DOES EXPECTATION OF HIGHER PERFORMANCE IN A KNEE BRACE ACTUALLY AFFECT GAIT?

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This study presented 18 healthy young adults with two functionally identical knee braces. One brace was cosmetically altered and outfitted with a switch, LED light, and USB port, and participants were told that it was an experimental computerized brace capable of dynamic joint stiffness alteration. We surveyed participants on their expectations for the braces, analysed their gait kinematics and kinetics during walking, and then surveyed them on their perceptions and preference. Before the walking trial, 61% expressed preference for the "computerized" brace. After walking with both braces in random order, 83% preferred the "computerized" brace. Actual walking patterns were identical, with no significant differences in any of 11 gait parameters. Future research should consider blinding when including self-reported outcomes in studies of orthopaedic components.

KEY WORDS: knee orthosis, confirmation bias, walking.

INTRODUCTION: Orthotic devices, or braces, are almost ubiquitous in sports, used for protection of a joint following injury, or for injury prevention. The first use of prophylactic knee bracing in American football dates back over 35 years ago (Anderson, 1979). Along the way, materials and technologies have progressed in both sports and clinical orthoses.

As braces become more expensive, a stronger case is needed to establish their efficacy (Hebert and Liggins, 2005). The advent of microprocessor control in knee joint prosthetics and orthotics has led to a growing body of literature on outcome measures, as these devices can cost an order of magnitude more than their standard counterparts (Highsmith et al., 2016).

A psychological principle that might confound such research is the role of user expectation and confirmation bias. Handley et al. definitively concluded that expectations often lead individuals to "experience what they expect to experience" (2013). For example, Mohr et al. showed a difference in athletic performance based on users' knowledge (or blinding) of the weight of the shoes they wore (2016). If orthosis users expect a more advanced knee brace to perform better, then perhaps they will prefer it, regardless of its actual performance.

To test this theory, we presented users with two functionally identical knee braces. One was made to look technologically advanced, and its "features" were described to users. We then assessed three research questions: 1) Will participants expect the "computerized" (COMP) brace to perform better, than the standard brace (STD) 2) After use, will participants prefer COMP, and 3) Will participants actually walk differently in COMP vs. STD?

METHODS: Eighteen healthy young adults between the ages of 18-26 were recruited for the study (which was approved by our IRB). Participants were told the study was being conducted for a manufacturer collecting research about an advanced prototype knee brace. Users were shown a mock-up flyer explaining the features of the "new" brace, which noted the brace's microprocessor and accelerometer technology that enable it to dynamically alter knee joint stiffness. Participants were also told that COMP will likely cost approximately double STD when it is sold. Next, participants completed a survey to record their expected preference for COMP or STD in six categories: appearance, joint stabilization, cost, comfort, function in sports, and overall preference.

- **Figure 1: The STD (left) and the COMP brace (right). The Mueller® logo was covered with tape during testing**

The project used two Mueller® Adjustable Hinged Brace model number 6455 off-the-shelf knee braces (Fig. 1). The COMP brace was altered by changing the color of the straps, adding a small circuit with a switch and a red LED light, and adding a mini-USB port. Following walking trials that brace was connected to the laboratory computer to “download” the “dynamic joint stiffness” data.

An instrumented gait analysis was then conducted. Kinematics were measured at 100 Hz with an 8-camera Vicon motion analysis system (Oxford Metrics, UK), and kinetics at 1000 Hz using two AMTI force platforms (Watertown, MA, USA). Temporal and spatial parameters were analysed along with bilateral knee flexion angles and ground reaction forces. One brace was tested after the other in random order, and steps were taken to insure identical placement and strap tensile force. Gait data were tested for normality and then analysed using repeated measures ANOVA.

Finally, users repeated the first survey, indicating their preference for one brace or the other. As part of our ethics protocol, users were then told that the braces were actually identical.

RESULTS: Ten males and eight females participated. The average age, height, and weight were 21.9 (+/- 1.30) years, 1.69 (+/- 0.101) meters, and 71.94 (+/- 14.31) kilograms, respectively. Upon randomization, ten of the participants started with STD while the other eight started with COMP.

In all categories, preference for COMP increased following the walking trials. Before the walking trial, 61% of participants expressed an overall preference for COMP. After walking with both braces, overall preference for COMP increased to 83% (Tables 1 and 2). This was the largest change of any factor. The factor “Cost” showed the second greatest increase in preference for COMP between the two questionnaires.

Table 1
Expectations from pre-trial survey

Item	% who prefer STD	% with no preference	% who prefer COMP
Appearance	22	44	33
Stabilization	22	11	67
Cost	78	6	17
Comfort	33	33	33
Function in Sports	28	17	56
Overall preference	22	17	61

Table 2
Preferences from post-trial survey

Item	% who prefer STD	% with no preference	% who prefer COMP
Appearance	17	44	39
Stabilization	22	6	72
Cost	50	17	33
Comfort	33	22	44
Function in Sports	17	17	67
Overall preference	11	6	83

There were no significant differences in any kinematic or kinetic outcomes between the braces (Table 3). Ensemble average of walking speeds was exactly 1.19 m/s for both brace conditions. Stride length was also identical, 1.26 m. There were no differences in either the stance phase or swing phase peaks of knee flexion for the braced (right) leg (p=0.54 stance, p=0.59 swing) or for the contralateral (left) leg (p=0.78 stance, p=0.95). Similarly, the first and second peaks of the vertical ground reaction force showed no significant differences for either leg, with p values ranging from 0.94 to 0.97. Moreover, the full-cycle shapes of these curves were very similar (Figure 2).

