European Journal of Sport Science

ISSN: 1746-1391 (Print) 1536-7290 (Online) Journal homepage: https://www.tandfonline.com/loi/tejs20

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To cite this article: Arran J. Davis, Florentina Hettinga & Chris Beedie (2019): You don't need to administer a placebo to elicit a placebo effect: Social factors trigger neurobiological pathways to enhance sports performance, European Journal of Sport Science, DOI: 10.1080/17461391.2019.1635212

To link to this article: https://doi.org/10.1080/17461391.2019.1635212

Accepted author version posted online: 15 Jul 2019.
Published online: 21 Jul 2019.

European Journal of Sport Science, 2019
https://doi.org/10.1080/17461391.2019.1635212

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ORIGINAL ARTICLE

You don't need to administer a placebo to elicit a placebo effect: Social factors trigger neurobiological pathways to enhance sports performance

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Abstract
The placebo effect is traditionally viewed as a positive outcome resulting from a person's belief that an inert substance is in fact an active drug. In this context, it is often viewed as an intrapsychic phenomenon. However, most placebo effects reported in scientific research result from social interactions. These might be explicit, such as the description and administration of a treatment by a practitioner, or less explicit, for example, the recipient's perceptions of the practitioner's credibility, expertise, or confidence. On this basis, placebo effects are arguably social in origin. Many phenomena in sport are likewise social in origin, from the facilitation effects of a home field crowd or a cohesive team, to anxiety induced by an expert opponent or perceived underperformance. Such social effects have been the subject of research not only in social psychology, but also in experimental physiology. Emergent research in cognitive and evolutionary anthropology suggests that these social effects can be examined as a form of placebo effect. This suggestion is not a speculative position predicated on social and placebo effects sharing similar environmental cues and outcomes, but one based on a growing database indicating that drug, placebo, and social effects operate via common neurobiological mechanisms. In this paper, we examine the theoretical and empirical overlap between placebo and social effects and describe emergent research reporting specific brain pathways activated by socio-environmental cues as well as by drugs and placebos. We do so from three perspectives: the competitor, the teammate, the researcher.

Keywords: *psychology, anthropology, environment, social support, placebo, researcher effects*

Highlights

- Placebo effects are often socially contingent. In this context they result from, for example, socially learned information about a treatment, or beliefs about a practitioner's credibility and competence.
- In sport and exercise, social information - in the form of competition or social support from others - has been shown to affect physical performance. Research suggests that these effects may be underpinned by the same self-regulatory, neurobiological mechanisms that underpin placebo effects.
- Placebo effects and social effects in sport and exercise can be viewed as overlapping components of broader psychophysiological responses to environmental cues that affect motivation, selfefficacy, resource availability, and safety.

Introduction: people as placebos

The Performance Director of a UK Olympic Team was recently described by one of his sports science support staff as a 'human placebo'. This statement was qualified by a description of how the person in question always brings out the best performances from the athletes, often through social, as opposed to technical, processes. Some people in the room understood the use of the word 'placebo' in the context of it being a positive effect, albeit one that appears to have no clear mechanism. However, it was actually a reference to an earlier discussion between one of the authors of this paper and the Performance Director, a discussion that had centred on the possibility that neurobiological pathways that are triggered by drugs and performance-enhancing ergogenic substances might also be triggered by a broader range of cues, including social interactions. In short, that social processes can be as ergogenic as (beliefs about) drugs. This suggestion itself was

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based on emergent research in cognitive and evolutionary anthropology, and recently sports science, that is at the core of the present paper.

