in performance between the output constraint, input constraint, and control.

$$\mu_1 = \mu_2 = \mu_3$$

- H_a1: There is a difference between the input constraint trial, output constraint trial, and control trial concerning performance.

$$\mu_1 \neq \mu_2 \neq \mu_3$$

RQ2. Will there be a statistical difference between the means of the rubric scores of the input-constraint and the control in terms of performance?

- $H_0$2: The mean performance level of soccer players with an input constraint will be the same as the control.

$$\mu_1 = \mu_2$$

- H_a2: The mean performance level of soccer players with an input constraint will be higher than the control.

$$\mu_1 > \mu_2$$

RQ4. Will there be a statistical difference between the means of the rubric scores of the output-constraint and the

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control group in terms of performance?

- $H_0$3: The mean performance level of soccer players with an output constraint will be the same as the control.

$$\mu_1 = \mu_2$$

- H_a3: The mean performance level of soccer players with an output constraint will be higher than the control.

$$\mu_1 > \mu_2$$

RQ5. To what extent are constraints related to constraint effectiveness in NCAA Division II soccer players and is this relation moderated by their temperament.

- $H_0$4: No difference exists in performance between the output constraint, input constraint, and control moderating through temperament.

$$\mu_1 = \mu_2 = \mu_3$$

- H_a4: There is a difference between the input constraint, output constraint, and control concerning performance moderating through temperament.

$$\mu_1 \neq \mu_2 \neq \mu_3$$

GPAI data were collected over three practices on three separate days. During the first day, we travelled to the soccer practice field. The first data collection round involved the soccer players conducting a Rondo drill, similar to keep away, with no constraints (control). The head soccer observed each attending player conducting warm-up drills and structured drills for approximately 35 minutes. The head coach utilized the GPAI rubric and assessed each player based using the 20 point scale. The second data collection round occurred five days later and involved a Passing Box drill with input constraint condition (limiting the number of touches and prescribing the passing sequence) following the same prescribed procedure. The third data collection round occurred six days from the control and involved a 10 versus 7 drill the featured the output constraint (prescribing distance between players and the appropriate passing type). After each data collection round, the data were collected, placed in an envelope, and were not reviewed until statistical analysis was performed.

III. Descriptions of Participants

Temperament data were collected from 18 of the 19 soccer players. As shown in Fig. 1, 4 identified as Sanguine (21.1%), 5 identified as Choleric (26.3%), 3 identified as Melancholy (15.8%), and 6 identified as Phlegmatic (31.6%).

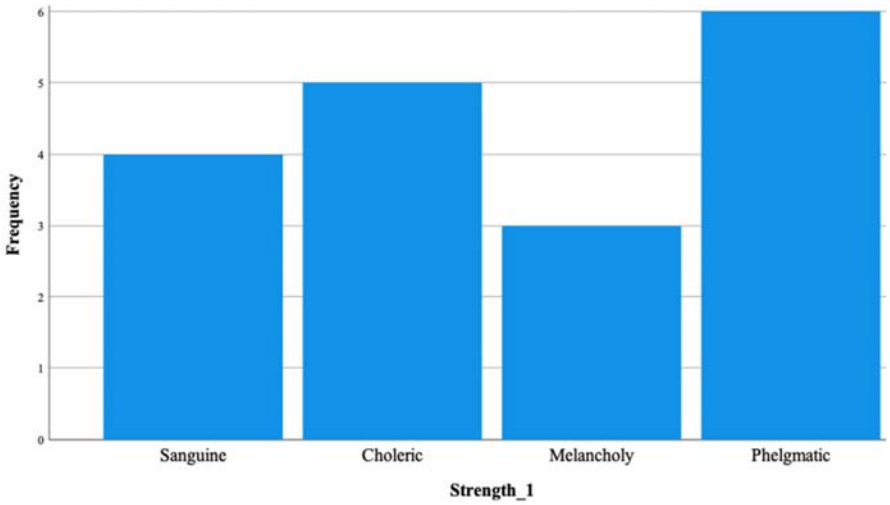

Fig. 1 LPP Temperament Data

To address Hypothesis 1, a non-parametric Friedman test was calculated for the sub-components for GPAI and a one-way repeated measures ANOVA for total GPAI score. Teamwork, position, trapping, and dribbling displayed unequal variances and violated normality, so a Friedman test was used to determine statistical significance.

A Friedman test was run to determine if there were differences in teamwork during a constraint intervention. Pairwise comparisons were performed with a Bonferroni correction for multiple comparisons. Teamwork was statistically significant at different time points during the constraint intervention, $\chi^2(2) = 10.647, p = .005$. Pot hoc analysis did not reveal a statistic different in teamwork from the control (*Mdn* = 16) to the input (*Mdn* = 8) (p = .105) and output (*Mdn* = 8) (p = .370).

