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Investigating the Impact of Sportswear Design on the Psychological States of University Students in Physical Education Courses

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ABSTRACT

This study examines the dual role of sportswear as both a functional textile product and a psychological influencer within the context of university physical education (PE). While textile engineering research has extensively optimized the ergonomic and physicochemical properties of athletic apparel for elite performance, the psychological implications of fundamental garment design parameters among non-athlete wearers remain insufficiently explored. This research systematically investigates the psychological effects of two core apparel design variables: fabric color (an aesthetic attribute) and garment fit (a structural, ergonomic attribute). Utilizing a 2 × 2 between-subjects experimental design (N = 256), the study evaluated custom-manufactured sportswear in which all textile properties (100% polyester interlock, 150 g/m²) were held constant except for the manipulated variables: color (red vs. gray) and fit. The ergonomic fit was developed using anthropometric data, contrasted with a standard loose-fit pattern. Psychological wear comfort was assessed using validated instruments measuring intrinsic motivation (IMI), self-confidence (SSES), and mood (PANAS), administered pre- and post-activity. A two-way ANOVA of change scores revealed that fabric color exerted a significant main effect on motivation ($F(1, 252) = 18.31, p < 0.001, \eta^2 = 0.067$), whereas garment fit significantly influenced self-confidence ($F(1, 252) = 21.58, p < 0.001$). These findings provide empirical evidence that strategic manipulation of basic textile and apparel design parameters—specifically color selection and garment construction for fit—can directly enhance the psychological comfort and engagement of wearers. The research contributes to the field of functional textiles by quantifying the psychological dimension of wear comfort and offers actionable insights for textile manufacturers and apparel designers.

KEYWORDS

sportswear design, wear comfort, garment fit, fabric color, apparel engineering

INTRODUCTION

University physical education courses play a crucial role in student development, extending beyond physical fitness to encompass mental health, stress reduction, and the cultivation of lifelong wellness habits [1,2]. However, student engagement and motivation in these courses are highly variable and influenced by a multitude of factors, including curriculum design, instructor behavior, and peer dynamics [3,4]. A frequently overlooked yet pervasive factor is the apparel worn during physical activity. The concept of enlothed cognition posits that clothing systematically influences the wearer's psychological processes and behaviors, intertwining the physical experience of wearing garments with their symbolic meanings [5]. Foundational studies in this area have primarily examined the impact of garments' symbolic meanings (e.g., a doctor's coat enhancing attentiveness). This study seeks to extend this framework by investigating whether the fundamental physical and aesthetic properties of clothing—specifically color and fit—can directly affect psychological states, independent of symbolic associations. This interaction between the physical and psychological domains suggests that sportswear is not merely a functional tool but also a salient environmental component shaping students' experiences in PE settings [5-7].

While substantial research in textile science and sports psychology has focused on the ergonomic and physiological benefits of advanced sportswear for elite athletes—such as improved thermoregulation, reduced drag, and muscle compression—the psychological impact of these garments on non-athlete student populations has received considerably less attention [8,9]. For students enrolled in mandatory or elective PE courses, factors such as body image anxiety, low self-confidence, and fluctuating motivation can pose significant barriers to participation [10]. The sportswear provided or required for these classes may either alleviate or exacerbate these psychological states. Design elements such as fit, color, and texture can influence students' perceptions of competence, willingness to engage in physical tasks, and overall emotional state during class [11,12].

The existing literature provides a robust basis for hypothesizing these effects. Research in color psychology has consistently demonstrated that different hues evoke specific emotional and behavioral responses, with warm colors such as red being associated with energy and dominance, and cool colors with calmness and focus [13]. Similarly, garment fit is central to both physical and psychological comfort. An ergonomic fit that accommodates body movement can enhance feelings of competence and reduce distraction, whereas an ill-fitting uniform may increase self-consciousness and detract from physical activity [14]. Despite this theoretical

foundation, empirical research systematically investigating these design variables within the context of university PE courses is lacking. This study therefore aims to bridge this gap by isolating and examining the effects of two fundamental sportswear design elements—color and fit—on the intrinsic motivation, self-confidence, and mood of university students. The primary objective is to provide robust, data-driven insights into how thoughtful sportswear design can be leveraged to improve student experience and foster positive psychological outcomes in physical education.