A placebo is an inert treatment that is administered under the guise of it being real. The placebo effect is traditionally seen as being the result of the administration of a placebo. However, the idea of the placebo effect is perhaps better conceived as 'placebo effects'; that is, numerous discrete neurobiological mechanisms appear to play a role, depending on treatment, context, and method of administration (Benedetti, 2013). In fact, it is perhaps as inaccurate to talk of *the* placebo effect as it is to talk about emotion, both placebo effects and emotions come in many discrete forms. Given this, definitions can be problematic. Elsewhere in this issue, and with the sports context in mind, we propose the following definitions: a placebo effect is a neurobiological response resulting in improved performance, which stems from an inert treatment such as sham drugs, nutrients, or equipment, and which is usually associated with cues to improved performance, such as verbal suggestions, explicit expectations, or implicit experience. We also define the nocebo effect as a neurobiological response resulting in worsened performance, which stems from an inert treatment such as sham drugs, nutrients, or equipment, and which is usually associated with cues to worsened performance, such as verbal suggestions, explicit expectations, or implicit experience (Szabó, Lindheimer, Raglin, & Beedie, In Press). However, and again in this issue (Lindheimer, Szabó, Raglin, & Beedie, In Press), we argue that the placebo effect can be studied *without the use of placebos*; social cues to enhanced performance alone might elicit the effect. For example, enhanced analgesia has been reported among patients who received enhanced treatment expectations compared to treatment alone and no treatment (Kong et al., 2018), an effect that was evident via fMRI in brain regions previously reported to mediate placebo effects (Amanzio, Benedetti, Porro, Palermo, & Cauda, 2013). The counterintuitive implication of this is that an individual can experience a placebo effect without having been administered a placebo, or at least, a physical placebo.

It can, in fact, be argued that a placebo is nothing more than the vehicle for an effect that is in reality triggered by an environmental or social process. This arguably leaves the above definitions wanting. However, it is probably legitimate to simply rephrase the definition: a placebo effect is a neurobiological response resulting in improved performance, which stems from an inert treatment such as sham drugs, nutrients, or equipment *and/or* cues to improved performance, such as verbal suggestions, explicit expectations, or implicit experience. This opens up the possibility that many psychological phenomena might in fact operate via placebo mechanisms, which we address elsewhere (Beedie, Foad, & Hurst, 2015).

An evolutionary perspective on placebo and social support effects

Humans are a socially interdependent species. For a significant part of our evolutionary history, human ancestors relied upon one another for purposes ranging from predation deterrence to raising young and acquiring nutrient-rich food sources (Tomasello, Melis, Tennie, Wyman, & Herrmann, 2012). As a result, many cognitive processes appear hard-wired to reward cues to success in social relationships (e.g., status, acceptance, empathy, and bondedness), and lead to negative affect when social failure is cued (e.g.,, in loneliness, shame, jealousy, and rejection) (Eisenberger, Lieberman, & Williams, 2003). These psychophysiological (i.e., emotional) states are underpinned by neurobiological processes that also mediate other aspects of our relationship with the environment, such as reward, learning, and pain. For example, empathy and altruism promote pleasure through the dopamine reward pathway, whilst social exclusion can elicit pain through the same brain pathways by which the pain of physical injury are processed (Eisenberger, 2012; Eisenberger et al., 2003; Novembre, Zanon, & Silani, 2015). The brain, despite its extraordinary complexity, is thus an exemplar of economic design; a single pathway or structure is often used to facilitate numerous outcomes, a good example being the endogenous opioid system, which is involved in processes ranging from rewarding positive social interactions to the regulation of pain and stress.

As is highlighted elsewhere in this issue (Beedie et al., In Press), the placebo effect is often considered a regulator of the relationship between an organism and its environment, one of a broad range of self-regulatory processes that includes emotion regulation, re-appraisal, and self-control (Lieberman, 2007). These regulatory processes engage numerous brain processes, including emotion, memory, and prospection (i.e., the conscious anticipation of future events), and in doing so they activate broad neurophysiological responses (Ashar, Chang, & Wager, 2017). In short, humans have a repertoire of adaptive mechanisms that are catalysed by encounters with our physical and social environments, and one of these mechanisms is what we loosely term the placebo effect. Unlike most other regulatory processes, however, the placebo effect is somewhat mercurial, and in most cases, cannot be consciously switched on or off by the individual.

To understand placebo effects from this perspective, it is useful to consider why evolution would result in adaptations that alter psychophysiological processes based on socio-environmental cues. Of course, certain socio-environmental cues favour certain psychophysiological responses. For example, the presence of a predator usually favours the psychophysiological state associated with the fight-or-flight response. In humans, biomedical treatments, and the impending improvements and resource abundance they are associated with, may favour reductions in (protective) pain or increases in immune activity. Protective pain may be less necessary when safety is assured, and enhanced immune activity may be more optimal when individuals are likely to be able to replenish used immune resources. Given that caring for the elderly, sick, injured is likely an evolutionarily ancient trait – archaeological evidence for care for others dates back to over one million years ago (Lordkipanidze et al., 2005) – it is probable that humans have adaptations that respond to cues of care and support from others with appropriate psychophysiological changes. In the context of physical exertion, these adaptations may favour greater outputs when socio-environmental cues signal relative safety (e.g., that others will care for them when they are exhausted) or resource abundance (e.g., additional resources from a performance-enhancing drug). However, these adaptations can be 'tricked' by false cues, such as placebo treatments, that suggest additional resources when none are actually available. Nonetheless, unconscious cost–benefit analyses (about resource availability, safety, etc.) are altered by these cues, and this can lead to the psychophysiological changes associated with some types of placebo effects (Humphrey & Skoyles, 2012).

