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Short communication

Confirmation bias affects user perception of knee braces

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ABSTRACT

Technological advances in orthopedic devices such as prostheses and orthoses are intended to improve function but may also result in increased complexity and expense. Consequently, accurate determination of effectiveness is important. When devices with advanced technology are used, it is possible that confirmation bias – the tendency for a user to actually experience what he or she expects to experience – will influence outcomes. This study assessed confirmation bias in 18 healthy young adults walking in knee braces. Participants wore two identical braces, but one was cosmetically modified and participants were told that it was a prototype computerized brace that could dynamically alter its stiffness. Before using the braces, the majority of users indicated a preference for the "computerized" brace. Actual walking showed no differences between the two braces. Following walking, users maintained preference for the "computerized" brace, indicating the presence of confirmation bias. These results underscore the importance of blinding when self-reported outcomes are used and the need to consider a placebo effect when comparing orthopedic devices.

1. Introduction

In recent years, a technology infusion has transformed many orthopedic devices from passive to active. Both prosthetic and orthotic joints have evolved to include dynamic stiffness adjustment, microprocessor control, and active motors. Such advances have increased the complexity and expense of these devices compared to conventional counterparts, and consequently their relative effectiveness has been closely scrutinized.

For at least one category of devices – microprocessor-controlled prosthetic knee joints – the literature varies significantly about functional improvement (Sawers and Hafner, 2013), but is consistent that more advanced devices bring issues such as durability and cost (Andrysek, 2010). Nonetheless, in a broad sense studies have shown users tend to prefer more advanced prosthetic and orthotic components (Bernhardt et al., 2006; Macfarlane et al., 1991; Marchini et al., 2014; Menard et al., 1992; Mizuno et al., 1992; Nielsen et al., 1988; Postema et al., 1997; Torburn et al., 1990).

Advanced devices present a challenge associated with the measurement of outcomes during their use. The potential effects of cognitive biases make it difficult to determine whether outcomes changed because of the actual function of the devices, or because the advanced technology has caused users to expect the devices to function better. A long history of research has documented how expectations affect outcomes (Handley et al., 2013). From placebo effects in pharmaceutical research to experimenter bias based on preconceived theories, it is often difficult to remove the psychology of expectation when analyzing study results. Specifically, confirmation bias occurs when perceptions of a stimulus are affected by an observer's expectations about the stimulus (Price et al., 2008).

Historically, confirmation bias has not been considered in studies of outcomes from advanced technology orthopedic devices. Mohr et al. did examine bias in a related area in a study on the effects of expectation of shoe weight on athletic performance (Mohr et al., 2016). Two groups each wore three pairs of differently weighted basketball shoes. One group was told which shoes were lighter, medium, or heavier. In addition, the researchers told these participants that they expected them to perform better in the light shoe condition, and worse in the heavy shoe condition. The second group was blinded to the weight of each shoe they wore. Both groups wore the three pairs of shoes while completing performance tests at maximal effort. The results showed a significant increase in performance during two of the tests when the participants were aware they were wearing the light shoe, versus the other shoes. The blinded group did not exhibit any significant difference among the three pairs of shoes. The results suggest

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additional questions. If the shoes were actually all identical, would performance for the two groups have reversed?

This study examined the expectations and outcomes of healthy young adults wearing knee braces. Participants wore two braces that were functionally identical but cosmetically different, and were told that one contained advanced dynamic stiffness control. The study assessed users' expectations, measured their gait, and then assessed their subjective feedback following the walking trials. We tested two hypotheses: (1) Users who are told that one brace is more advanced than another will report that it performed better, even if the two are functionally identical; and (2) Healthy young adults will walk the same in two braces, even though they think one is performing better.

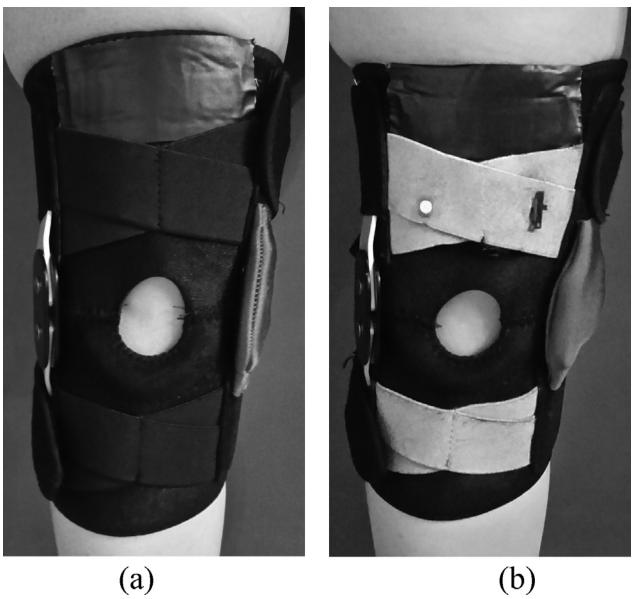

Fig. 1. Mueller® Adjustable Hinged Braces (model 6455) with two hook-and-loop straps, a patellar opening with patellar cushion, and a hinged metal bar on either side of the knee. Standard, unmodified brace (A) compared to "computerized" brace (B), cosmetically altered by adding a power switch, an LED light to indicate power, a micro-USB port, and silver paint.