LITERATURE REVIEW

The foundation of this research lies at the intersection of three related fields: textile engineering, which focuses on the functional properties of apparel; sports psychology, which examines the mental aspects of performance; and social psychology, particularly the theory of enclothed cognition. Functional sportswear has advanced significantly, with research primarily targeting the enhancement of athletic performance. Studies have detailed the influence of fabric properties—such as moisture management, thermal resistance, and air permeability—on athletes' physiological responses and endurance. For example, polyester and its blends have been shown to offer superior thermoregulatory benefits compared to natural fibers like cotton during intense exercise, by wicking moisture away from the skin and maintaining physiological comfort, thereby potentially delaying fatigue [8,15]. Ergonomic considerations are also paramount; research has demonstrated that compression garments can improve blood flow and reduce muscle oscillation, while aerodynamic designs can minimize drag in sports such as cycling and swimming [16,17]. Although this body of research is vital, its focus remains on physiological and biomechanical advantages for competitive athletes, largely overlooking the psychological experience of everyday wearers in non-competitive settings [9,18].

The psychological dimension of clothing is articulated by the theory of enclothed cognition, which asserts that clothing influences human behavior not only through its symbolic meaning but also through the physical experience of wearing it [18,19]. The effect is dependent on both the presence of the clothing and the meaning ascribed to it, extending beyond professional uniforms to everyday apparel, including sportswear. Donning designated athletic apparel can trigger a mental shift, preparing individuals for physical exertion and potentially enhancing their perceived athletic ability [20]. This mental preparation is a key component of the student experience in PE classes, where prescribed attire signals the transition from a sedentary academic mindset to an active, physical one [21,22]. The design of such attire may significantly mediate the nature and efficacy of this psychological shift.

Within the broader domain of clothing psychology, specific design elements have been identified as key influencers of emotion and perception. Color is perhaps the most studied element [18,23]. Research in sports contexts has consistently found that the color red is associated with higher heart rates, perceptions of dominance, and enhanced performance in short, intense activities [12,24]. Conversely, colors such as blue and green are frequently linked to calmness and concentration, which may be more beneficial for precision-based sports. These associations are not confined to competitive environments [25,26]; the colors worn can influence an individual's mood and energy levels in daily life, suggesting that the choice of color in PE sportswear could affect students' general disposition and readiness to participate.

Equally important is garment fit. The tactile sensation and physical freedom afforded by clothing are integral to psychological comfort. Ergonomic sportswear, emphasizing a tailored fit that accommodates body movement without restriction, can reduce physical distractions and facilitate greater focus on the activity [27]. For students who may already feel self-conscious in PE settings, a well-fitting garment can significantly improve body image and boost self-confidence [28]. In contrast, a poorly fitting, one-size-fits-all uniform can draw unwanted attention to the body, leading to discomfort and anxiety that detract from the learning experience [7,29]. Although the importance of comfort is widely acknowledged, few studies have experimentally isolated the variable of fit to quantify its specific impact on psychological states such as self-confidence and motivation in educational contexts. This study addresses this gap by creating a controlled experimental environment to dissect the independent and interactive effects of color and fit, thereby extending the principles of enlothed cognition into the practical setting of university physical education.

METHODOLOGY

Participants

A total of 256 undergraduate students (128 male, 128 female) from a large comprehensive university participated in this study. Participants' ages ranged from 18 to 23 years ($M = 19.7$, $SD = 1.3$). All were enrolled in a mandatory 100-level Health and Wellness physical education course involving various moderate-intensity physical activities. To control for confounding variables, only students who were not members of university varsity sports teams were included. All participants provided written informed consent, and the study received approval from the university's Institutional Review Board. Course credit was granted for participation.

Experimental Design and Materials

A 2 × 2 between-subjects factorial design was employed, with two independent variables: sportswear color (energizing vs. neutral) and sportswear fit (ergonomic vs. standard). This design yielded four experimental conditions:

- Condition A: Red color / Ergonomic fit
- Condition B: Red color / Standard fit
- Condition C: Gray color / Ergonomic fit
- Condition D: Gray color / Standard fit

Four sets of sportswear (T-shirt and shorts) were custom-manufactured. To isolate the effects of color and fit, all other textile properties were held constant (100% polyester interlock knit, 150 g/m², identical weave, and moisture-wicking finish).