Cues from both the physical and social environment can affect overlapping self-regulatory mechanisms that determine psychophysiological states. Regarding the physical environment, In this context, it has been proposed that the placebo effect, now perhaps relatively unpredictable, was once a predictable set of responses to what were a relatively stable set of environmental conditions for much of our evolutionary history (what has been termed the human Environment of Evolutionary Adaptedness or EEA). It is however an effect that has been rendered significantly less predictable by the significant difference between that EEA and the contemporary environment (Harvey & Beedie, 2017).

Whilst Harvey & Beedie (2017) were addressing factors in the *physical* environment, such as temperature, nutrient intake, and oxygen availability, the same statement might be equally true of the social environment. Self-regulatory processes such as emotions are catalysed by a number of cues. The placebo effect, which is popularly associated with medicines, is likely no exception. Receiving a medicine might catalyse cognitive, emotional, and somatic responses. The emotional and cognitive responses are underpinned by neurobiological mechanisms. Any or all of these mechanisms might also be catalysed by a placebo medicine. Consistent research evidence going back as far as the late 1970s (Levine, Gordon, & Fields, 1978), suggests that placebo medicines not only exert an effect, but often do so by using the same neurobiological pathway as the actual medicine the placebo purports to be. More recent findings indicate that placebo opioids activate endogenous opioid pathways (Benedetti, Pollo, & Colloca, 2007), whilst placebo non-steroidal anti-inflammatory drugs activate endocannabinoid pathways (Benedetti, Amanzio, Rosato, & Blanchard, 2011).[1] That placebo drugs use pathways targeted by the 'real' drug is perhaps most clinically meaningful in the effects of sham L-DOPA in the treatment of dopamine deficiency in the basal ganglia of Parkinson's Disease patients (Benedetti et al., 2016). Whilst mechanistic evidence in sport is limited, the same specificity of pathways was demonstrated in human performance: Benedetti et al. (2007) showed pain endurance and physical performance increased following a placebo treatment that was preceded by a morphine conditioning procedure. The opioid antagonist naloxone was shown to (partially) block this conditioned placebo response. Taken collectively, these data suggest that these pre-existing pathways can be activated by a range of cues over and above biologically active drugs, and that the context of the placebo cue can determine which pathway is activated.

Sport is arguably an extension of our human social nature, a process that allows us to express our competitive (winning and losing), collaborative (conformity and belonging), and social (teammates and opposition) traits in a physically demanding and often emotional environment. Given evident crossover between the social dynamics of sport and our evolved social needs and structures, it makes intuitive sense that self-regulatory processes that evolved in the human social context might also exert significant effects on individuals' behaviour, perceptions, and emotions (including the neurobiological systems that underpin them) during sport. Below, we briefly synthesise findings from both the sports science and anthropological literatures, in order to arrive at a tentative consensus on placebo effects resulting from social factors in sport. We specifically examine three contexts: competitors, team-mates, and researchers.

A sports scientific perspective: the competitor as a form of placebo?

