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# Purposeful practice: Constraints and temperament impact on physical performance of collegiate division ii soccer athletes

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**Abstract**
This quantitative quasi-experimental study examined differences in mean and median differences of millennial soccer athlete's performance. Research indicates that millennials struggle with complex tasks due to their fear of failure. Individual productivity has been shown to be positively influenced by the use of designed constraints. The study employed the C-BMN framework and the GPAI to analyze data pertaining to constraint-type and its influence on the productivity of 18 soccer players. Individual components teamwork and trapping showed statistical significance during the intervention, while positioning, passing, and dribbling did not. The overall GPAI showed statistical significance between the control and both constraint types. A two-mixed ANOVA showed no statistical significant interaction between constraints and temperaments however only 72% of participants completed the temperament assessment.

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## Introduction

The current study seeks to assist coaches to maximize practice performance by pairing the proper constraint with their temperament. This study focuses on millennial student-athletes, a millennial is anyone born between 1982 and 2004 (Weinbaum *et al*., 2016) [36]. Millennials grew up in a world where they were constantly afraid of failing (Atay & Ashlock, 2018) [4] and as a result have a hard time handling complicated activities (Krahl, 2018) [13]. Millennials' ability to synthesize and apply their knowledge in new situations is impacted by these experiences (McAllum, 2016) [17]. Understanding how a person tackles an issue from a motivational aspect (temperament) might help in developing strategies to improve their performance (Roskes, 2015) [23]. This study sought to assist soccer and other athletic coaches to design practice regiments that are specifically tailored to their players' temperament.

This study employed the constraint-based model of novelty (C-BMN) as a framework for purposeful practice. The C-BMN (Stokes, 2009) [30] is an ideal framework for this study, according to the literature, since it boosts an individual's ability to generate unique solution routes, related products, and physical performance pertinent to this research (Caniels & Rietzschel, 2015; Haught, 2015; Haught-Tromp, 2017; Torrents-Martin *et al*., 2015) [5, 10, 11, 35]. Stokes (2009) [30] first concept within the framework is creativity problem where any physical or mental construct that is novel, distinct, and contextually relevant to the larger domain is considered creative (Amabile, 1996; Henriksen *et al*., 2015) [2, 12]. The creativity problem begins as an unstructured problem, and its resolution is contingent on the intelligent application of these constraints (Stokes, 2006) [27]. Stokes also notes, that these tactical constraints shape the problem space in two ways: by restricting conventional solutions and encouraging creative ones.
Stokes (2009) [30] second concept is that of constraints. Constraints interrupt established solution pathways and facilitate the development of new ones.

(Hatchuel & Chen, 2017; Haught-Tromp, 2017; Henriksen & Mehta, 2015; Stokes, 2006; Torrents-Martin *et al*., 2015) [27, 11, 9, 12, 35]. Constraints are classified as either input or output constraints that have an effect on the process and product creativity phases (Rosso, 2014; Stokes, 2013) [24, 32]. How an individual solves a problem is determined by input constraints and output constraints limit acceptable resolutions by defining the outcome of the problem (Stokes, 2013) [32]. Enhancing performance requires correctly matching constraint types to an individual's temperament (Roskes, 2015) [23]. Research by Medeiros *et al* found that designed constraints could provide benefit to performance enhancement.

Variability is the next concept in Stokes (2009) [30] framework. The term "variability" refers to the quantity of viable solution pathways and the dimensions of the problem space (Stokes, 2006) [27]. The expertise required to create products that are considered novel, unique, and appropriate is distributed across a spectrum of variability that includes constraints (Stokes, 2006, 2007, 2008, 2009, 2010, 2013, 2014) [27, 29, 32]. The spectrum of behavioral variability ranges from complete predictability, which is considered low, to absolute unpredictability, which is considered high (Stokes, 1999) [29]. The high-variability behavior learning occurs when domain-specific strategic challenges are introduced early on to increase behavior variability and low-variability behaviors are rewarded and reinforced in order to increase their frequency in resolving new problem spaces (Stokes, 1999) [29].

The final concept of Stokes (2009) [30] framework is problem space. The problem space contains the sequential steps or directions necessary to solve any problem or task (Stokes, 2008) [29]. Constraints have a dual effect on the problem space: (a) they can expand the number of solution pathways available to the individual, and (b) they can constrain which solution pathways are deemed appropriate (Reitman, 1965) [22]. Every problem space has a set of constraints that must be met before a solution can be found. When a person uses these two constraints to complete a task, a chain reaction occurs. In the problem space, the constraints guide an individual through distinct solution pathways until the problem is resolved (Reitman, 1965) [22].