- **Color:** The energizing color was a vibrant red (Pantone 186 C), selected based on literature associating it with energy and arousal. The neutral color was a medium gray (Pantone Cool Gray 7 C).
- **Fit:** The ergonomic fit was designed using 3D body scanning data to create gender-specific patterns with anatomically placed seams and a tailored cut permitting full range of motion without restriction. The standard fit was a traditional, unisex, box-cut design with a loose and non-contoured shape, typical of basic institutional PE uniforms.

Measures

Three validated psychological questionnaires assessed the dependent variables, each demonstrating high internal consistency (Cronbach's $\alpha > 0.80$):

- **Intrinsic Motivation:** The Intrinsic Motivation Inventory (IMI) measured participants' subjective experience related to physical activity. The 7-item Interest/Enjoyment subscale, a direct self-report measure of intrinsic motivation, was used. Participants rated items (e.g., "I enjoyed doing this activity very much") on a 7-point Likert scale.
- **Self-Confidence:** The State Self-Esteem Scale (SSES) measured transient feelings of self-worth. The 6-item Performance Self-Esteem subscale (e.g., "I feel confident about my abilities") was administered, with responses on a 5-point Likert scale.

- **Mood:** The Positive and Negative Affect Schedule (PANAS) measured mood states, comprising two 10-item scales for positive affect (e.g., excited, enthusiastic) and negative affect (e.g., nervous, distressed). Participants rated their emotional state on a 5-point Likert scale.

Procedure

Participants were recruited during their initial PE class of the semester. After providing consent, they completed baseline measures for the IMI, SSES, and PANAS. Participants were then randomly assigned to one of the four experimental conditions and instructed to wear their assigned sportswear for the next scheduled PE session.

The experimental session occurred one week later. Upon arrival at the gymnasium, participants changed into their assigned sportswear and immediately completed the three questionnaires for a second time (pre-activity measure). They then participated in a standardized 45-minute PE session led by a certified instructor, which included a warm-up, a circuit of moderate-intensity exercises (e.g., bodyweight squats, planks, jumping jacks), and a cool-down. The instructor was blinded to the research hypotheses. Immediately following the session, participants completed the IMI, SSES, and PANAS for a final time (post-activity measure). After submitting their final questionnaires, participants were debriefed regarding the study's purpose.

Data Analysis

Data were analyzed using IBM SPSS Statistics (Version 28). The primary analysis focused on change scores between pre-activity and post-activity measurements for each dependent variable. A series of 2 (Color: Red vs. Gray) \times 2 (Fit: Ergonomic vs. Standard) between-subjects analyses of variance (ANOVAs) were conducted on change scores for IMI, SSES, positive affect (PANAS-P), and negative affect (PANAS-N). The significance threshold for all statistical tests was set at $\alpha = 0.05$.

RESULTS

Data from all 256 participants were included in the final analysis. To confirm successful randomization, 2 (Color: Red vs. Gray) \times 2 (Fit: Ergonomic vs. Standard) between-subjects ANOVAs were conducted on the initial baseline measures (IMI, SSES, PANAS) collected during the first PE class. No significant main effects for color or fit, nor significant interaction effects, were observed for any dependent variable (all $p > 0.20$), confirming psychological equivalence across the four experimental groups at baseline. Descriptive statistics for

change scores (post-activity minus pre-activity) on all dependent variables by condition are presented in Table 1.

Table 1. Mean Change Scores (SD) for Psychological Variables by Condition

Condition	N	IMI (Motivation)	SSES (Confidence)	PANAS (Positive Affect)	PANAS (Negative Affect)
Red / Ergonomic	64	0.98 (0.45)	0.85 (0.39)	5.11 (2.01)	-3.15 (1.55)
Red / Standard	64	0.89 (0.41)	0.52 (0.35)	4.89 (1.95)	-2.88 (1.49)
Gray / Ergonomic	64	0.55 (0.38)	0.79 (0.42)	4.05 (1.88)	-2.95 (1.61)
Gray / Standard	64	0.48 (0.35)	0.45 (0.33)	3.87 (1.82)	-2.76 (1.52)

Note: IMI = Intrinsic Motivation Inventory (Interest/Enjoyment); SSES = State Self-Esteem Scale (Performance); PANAS = Positive and Negative Affect Schedule. Change scores calculated as post-activity minus pre-activity.