Research from sport and exercise psychology – especially that on ergogenic placebos – has shown that physical outputs are dependent on a host of factors in athletes' external and internal environments (Beedie & Foad, 2009; Beedie, Lane, & Wilson, 2012; Benedetti et al., 2007; Davis & Cohen, 2018; Davis, Taylor, & Cohen, 2015; Pollo, Carlino, & Benedetti, 2008). Physical outputs are thus not solely determined by athletes' physiological capabilities, but also through environmentally dependent, self-regulatory processes that affect athletes' beliefs, motivations, and perceptions of energy and fatigue (Lambert, Gibson, & Noakes, 2005; Noakes, 2012; Noakes, Gibson, & Lambert, 2005; Stein, Collins, Daniels, Noakes, & Zigmond, 2007). Athletes' internal states and external environments contribute to both explicit and tacit cost–benefit analyses that determine physical output levels, taking into account, among other variables, current (perceived) physical capacities, energy availability, and the potential for negative outcomes (e.g., injury) or rewards (e.g., winning). Given the highly social nature of the human species (e.g., Tomasello, 2014), other people – which include teammates, competitors, coaches, and practitioners, such as trainers, medical doctors, and, in the case of placebo effect research, experimenters (see final section below) – are likely to have a large effect on athletes' analyses of their external environments. Indeed, social environments have been shown to affect exercisers' estimates of the difficulty of physically demanding tasks (Schnall, Harber, Stefanucci, & Proffitt, 2008), and athletes' performance in physical fitness tests (Davis et al., 2015), while human–environment interactions are seen as crucial to competitive performance (Hettinga, Konings, & Pepping, 2017; Konings & Hettinga, 2018; Smits, Pepping, & Hettinga, 2014). Social environments can therefore influence athletes' explicit and implicit beliefs, expectations, and motivations, leading to changes in the self-regulatory processes that govern physical outputs.

In a clinical setting, a placebo might exert its effect through neurobiological mechanisms associated with conditioning and/or expectation (Benedetti, 2013). Environmental and social effects related to administration of the placebo, such as expectations, previous experiences, the interaction between participant and researcher, trust, empathy and the ritual surrounding the administration, all contribute to the effectiveness of a placebo treatment (Beedie et al., 2018). In sports, athletes are surrounded by a multitude of environmental and social stimuli that potentially impact their expectations and alter their performance (Hettinga et al., 2017). Human–environment interactions have been found to be crucial to performance (Smits et al., 2014) and environmental cues clearly have their impact on the outcome of the athletic decision-making process (Konings & Hettinga, 2018). Competitors and opponents are environmental factors of interest in sports, as they have been suggested to impact athletes' motivation and effort via neurophysiological pathways or modifications in the perception and prioritising of different stimuli (Schiphof-Godart & Hettinga, 2017). Theoretically, both placebo effects and opponent effects can result in better performance. Even the presence of a competitor perceived as unbeatable, which might be considered a nocebo (especially if the ambition of the athlete is to win), might be considered a placebo if the ambition of the athlete is simply to achieve a personal best time. Therefore, it is interesting to explore where placebo effects would fit into the theoretical framework of athlete-environment interactions.

A recent review has shown that the behaviour of an opponent is an essential determinant in the regulation of performance intensity (Konings & Hettinga, 2018). A direct coupling between perception and action, rather than in distinct serial stages within a brain governor system (as argued by the ecological-psychological approach towards pacing), has been suggested. However, which affordances the athlete selects to realise among the variety of affordances that are presented simultaneously and continuously, will also be based on the athlete's motivation, previous experience, the internal state of the athlete and/or the perceived level of exertion. In this model, it is easy to imagine that opponents, like placebos, could have an impact on beliefs, motivations 2017 and expectations in a similar way, and could thereby affect pacing behaviour and performance by modifying the perception and prioritisation of different external and internal stimuli via similar pathways as placebos (Konings & Hettinga, 2018).

When an athlete takes a placebo, positive verbal and environmental cues could lead to their believing that a slightly faster pace and performance is attainable, thereby impacting on the pacing decision-making process during performance. Similarly, when that same athlete sees an opponent of a similar level executing a pacing strategy slightly faster than their own self-paced preference, it potentially shows the athlete that this strategy is both realistic and attainable, and thereby could impact on the belief that it is possible to achieve a slightly faster pace and performance. It has been argued that Roger Bannister's breaking of the four-minute mile mark in 1954 broke an invisible performance ceiling, which allowed many other runners, all of whom were hitherto unable to break this mark, to do so. There is some credibility to this argument; organised attempts on the 4-minute mile had been made since 1886 (Bryant, 2004). That the 4-minute mark remained unattainable for 68 years suggests that it would be a unique individual and/or performance that would break this record. However, seventeen sub-4 min miles were recorded in the five years following Bannister's record, three of them in one race in 1955. Of course, there are a multitude of possible alternative explanations, but social facilitation, driven by changed beliefs and expectations of what was possible among the running community, appears an increasingly strong hypothesis.