Temperament is the intrinsic, heritable, fundamental aspect of a person's character (Abrams, 2012) [1]. Therefore, "temperament is mostly the neurobiological profile of what an infant receives from his or her parents (including genes), and the remainder is due to environment conditions surrounding the mother during pregnancy" (Abrams, 2012, p. 58) [1]. Although temperament and personality share a number of key components, there is a general consensus that temperament forms the lasting and biologically foundation of personality (Deal, Halverson, Havill, & Martin, 2005) [6]. The conventual view is that temperament traits are largely distinctive and generally constant across the lifespan (Strelau, 1987: Thomas & Chess, 1977) [25, 34], whereas personality characteristics are learned progressively through experiences. Allport (1961) [3] refers to temperament as reliant on inherent nature, and therefore mainly heredity in foundation. According to Mammadov temperament in combination with experience forms the basis for later development of personality traits. According to McCrae (2000) [18] personality traits, like temperaments, are endogenous characters that track intrinsic paths and are autonomous of environmental influences. Much of our personality is inherited, and much of it is shaped and influences by our unique environments (Ekstrand, 1995) [7].

According to Romilia, Teodorescu, and Tonita knowing a player's temperament can help the coach in communication relationship between the coach and the player. They refer to temperament as the dynamic and active side of an individual personality. Romilia *et al* state that temperament's traits are represented by the "individual to process information and withstand stress" (p. 70).

Littauer (1992) [15] describes temperance through the "personality profile and how the traits define your emotions, work performance and relationships" (p. 1) defined as either sanguine, choleric melancholy, and phlegmatic. Lester (1990) [14] refers to sanguine as someone who gets excited and is pleasant yet has tendencies of being shallow and also acts to a broad range of objects and situations. According to Romilia *et al* the sanguine is referred to as strong, balances and mobile. This individual adapts to new situations and is capable of sustained effort if needed. Sanguine are fundamentally impulsive and pleasure-seekers and it often referred to as "the talker" (Ekstrand, 1995) [7]. Additionally, Ekstrand notes that sanguine individuals' desire influence, enjoys being the center of attention, creative, possesses energy and enthusiasm, and are sincere at heart but might find themselves struggling with completing various tasks.

An individual who is referred with a choleric temperament (Lester, 19090) [14], is someone who is excited, has unpleasant emotions and tends to be deep and acts to a broad range of objects and situations. According to Romilia *et al* choleric is a strong individual, unbalanced, and can get angry very quickly. Ekstrand (1995) [7] refers to the choleric as the stronger of the extrovert temperaments, and can be called "Type A" personality or "the doer". Choleric is the dominant personality who desire control, has a lot of aggression, energy, and passion, and requires quick decisions (Ekstrand, 1995) [7]. This type of individual can perform movement's quick, and is an explosive person.

The melancholic temperament (Lester, 1990) [14] is someone who is calm often with unpleasant emotions yet has tendencies to be deep with a narrow range of emotions. According to Romillia *et al* the melancholic is a very sensitive person, with low energy level and does not initiate independent actions. This person does not cope with stress and is very sensitive. Melancholy individuals and introverted and thoughtful and are referred to as "the thinkers" (Ekstrand, 1995) [7]. Ekstrand notes that these individuals tend to be deep-thinkers, are highly creative, have high degree of perfectionist tendencies, and set a very high standard for themselves. Additionally, Ekstrand believes like most, that no individual has only one dominant type of temperament, but rather one dominant and one secondary temperament.

Finally, Lester (1990) [14] refers to phlegmatic as someone who is calm and has pleasant emotions, yet has tendencies of being shallow and has a narrow range of emotions. Ekstrand (1995) [7] indicated phlegmatic temperament is fundamentally relaxed and quiet and is referred to as "the watcher". This individual executes movement very slowly, and is self-controlled (Lester, 1990) [14]. Phlegmatic likes to be mediators, avoids conflict, agreeable and intuitive, and they are good at seeing the big picture (Ekstrand, 1995) [7]. According to Merenda (1987) [19], understanding the dissimilarities in temperament and other emotional trait between people is critical to understanding human personality and performance.

Therefore, the overarching question for this study purpose, is do designed constraints affect the performance of collegiate Division II soccer players mediating through temperament? Specifically, research question (RQ) 1. Will there be a statistical difference between the mean of the total GPAI rubric scores of the input-constraint, output-constraint, and the control in terms of performance of collegiate Division II soccer players? RQ 2. Will there be a statistical difference between the mean of the total GPAI rubric scores of the input-constraint and the control in terms of performance? RQ 3. Will there be a statistical difference between the mean of the total GPAI rubric scores of the output-constraint and the control group in terms of performance? RQ 4. To what extent are constraints related to constraint effectiveness in collegiate Division II soccer players and is this relation moderated by their temperament.