Intrinsic Motivation

The 2×2 ANOVA on IMI change scores revealed a significant main effect for color, $F(1, 252) = 18.23, p < 0.001, \eta_p^2 = 0.067$. Participants who wore red sportswear ($M_{\text{change}} = 0.94, SD = 0.43$) reported a significantly greater increase in intrinsic motivation than those who wore gray sportswear ($M_{\text{change}} = 0.52, SD = 0.37$). The main effect for fit was not significant, $F(1, 252) = 2.01, p = 0.157$. The color \times fit interaction effect was also not significant, $F(1, 252) = 0.45, p = 0.502$.

Self-Confidence

For SSES change scores, the ANOVA indicated a non-significant main effect for color, $F(1, 252) = 1.34, p = 0.248$. However, a significant main effect for fit was identified, $F(1, 252) = 21.58, p < 0.001, \eta_p^2 = 0.079$. Participants in the ergonomic fit condition ($M_{\text{change}} = 0.82, SD = 0.41$) exhibited a significantly greater increase in state self-confidence compared to those in the standard fit condition ($M_{\text{change}} = 0.49, SD = 0.34$). The color \times fit interaction was not significant, $F(1, 252) = 0.29, p = 0.591$. The results for self-confidence are visualized in Figure 1.

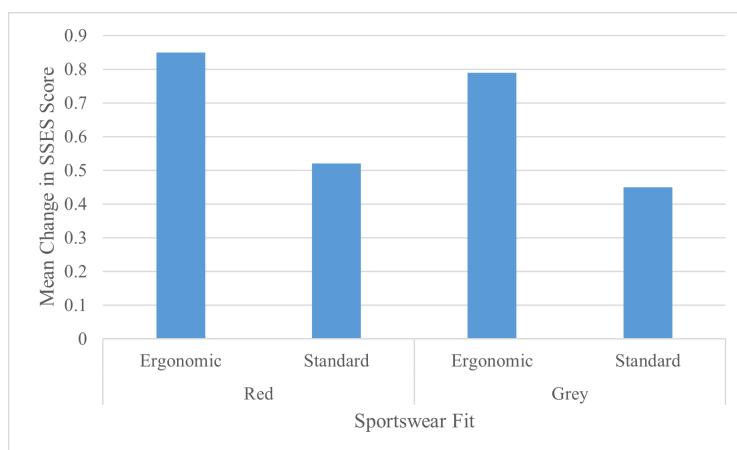


Figure 1. Mean Change in Self-Confidence by Sportswear Color and Fit

Mood (PANAS)

Analysis of PANAS positive affect change scores revealed a significant main effect for color, $F(1, 252) = 8.99$, $p = 0.003$, $\eta_p^2 = 0.034$. Participants in the red color condition ($M_{\text{change}} = 5.00$, $SD = 1.98$) reported a larger increase in positive mood compared to those in the gray color condition ($M_{\text{change}} = 3.96$, $SD = 1.85$). Neither the main effect for fit ($p = 0.310$) nor the interaction effect ($p = 0.815$) was statistically significant.

For PANAS negative affect change scores (reflecting a decrease in negative mood), the ANOVA revealed no significant main effects for color ($p = 0.621$) or fit ($p = 0.488$), and no significant interaction effect ($p = 0.850$). All groups experienced a similar reduction in negative affect following physical activity.

DISCUSSION

This study sought to determine the extent to which two fundamental sportswear design elements—color and fit—influence the psychological states of university students in physical education contexts. The findings provide clear empirical support for the hypothesis that sportswear is not a passive element but an active contributor to the student experience. The results demonstrate that specific design choices can independently and significantly enhance distinct psychological outcomes, specifically intrinsic motivation and self-confidence. By manipulating these variables while holding textile properties constant, the study offers focused insights that align with and extend the theory of enclothed cognition.

The significant main effect of color on intrinsic motivation is particularly noteworthy. While red sportswear aligns with principles of color psychology associating it with heightened energy, excitement, and arousal, it is important to consider the neutral-color baseline. Gray (Pantone Cool Gray 7 C) is often associated with neutrality and formality, but in an active context, it may be perceived as uninspiring. Thus, the observed main

effect may reflect both a motivating red effect and a potentially demotivating gray effect relative to a normative baseline. In either case, the results suggest that replacing drab, neutral-colored uniforms with more vibrant options could be a straightforward strategy for educational institutions seeking to enhance student engagement. This effect was also observed in the increased positive affect, indicating that red contributed to a more pleasant emotional experience during activity.