Both a placebo treatment and the performance of an opponent can be seen as a method by which to increase athletic drive to compete. It has also been suggested that the opposite is true for mental fatigue (Schiphof-Godart, Roelands, & Hettinga, 2018): mental fatigue can influence endurance performance by decreasing athletes' drive to exercise by increasing the perceived effort necessary for a given task or by decreasing the perceived value of the reward that can be obtained. These mechanisms might play a role in both placebos as well as opponent effects. For example, it has been shown that, when racing an opponent, improved performance is associated with the ability to tolerate higher levels of muscle fatigue, while still perceiving a similar rate of exertion as when performing alone; a higher velocity is prioritised when racing an opponent, whereas it seemed unnecessary or unachievable when racing alone (Konings & Hettinga, 2018). It is also easy to imagine that the opposite occurs: if an athlete is being outperformed by an opponent, this could have a negative impact on their beliefs and perceptions of self-efficacy, resulting in an effect comparable to a nocebo effect, that is, an undesirable effect resulting from anticipated or conditioned negative outcomes. This links to findings related to the impact of negative momentum in sports (i.e., when regressing related to the goal) that have been reported in rowing performance: when the team's avatar gradually regressed further away from victory compared to the opponent's (manipulated) performance, this was associated with negative psychological changes, a rapid decrease in exertion, and lower task efficiency and cohesion (Den Hartigh, Gernigon, Van Yperen, Marin, & Van Geert, 2014). Again, it seems that similar mechanisms are underlying performance improvements, but more studies are needed exploring placebo as well as opponent effects, and potentially also the other end of the continuum that is mental fatigue, to determine whether similar underlying mechanisms play a role.

An anthropological and neurobiological perspective: the teammate as social placebo

Anecdote, empirical observation, and ethnography all suggest that positive social environments, such as cheering fans or supportive teammates, can enhance performance in sport and exercise (Carron, Colman, Wheeler, & Stevens, 2002; Gotaas, 2012; Kraus, Huang, & Keltner, 2010). The causal mechanisms involved in these effects are likely varied and dependent on the type of performance being measured. In this section, we will focus on performances that are highly dependent on the self-regulatory mechanisms of pain and fatigue, two phenomena demonstrated as placebo responsive in neuroscientific literature (Benedetti, Barbiani, & Camerone, 2018; Pollo, Carlino, & Benedetti, 2011). Although performance in sport is also enhanced by, for example, high levels of cooperation amongst cohesive teammates (Kraus et al., 2010), placebo studies have focused almost exclusively on how belief and conditioning influence the self-regulation of physical outputs. Theoretical and experimental evidence suggest that socially supportive environments might also affect self-regulation, and that these effects work through similar neurobiological pathways to those mediating ergogenic placebo treatments.

Research on ergogenic placebo effects suggests that belief and conditioning processes can alter outputs during physically strenuous tasks through their influence on self-regulatory systems involved in pain and fatigue. We have already mentioned a study by Benedetti et al. (2007), which showed that the opioid antagonist naloxone *partially* blocked a conditioned placebo response in muscle performance. These findings suggest that, like placebo analgesia (e.g., Wager, Scott, & Zubieta, 2007), ergogenic placebo effects are likely underpinned by endogenous opioid activity, as well as activity in non-opioidergic systems, such as the endocannabinoid system (Benedetti et al., 2011).

Importantly, both the endogenous opioid and endocannabinoid systems are involved in the formation, maintenance, and signalling of human social bonds (Inagaki, Ray, Irwin, Way, & Eisenberger, 2016; Machin & Dunbar, 2011; Tarr, Launay, Benson, & Dunbar, 2017; Trezza, Baarendse, & Vanderschuren, 2010). For example, endogenous opioid activity brought about by positive and cooperative social interactions (such as shared laughter, and group song and dance) has been shown to lead to positive affective states and associated increases in social bonding (Dunbar et al., 2011; Tarr, Launay, Cohen, & Dunbar, 2015). Further research suggests that endogenous opioid and endocannabinoid activity can signal social connections with others, and reward affiliation and interaction with close others (Inagaki et al., 2016; Trezza et al., 2010; Wei, Allsop, Tye, & Piomelli, 2017). Given the implication of the endogenous opioid and endocannabinoid systems in analgesic and ergogenic placebo effects, these findings suggest that social environments might influence the neurobiological underpinnings of pain and fatigue. Indeed, Coan, Schaefer, and Davidson (2006) showed that the presence of socially supportive others (i.e., spouses), reduced the reported unpleasantness and severity of experimentally induced pain. This effect was moderated by the quality of the relationship, with higher quality predicting greater attenuation of the pain response. Other research has shown that even mere cues to the presence of social support – such as photos of loved ones – can reduce perceptions of experimentally induced pain (Eisenberger et al., 2011; Master et al., 2009). Pollak et al. (2014) showed that metabolites from working muscles evoke sensations described as 'fatigue' when at low concentrations (i.e., when found with moderate physical exertion) and 'pain' when at high concentrations (i.e., when found with intense physical exertion), suggesting that pain and fatigue seem to occupy ranges on a single scale of physical discomfort. It is therefore likely that social support affects perceptions of fatigue in addition to perceptions of pain, that these effects might work via similar mechanisms to placebo effects (i.e., opioid and endocannabinoid pathways), and that they have important implications for physical performance.