## Method

### Participants

A convenience sample of $n$ = 25 men from a mid-west collegiate Division II soccer team were invited to participate in this study. Nineteen men elected to participate with a class distribution of eight seniors (42.1%), two juniors (10.5%), four sophomores (21.1%), and five freshman (26.3%).

### Measures

### Game Performance Assessment Instrument

A modified Game Performance Assessment Instrument (GPAI; Oslin *et al*., 1998) [21] was adapted for this study to measure a participants' soccer skills performance (Harvey, 2003). The modified rubric includes statements using a scale range of 0 or 4 *below expectations*, 5 or 9 *needs improvement*, 10 or 15 *meets expectations*, and 16 or 20 *exceeds expectations* that measures each of the five criteria; Teamwork & Supporting Behavior, Position or Direction, Trapping, Dribbling, and Passing. After the individual criteria were assessed, participants were then assigned a total score by adding each of the five sub-components.

### Florence Littauer's Personality Plus

Florence Littauer's Personality Plus test (LPP; Littauer 2007) [16] is used to assess an individuals' temperament. The test consists of a 40-questions that were divided into four columns where an individual selects and circles the appropriate adjective that describes them. After completing the test, the responses are transferred to an answer sheet and then the columns are added up. The column with the greatest number of responses determines one's temperament to be categized as either Sanguine, Choleric, Melancholy, or Phlegmatic.

### Procedure

After receiving IRB approval, the GPAI and LPP tests were administered over five days during the first three weeks of the season. GPAI data was collected over three practices one-day each week for three weeks. During the first day (week 1), the researchers traveled to the soccer practice field to observe the first data collection by the coach. The first data collection round involved the coach observing each attending player conduct warm-up and structured drills like a Rondo similar to keep away with no constraints (control) for approximately 35 minutes. While drills were being performed, the head coach would follow the prescribed procedure of assessing each player utilizing the GPAI rubric form, place the forms in a sealed envelope, and then sent to the researchers to be opened and analyzed after all three data sets were collected. The second data collection round (week 2) occurred five days later and involved a Passing Box drill with input constraint condition (limiting the number of touches and prescribing the passing sequence). Finally, the third data collection round (week 3) occurred six days from the control and involved a 10 v 7 drill that featured the output constraint (prescribing distance between players, angle of support, type of pass, and number of touches). After each of the second and third data set collection rounds, the coach would follow the prescribed procedure outlined after the first data collection.

The LPP test was administered by the researchers twice to the participants, once at the beginning of the study (week 1) prior to the first GPAI and then again after the final GPAI data was collected (week 3). The week 1 LPP scores served as a baseline ensure that week 3 scores were consistent with participant responses and that the answer sheet was filled out accurately. Only week 3 LPP responses were entered for final analysis. In addition, a supplemental definition of terminology document was created to reduce potential language barriers for each assessment.

### Treatment of Data

The Statistical Package for Social Sciences (SPSS Statistics, 2012) was used to analyze the descriptive data where a non-parametric Friedman test was conducted to analyze the sub-components for the GPAI, a one-way repeated measures ANOVA for the total GPAI, and a two-way mixed ANOVA to evaluate GPAI change in a participants LPP temperament score. Post hoc tests were conducted when appropriate with significance defined at an alpha at the .05 level.

Prior to final analysis of the LPP test, one participant (freshman) was removed from analysis due to an incomplete assessment form. Additionally, the small sample size ($n$ = 18) of LPP scores, were assessed as non-significant. As a result, the four LPP personality categories were combined to create two categories of Introverts (Melancholy &Phlegmatic) and Extroverts (Sanguine & Choleric) for final assessment (Littauer, 1992) [15].

## Results

A non-parametric Friedman test was run to determine (RQ 1) if there were differences in the GPAI sub-components of 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, $\chi^2(2) = 10.647$, $p = .005$. Post hoc analysis (RQ 2 & RQ3) did not reveal a statistical difference in teamwork from the control ($Mdn$ = 16) to the input ($Mdn$ = 8), $p$ = .105 and output ($Mdn$ = 8), $p$ = .370. GPAI sub-components median difference are outlined in Table 1.

**Table 1:** GPAI Sub-Components Median Difference Scores

| Skill | Control | Input | Output | p | Post-hoc significance |
|---|---|---|---|---|---|
| Teamwork | 16 | 8 | 8 | .005 | No |
| Trapping | 8 | 16 | 8 | .020 | No |
| Positioning | 16 | 16 | 16 | n/a | n/a |
| Passing | 16 | 8 | 8 | .368 | n/a |
| Dribbling | 6 | 6 | 8 | .529 | n/a |

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, $\chi^2(2) = 7.818$, $p = .020$. Post hoc analysis (RQ 2 & RQ 3) did not reveal a statistic different in teamwork from the control (*Mdn* = 8) to the input (*Mdn* = 16), $p = .266$ and output (*Mdn* = 8), $p = .144$ (see Table 1).