Table 3
Kinematic and Kinetic outcomes

Variable	"Computerized" Brace	Standard Brace	*p*
Walking speed (m/s)	1.19	1.19	0.31
Stride length, braced side (m)	1.26	1.26	0.97
Stride length, opposite side (m)	1.26	1.26	0.64
Mean peak stance phase knee flexion, braced side (degrees)	43.8	42.2	0.29
Mean peak stance phase knee flexion, opposite side (degrees)	41.8	41.7	0.89
Mean peak swing phase knee flexion, braced side (degrees)	59.5	57.8	0.25
Mean peak swing phase knee flexion, opposite side (degrees)	62.4	62.3	0.75
Mean peak vertical ground reaction force, braced side, peak one (xBW)	1.52	1.52	0.83
Mean peak vertical ground reaction force, opposite side, peak one (xBW)	1.54	1.52	0.22
Mean peak vertical ground reaction force, braced side, peak two (xBW)	1.60	1.60	0.064
Mean peak vertical ground reaction force, opposite side, peak two (xBW)	1.61	1.60	0.59

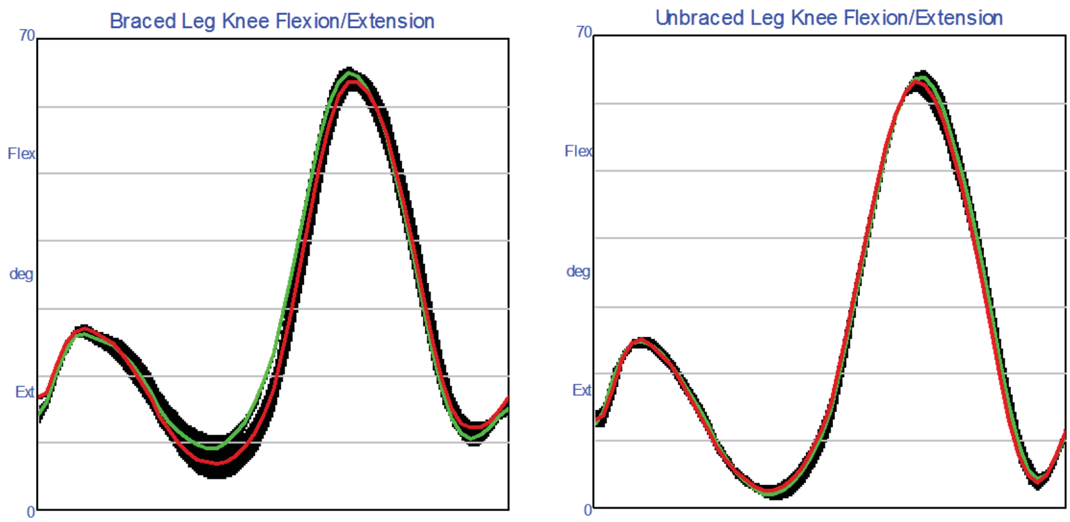

Figure 2: Example data from a single participant showing knee flexion/extension angles for both the unbraced leg and the braced leg averaged across all steps. Red indicates the standard knee brace trial; green indicates the "computerized" knee brace trial. Grey represents the standard deviation.

DISCUSSION: This study sought to determine if bias related to expectation influences overall device preference and/or biomechanical gait characteristics. Understanding the role of user psychology can in turn enable better understanding of the objective function of advanced orthopaedic devices.

The literature related to confirmation bias is extensive, but application to devices like orthoses or prostheses is very limited. This gap in the literature becomes more important as devices become more technologically advanced, with new materials and even microprocessor control. Furthermore, blinding can be practically difficult when testing braces that are worn on the arms and legs. Blinding can diminish confirmation bias. For example, Marchini et al. found that users preferred advanced experimental knee and ankle braces and that the braces improved muscle force control (2014). It is only because the users were blinded to brace type that it is possible to conclude that users preferred the advanced orthoses because of their functional improvements.

In our study, users established the possibility of expectation bias by reporting a preference for the "computerized" brace, even before they had seen it or used it. The study found confirmation bias was present as well, as user preference for a functionally identical brace increased in every surveyed factor. The "Cost" factor is particularly interesting. Before the trials, 78% of participants preferred the standard brace, having been told that COMP would cost more. Following the walking trial, only half the participants preferred STD for cost, implying that several users thought the function of COMP justified the higher cost, even though the actual function was the same. In addition, users expressed a strong preference for COMP for the factor "Function in sports", which increased following the walking trials, even though the only use of the brace in our test was walking and not sports. In effect, the users were – at least mentally – demonstrating Handley's definition of confirmation bias by experiencing what they expected to experience (2013).

Kinematic and Kinetic results were noteworthy in their similarity. Even though users thought the COMP brace was improving their joint stabilization and sports function, they did not actually move differently.

This study has important limitations. The questionnaires used were based on the literature but were created for this study and not independently validated. The cosmetic alterations we applied to the COMP brace were limited. The involvement of a manufacturer could produce a more convincing "high-tech" brace. In addition, the population likely affected the results. Since these were healthy participants who did not need a knee brace, a possible ceiling effect could have limited preference for one brace over the other and very likely limited changes in gait. Essentially, if participants were already walking with an optimized gait pattern, changes in that pattern would have to deviate from that optimized pattern and would likely have been negative. Consequently, it is probably more likely that we did not find differences in gait pattern with this population as opposed to a population of individuals using a knee brace to recover from injury, surgery, or some other gait abnormality.

CONCLUSION: Users did express an expectation for higher performance for the "computerized" brace. After use, they preferred that "computerized" brace, indicating the presence of confirmation bias. However, they did not walk differently in one brace condition compared to the other.

The study reiterated the importance of blinding, particularly when self-reported outcomes are assessed.

Coaches and rehabilitation practitioners should be cognizant of the potential for confirmation bias when considering advanced devices. In particular, a placebo effect may be possible in self-report of improvement following injury.

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