While a wide body of literature suggests a positive link between measures of social support and cohesion and variables such as motivation and performance (e.g., Carron et al., 2002; Christensen, Schmidt, Budtz-Jørgensen, & Avlund, 2006; Filho, Dobersek, Gershgoren, Becker, & Tenenbaum, 2014; Freeman & Rees, 2008), relatively little work focuses directly on levels of fatigue and subsequent physical outputs as outcomes. A series of studies have shown that synchronous rowing – as opposed to non-synchronous or solo rowing – leads to higher post-exercise pain thresholds (Cohen, Ejsmond-Frey, Knight, & Dunbar, 2010; Sullivan & Rickers, 2013; Sullivan, Rickers, & Gammage, 2014). These increases in pain threshold are thought to be underpinned by heightened endogenous opioid activity resulting from synchronous movement, which has been theorised to be a cue to the presence of bonded, supportive, and cohesive relationships amongst group members (Reddish, Fischer, & Bulbulia, 2013; Wheatley, Kang, Parkinson, & Looser, 2012). While these studies controlled physical outputs, the observed increases in pain threshold suggest that cohesive social environments cued by synchronous movement could increase physical outputs through blocking signals of pain and fatigue that attenuate motor drive during exercise, as was the case in the ergogenic placebo study conducted by Benedetti et al. (2007). A further study examined synchrony effects on anaerobic performance. Davis et al. (2015) manipulated synchronous movement in a warm-up with a rugby team ahead of a maximal anaerobic conditioning test. In a within-subjects design, athletes performed a pre-learned set of dynamic stretches either synchronously (same movements simultaneously) or non-synchronously (different movements simultaneously) with a teammate, or on their own. Even though athletes were separated following the warm-up and completed the anaerobic test individually and in isolation (they were observed only by the experimenter), they ran significantly faster times, 253s as compared to 259s, after warming up synchronously with a teammate, as compared to warming up non-synchronously with a teammate.

Only one study has used a more direct social manipulation before a strenuous physical exercise task. Davis and Cohen (2018) tested the effects of social support through manipulating the presence of a socially bonded companion – friends and romantic partners in this case – during a series of anaerobic tests. Socially supported participants produced greater initial outputs and steeper declines in performance over time, as compared to controls. This finding suggests that supported exercisers 'overshot' optimal initial outputs, perhaps due to heightened activity in endogenous pain and fatigue modulation systems. Indeed, this pattern of results is similar to those found in research using the opioid agonist fentanyl. Compared to those who received placebo, those in the fentanyl condition showed increased outputs in the first half of a 5 km cycling trial, and decreased outputs during the second half; this was hypothesised to result from the opioid-mediated blockade of motor-drive-attenuating pain and fatigue signals from peripheral muscles, causing initial overshoots of optimal outputs (Amann, Proctor, Sebranek, Pegelow, & Dempsey, 2009). It is not unreasonable to argue that reductions in pain and fatigue resulting from social support could have similar effects on physical outputs, working through neurobiological pathways known to be involved in performance-enhancing drugs (e.g., morphine) and placebo effects (Benedetti et al., 2007).