A Friedman test was run to determine (RQ 1-3) 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 non-significant, $\chi^2(2) = 2.000$, $p = .368$ (see Table 1).

A one-way repeated measures ANOVA was run to determine (RQ 1) if there was a difference between GPAI total during a constraint intervention. There were no outliers and the data was 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], $p = .062$).

LPP data were collected from *n* =18 soccer players to determine their temperament. Nine soccer players were classified as Introverts (Melancholy *n* = 3, 15.8% & Phlegmatic *n* = 6, 31.6%) and nine classified as Extroverts (Sanguine *n* = 4, 21.1% & Choleric *n* = 5, 26.3%).

A two-way mixed ANOVA was used to determine (RQ 4) whether the GPAI change is different for a participant's temperament. There were no outliers as assessed by a boxplot. The data was normally distributed as assessed by Shapiro-Wilk test of normality ($p > .05$). There was no statistically significant interaction between the constraints and temperament, $F(2, 32) = 1.814$, $p = .179$, partial $\eta^2 = .062$.

## Discussion

The findings of this study corroborated prior research indicating that constraint-based practices enhanced productivity when the Stokes (2009) [30] C-BMN conceptual framework was used (Caniels & Rietzschel, 2015; Eckert *et al*., 2012; Haught, 2015; Haught-Tromp, 2017; Onarheim, 2012; Stokes, 2006, 2007, 2008, 2010, 2013; Torrents-Martin *et al*., 2015) [5, 27, 10, 11, 29, 35, 32]. Constraints are obstructions that help guide individuals towards to successful task completion and are required in the problem space to create new cognitive pathways where individuals benefit from the strategic application because it simplifies the problem space (Stokes, 2006) [27].

This study's findings added to the body of knowledge in the field of constraints and productivity (Stokes, 2006) [27]. Constraint usage has been demonstrated to be beneficial for problem solving and product development (Caniels & Rietzschel, 2015; Eckert *et al*., 2012; Haught, 2015; Haught-Tromp, 2017; Torrents-Martin *et al*., 2015) [5, 10, 11, 35], using the concepts outlined in Stokes (2009) [30] C-BMN. According to Hatchuel and Chen (2017) [9], 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 (Haught, 2015; Haught-Tromp, 2017) [10, 11].

Soccer coaches can adopt a designed constraint approach to address possible. This study provides coaching staffs with tool to increase performance productivity by using design constraints. Using designed constraints targeting the millennial generation (Roskes, 2015; Rosso, 2014) [23, 24] has the potential to increase performance and problem solving (Caniels & Rietzschel, 2015; Eckert *et al*., 2012; Haught, 2015; Haught-Tromp, 2017; Torrents-Martin *et al*., 2015) [5,10, 11, 35]. One proven strategy for improving productivity involves extended and alternating practice using varied constraints to simultaneously promote productivity (Atay & Ashlock, 2018) [4], new skill acquisition (Stokes, 1995, 1999) [26], task persistence and learning transference. Professional development can assist veteran coaches in identifying and beneficially using constraints to improve their players' productivity. The direct practice involves identifying how productive individuals use constraints to change the overall domain (Stokes, 2008) [29]. Indirect practice includes the "constraint-finding" (Stokes, 1999) [26] by negotiating the ill-structured problem's framework by imposing constraints that promote novel and limit standard solutions (Stokes, 2008) [29]. Constraint finding is essential for soccer coaches to design drills that will assist their players maximize their field productivity. Extended usage and alternating planned constraints facilitate the acquisition of new abilities (Stokes, 1999) [29], persistence and learning acquisition. This direct practice entails determining how productive individuals employ constraints to alter the domain as a whole (Stokes, 2008) [29]. Indirect practice entails "constraint-finding" (Stokes, 1999) [26] by negotiating the framework of an ill-structured problem by setting limitations that encourage new solutions and constrain typical responses (Stokes, 2008) [29].

In conclusion, Stokes (2009) [30] C-BMN has the potential to inform researchers' and coaches' the role that constraints can play in promoting player development. Specifically, coaches should look to add input and output constraints to existing practice drills and tasks that challenge players directly (through the activity) and indirectly (unconsciously) with the goal to improve player performance.

## Future Research

Future research is warranted to precisely determine what constraint-based drills are most effective in improving soccer skills. Additionally, since the sample size was identified to be too small to assess an individual's temperament (Sanguine, Choleric, Melancholy, and Phlegmatic) influence on constraints, a longitudinal study would need to be conducted to create a larger sample size to further investigate those interactions.

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