The most compelling result is the strong main effect of fit on self-confidence. Students wearing ergonomic, well-fitting sportswear experienced a significantly greater increase in performance-related self-esteem than their peers in standard, loose-fitting garments. This finding underscores the profound connection between physical comfort, body perception, and psychological state. An ergonomic fit, by moving seamlessly with the body and providing a sense of tailored support, likely reduces physical distractions and minimizes self-consciousness. When students are not preoccupied with adjusting ill-fitting clothing or their appearance, they can focus more fully on the activity, resulting in enhanced competence and confidence. This finding directly addresses the challenges of body image anxiety prevalent in this age group and context.

It is notable that no significant interaction effects were found between color and fit. Motivation was primarily influenced by color, while self-confidence was primarily influenced by fit. This suggests that these design elements may operate via distinct psychological pathways: color influences affective and motivational states, whereas fit impacts cognitive and self-perceptual dimensions related to body image and competence. This distinction is valuable for textile designers and educators, indicating that optimizing the psychological benefits of sportswear requires the simultaneous consideration of multiple design elements, each addressing different psychological needs.

Regarding mood, the analysis of negative affect (PANAS-N) revealed no significant differences between groups, as all participants experienced a similar reduction. This non-significant finding should not be interpreted as a failure of the experimental manipulation. Rather, it highlights the robust, well-documented mood-enhancing effects of physical exercise itself. The standardized 45-minute PE session likely provided a strong psychological intervention that uniformly reduced negative affect across all conditions, potentially masking any subtle garment-based influences.

This research has several limitations. First, the methodological design confounded the baseline measurement: the pre-activity measure was taken after participants had changed into the experimental garment, thus already reflecting its initial psychological impact. A change score from the initial baseline (prior to randomization) to post-activity would have more clearly captured the total intervention effect. Second, the intervention

was limited to a single 45-minute session, potentially capturing only short-term or novelty-based effects rather than sustained psychological change; for example, the arousal effect of red may diminish or become distracting over time. Third, the manipulation of fit contained critical confounds, as no measures differentiated between aesthetic fit (perceived appearance) and functional fit (freedom of movement), both of which likely contribute to self-confidence. Additionally, the ergonomic fit utilized gender-specific patterns, whereas the standard fit was unisex, making the observed main effect inseparable from the psychological impact of a unisex garment, which may have different implications for male and female participants.

Finally, the study's homogeneous sample, drawn from a mandatory, non-competitive Health and Wellness course and excluding varsity athletes, limits the generalizability of findings and may explain the absence of a color \times fit interaction. Future research should de-confound fit variables, utilize a true pre-manipulation baseline, and investigate these effects in longitudinal studies across diverse populations and activity types.

CONCLUSION

This study provides compelling evidence that sportswear design significantly influences the psychological well-being of students in university physical education courses. By isolating the effects of color and fit, the research demonstrates that an energizing color (red) can enhance intrinsic motivation and positive mood, while an ergonomic fit can bolster self-confidence. These findings empirically validate the application of enclothed cognition theory to educational sportswear and underscore the importance of considering apparel as more than functional equipment. Sportswear is an integral component of the learning environment, capable of shaping student attitudes, engagement, and self-perception. For universities, physical education programs, and textile manufacturers, these results highlight a meaningful opportunity: the thoughtful, psychologically informed design of student sportswear is not a trivial aesthetic decision but a potential tool for fostering a more positive, inclusive, and motivating environment for physical activity. While practical and cost considerations were not addressed in this study, investment in well-designed apparel may be a worthwhile strategy for enhancing student health and well-being.

Author Contributions

Ling Ma designed, collected and analyzed the data, and drafted the manuscript. Ling Ma conducted the study, critically revised the manuscript for important intellectual content, and gave final approval of the version to be published. Ling Ma participated fully in the work, take public responsibility for appropriate portions of the

content, and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Conflicts of Interest

The author declares no conflict of interest.

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Ethics Approval and Consent to Participate

This survey was conducted in compliance with Ethics Committee of Wenhua College. Participants were informed of the study's purpose and data usage prior to participation, and responses were collected anonymously. No personally identifiable information was stored.

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Not applicable.

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