Data indicate that social variables such as coordinated movement (social motion) can affect physical outputs likely related to one or more of intensity, quality, and efficiency of movement. It has been theorised that these social variables affect the neurobiological mechanisms involved in the self-regulation of physical outputs (Davis & Cohen, 2018). Ascending neural pathways not only affect perceptions of pain and fatigue, but also inhibit areas of the CNS involved in motor drive, 'thereby contributing to the conscious and/or subconscious determination of the magnitude of central motor drive during high-intensity endurance exercise' (Amann et al., 2009, p. 279). Although more research is needed, these findings give some neurobiological credence to long-held beliefs about the effects of cheering supporters and cohesive teams or social environments on performance during sport and exercise. Crucial to the present paper, by eliminating audience effects and consequent motivational confounds, the Davis et al. (2015) and Davis and Cohen (2018) studies suggest that supportive social environments in sport might do more than just increase conscious motivation, that is, the volitional decision to allocate a certain quantity of resources to a certain task (arguably, what is termed pacing or effort); they may alter the subconscious, neurobiological, and self-regulatory processes that govern physical outputs related to intensity, quality, and efficiency of movement. Results suggest that social environments that signal support and safety could reduce perceptions of pain and fatigue during physical exertion through mechanisms similar to those underpinning ergogenic placebo effects. When a social environment signals relative safety, the potential of care from others, and resource availability, optimal levels of pain and fatigue – which, ultimately, function to protect against exhaustion and injury – may be reduced (Humphrey & Skoyles, 2012). Self-regulatory reductions in pain and fatigue could ultimately allow athletes to push themselves harder and for longer.

These findings have potentially far-reaching implications. For example, it seems that these effects also affect pacing strategies, and that athletes should take into account social variables such as crowd support when determining optimal output strategies. More broadly, researchers and athletes alike should begin to consider the importance of social support and cohesion in determining physical performance in members of the public interested in physical fitness to top-level athletes striving for maximal performance.

The methodological perspective: the researcher as social placebo

Placebo effects have been termed 'belief effects' because, for a placebo treatment to be effective, its recipients must (consciously or unconsciously) *believe* that it will be effective (Moerman, 2002). Belief in the efficacy of a treatment can arise through conditioning procedures or from social learning. If individuals have not yet taken a purported treatment (i.e., they haven't been conditioned to expect a certain effect), then placebo effects will most likely depend on socially learned information about the treatment. Of course, the strength of socially learned beliefs about a treatment will then depend on what individuals have learned, how they learned it, and who they learned it from. Here, we will focus on the latter of these variables: the experimenters administering placebo treatments.

Currently, there is considerable interest in factors that might explain variability in response to any specific treatment, such as ergogenic aids (Pickering & Kiely, 2018) or exercise (Atkinson & Batterham, 2015). It has been demonstrated that both active/biological and placebo/psychological factors contribute to the effects of legitimate treatments, such as caffeine (Foad, Beedie, & Coleman, 2008). It has also been demonstrated that treatments administered without the knowledge of the patient are less effective than those administered with patient knowledge (Benedetti, 2013); in this latter case, zero expectation of benefit would theoretically exclude the possibility of a placebo component to treatment, reducing overall effectiveness. On this basis, variability in response to any treatment could be evident in (i) the response to the biologically active component of the treatment, (ii) to the placebo component of the treatment, or (iii) to both. Previous findings suggest that inter-individual variation in performance following the administration of a placebo treatment is greater than at baseline, which in turn suggests that not all people respond in the same way to a placebo (Beedie & Foad, 2009). These factors suggest that variation in placebo responsiveness might be a factor in variation to real treatments.

Whilst it has been proposed that placebo responses reflect nothing more than random variation, there is little doubt (given the mechanistic neurobiological work cited above) that they are robust effects, and that similar interventions lead to effects of a similar magnitude in a number of contexts. However, as suggested above, not all people respond to a placebo treatment. Further, there are relatively little data attesting to the intra-individual reproducibility of the effect over time. In this context, the concept of the 'placebo responsive personality' has been the subject of research for over 60 years since Beecher first proposed that placebo responsiveness might be a trait (Beecher, 1955). The idea under examination is that some people do, and some do not, respond to placebos, and that this responsiveness is a function of personality and genetics (Hall, Loscalzo, & Kaptchuk, 2015). The subject has also been addressed in sport (Beedie, Foad, & Coleman, 2008), albeit without much success. This is, of course, consistent with the intrapsychic paradigm alluded to above, which is that the placebo response is a function of the person receiving the placebo. We hope that at this point in the paper it is evident that social factors contribute significantly to placebo effects, and that the line between some social effects and placebo effects might be blurred. In introducing this paper, we described a team who perceived their performance director as a 'human placebo'; someone with the ability to enhance team performance without any clear mechanism. This perhaps suggests that the capacity to elicit a placebo effect lies as much with the practitioner as the recipient.