A Friedman test was run to determine if there were differences in trapping during a constraint intervention. Pairwise comparisons were performed with a Bonferroni correction for multiple comparisons. Trapping was statistically significant at different time points during the constraint intervention, $\chi^2(2) = 7.818, p = .020$. Pot hoc analysis did not reveal a statistic different in teamwork from the control (*Mdn* = 8) to the input (*Mdn* = 16) (p = .266) and output (*Mdn* = 8) (p = .144).

A Friedman test was run to determine if there were differences in positioning, passing, and dribbling during a constraint intervention. Positioning remained the same from the control to the input and the output (*Mdn* = 16). Dribbling remained the same between the control (*Mdn* = 6) and the input (*Mdn* = 6) and increased in the output (*Mdn* = 8), but the differences were not statistically significant, $\chi^2(2) = 1.273$, $p = .529$. Passing decreased from the control (*Mdn* = 16) to the input (*Mdn* = 8) and the output (*Mdn* = 8), but the differences were statistically significant, $\chi^2(2) = 2.000$, $p = .368$.

A one-way repeated measures ANOVA was run to determine if there was a difference between GPAI total during a constraint intervention. There were no outliers and the data were normally distributed, as assessed by boxplot and Shapiro-Wilk test ($p > .05$), respectively. The assumption of sphericity was violated, as assessed by Mauchly's test of sphericity, $\chi^2(2) = 8.494$, $p = .014$. Therefore, a Greenhouse-Geisser correction was applied ($\varepsilon = 37.605$). The constraint intervention elicited statistically significant changes in GPAI over time $F(1.435, 25.838) = 28.535$, $p < .001$, partial $\eta^2 = .613$, with GPAI total increased from control (M = 42.36, SD = 11.88) to the output (M = 52.74, SD = 9.69) to the input (M = 55.37, SD = 10.44). Post hoc analysis with a Bonferroni adjustment revealed that GPAI total significantly increased from the control to the input (M = 12.105, 95% CI [6.87, 17.34], p < .01, and from the control to the output (M = 9.474, 95% CI [4.53, 14.42], p < .01, but not from the output to the input M = 2.632, 95% CI [-.108, 5.37], p = .062.

A two-way mixed ANOVA was used to determine whether the GPAI change is different for a participant's temperament. There were no outliers, as assessed by boxplot. The data were normally distributed as assessed by Shapiro-Wilk test of normality (p > .05). There was no statistically significant interaction between the constraint and temperament, $F(2, 32) = 1.814$, p = .179, partial $\eta^2 = .062$.

Soccer Performance

There were two major results: First drill constraints significantly improved GPAI scores for NCAA Division II soccer players. Second, there was a significant difference in performance between the experimental trials and the control trials. This study did not find a statistical significance when moderating constraints through temperament.

Data analysis performed to test the first research hypothesis revealed a significant statistical difference between the GPAI scores of the input-constraint trial, output-constraint trial, and the control trials in terms of soccer performance through a one-way repeated measures ANOVA ($F1.435, 25.838) = 28.535$, $p < .001$). Statistical analyses for the second hypothesis revealed a significant difference between the input-constraint trial and the control trial for soccer performance ($p < .01$). Data analysis performed to test the third hypothesis revealed a significant difference between the output-constraint trial and the control trial for soccer performance ($p < .01$). Statistical analyses for the fourth hypothesis revealed no significant interactions between constraint and temperaments (p = .179).

IV. Conclusions

The findings of this study corroborated prior research indicating that constraint-based practices enhanced creativity when the Stokes (2009) C-BMN conceptual framework was used [2], [6], [11]-[18]. Constraints are obstructions that guide individuals towards to successful task completion [11]. Constraints are required in the problem space to create new cognitive pathways [11]. Individuals benefit from the strategic application of constraints because it simplifies the problem space [11].

This study's findings added to the body of knowledge in the field of constraints and productivity [11]. Constraint usage has been demonstrated to be beneficial for problem solving and product development [2], [18], using the concepts outlined in Stokes (2009) C-BMN. According to [4] deliberate exercises that redefine the problem space increase an individual's productivity. Constraint-based practices improve an individual's performance and can increase the variability of possible solutions in a problem space [12].

Soccer coaches can adopt a designed constraint approach to address possible deficits [5]. This study provides coaching staffs with one tool to increase performance productivity by using design constraints. Using designed constraints targeting the millennial generation [5], [9], [10] has the potential to increase performance and problem solving [2], [18]. One proven strategy for improving creativity involves extended and alternating practice using varied constraints to simultaneously promote productivity [1] new skill acquisition [19], task persistence [13], and learning transference [16]. Professional development can assist veteran coaches in identifying and beneficially using constraints to improve their players' productivity. The direct practice involves identifying how creative individuals use constraints to change the overall domain [13]. Indirect practice includes the "constraint-finding" [10] by negotiating the ill-structured problem's framework by imposing constraints that promote novel and limit standard solutions [13].

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