2. Methods

Eighteen healthy young adults, aged 18–26 years old, participated in this IRB-approved study. Participants completed a Physical Activity Readiness Questionnaire (PAR-Q) (Thomas et al., 1992), and were not eligible if they answered yes to any of the questions. Subjects also could not have worn a knee brace during the last year and had to fit within the given size parameters from the brace manufacturer.

The project was described as a manufacturer-funded study of a new prototype knee brace. Following informed consent, each participant was shown a flyer describing the "computerized" brace. The flyer included phrases such as, "Using a state-of-the-art microprocessor, accompanied with an accelerometer, this knee brace can measure and adjust joint stiffness in real time." In addition, the flyer included a fabricated graph of knee flexion angles during preliminary testing.

Table 1
Average Likert score for each factor across all subjects and standard deviation. Values below 5 indicate preference for standard brace; values above 5 indicate preference for "computerized" brace. Strongest possible preference would be 1 or 9 for standard or "computerized" brace, respectively.

Factor	Average before walking (std. dev.)	Average after walking (std. dev.)
Appearance	5.5 (1.9)	5.8 (1.7)
Stabilization	6.9 (2.1)	6.9 (1.9)
Cost	3.8 (2.5)	4.9 (2.5)
Comfort	5.3 (2.0)	6.0 (2.3)
Function in Sports	6.1 (2.7)	6.8 (2.0)
Overall Preference	6.1 (2.0)	6.9 (1.4)

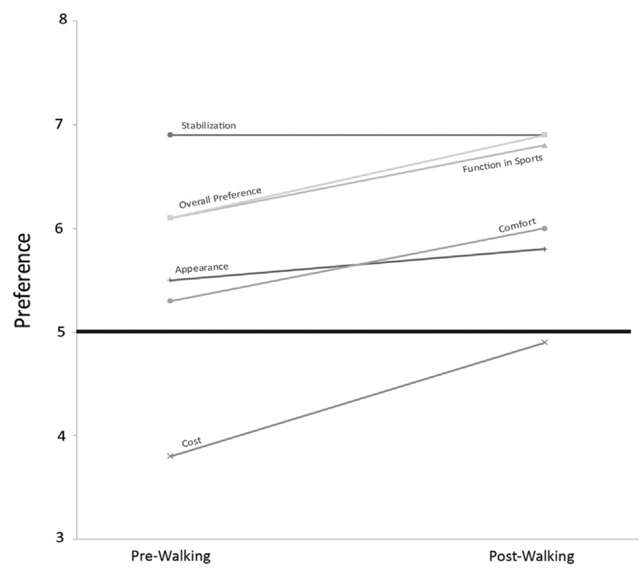

Fig. 2. Average Likert score for each factor across all subjects both before and after the walking trial. The horizontal line at "5" indicates no preference; values below the line indicate increasing preference for standard brace, and values above the line indicate increasing preference for "computerized" brace.

Table 2
Gait outcome means and (standard deviations), comparing standard knee brace to cosmetically altered but functionally identical "computerized" brace, along with p-values and effect sizes.

Variable	*Standard brace* mean (std dev)	*"Computerized" brace* mean (std dev)	*p*	*Cohen's d*
Walking speed (m/s)	1.18 (0.133)	1.19 (0.153)	0.31	0.07
Stride length, braced side (m)	1.26 (0.109)	1.26 (0.138)	0.97	0.00
Stride length, opposite side (m)	1.26 (0.109)	1.26 (0.138)	0.64	0.03
Peak stance phase knee flexion, braced side (degrees)	42.2 (6.83)	43.8 (6.39)	0.29	0.25
Peak stance phase knee flexion, opposite side (degrees)	41.7 (4.42)	41.8 (4.43)	0.89	0.02
Peak swing phase knee flexion, braced side (degrees)	57.8 (7.08)	59.5 (6.79)	0.25	0.25
Peak swing phase knee flexion, opposite side (degrees)	62.3 (4.83)	62.4 (4.65)	0.75	0.02
Peak vertical ground reaction force, braced side, peak one (xBW)	1.53 (0.322)	1.52 (0.311)	0.83	0.01
Peak vertical ground reaction force, opposite side, peak one (xBW)	1.52 (0.315)	1.54 (0.315)	0.22	0.04
Peak vertical ground reaction force, braced side, peak two (xBW)	1.58 (0.382)	1.60 (0.389)	0.064	0.04
Peak vertical ground reaction force, opposite side, peak two (xBW)	1.60 (0.370)	1.61 (0.381)	0.59	0.02

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