The capacity for people to elicit – or possibly to not elicit – placebo responses might help to determine effectiveness as a practitioner (Beedie et al., 2015). However, it might be problematic in the context of research, where it could bias and therefore reduce the validity of research findings. Most of what we know about the placebo effect beyond folk psychological perspectives and academic speculation, we know from empirical research. Research into placebo effects almost always requires that two or more people are involved in an encounter in which the exchange of information or an idea takes place, the characteristics of which might significantly influence the direction and magnitude of the effects observed in the study. What have been described as 'experimenter effects' in biomedical research – that is, differences in outcomes based on the characteristics of the person who administers the treatment or collects the data – may be best understood as differences between the abilities of individual experimenters to enhance recipients' beliefs about the efficacy of those treatments. In a situation in which the treatment is biologically efficacious, this effect might be small. With an inert placebo treatment, however, experimenter effects might constitute 100% of the overall outcome (Beedie et al., 2017).

If we are to understand the placebo effect, in its social context but also in others (e.g., in relation to drugs), scientists need to be able to reliably elicit the effects in controlled conditions. Anthropologists have stressed the importance of 'performative efficacy' in bringing about placebo effects. Performative efficacy requires practitioners and experimenters to recreate rituals and symbols associated with legitimate and effective treatments (Kaptchuk, 2002; Tambiah, 1990). In Western contexts, symbols and rituals include the doctor's white coat and medical language about treatment effects (Moerman, 2002). When patients or athletes are exposed to these cultural signals of medical efficacy, their beliefs in the legitimacy of practitioners and their treatments increase. The more culture-specific cues of medical legitimacy and support a patient receives, the stronger their response to a (placebo) treatment.

How treatments are presented and provided can thus affect participants' beliefs about treatment efficacy, and, ultimately, bring about placebo effects. For example, brand name medications have been shown to outperform their pharmacologically identical counterparts; the culturally defined legitimacy of brand names enhance beliefs about their effectiveness and increase resultant placebo effects (Branthwaite & Cooper, 1981)(Moerman, 2002). Research has also shown that placebo responses are stronger when practitioners invest more time into building relationships with their patients, and when these relationships are of higher quality (Kaptchuk et al., 2008); (Kelley et al., 2014)). Other work has shown that placebo effects have been increasing over time in randomised controlled trials in the United States, with researchers theorising that this increase has stemmed from longer practitioner–patient interactions and larger investments in the presentation of treatments (Tuttle et al., 2015).

Although these findings come from medical contexts, they are relevant to researchers interested in better understanding placebo effects in sport. The efficacy of a placebo treatment – especially one requiring social learning – is likely to be highly dependent on cultural cues that signal the legitimacy of the researcher and the efficacy of the treatment. Placebo manipulations in research should be based on providing participants with these culturally sanctioned cues. For example, researchers should present both themselves and the purported treatment (albeit a placebo) in a way that increases the legitimacy of the treatment in the eyes of participants. Given the likely importance of these subtleties in bringing about placebo effects, it is important that published placebo research provide detailed accounts of who administered placebo manipulations and how they were presented. Through these practices, it is likely that research will begin to reveal how specific characteristics of placebo treatments translate to placebo effects, and how experimenter effects can be explained as differences in the cultural cues of legitimacy and efficacy associated with a particular placebo treatment.

It is clear from the above that in researching the placebo effect, it is not unusual for researchers to be an active agent in what they study, suggesting what would be considered bias in many areas of research. However, an effect cannot be reliably studied if it cannot be reliably elicited, so those studying the placebo effect must also take these factors into account. This will ensure that we better understand the triggers, mechanisms, and effects brought about by placebo treatments. In short, those studying placebo effects cannot eradicate what would in other contexts be transparent bias; we must either control for it or systematically manipulate it.

Conclusion

Humans are a highly social species, consistently looking to conspecifics to glean information about current and future environments (Henrich, 2015). Although often overlooked, this social information plays an important and unavoidable role in determining outcomes in sport and exercise. Compelling evidence suggests that certain neurobiological pathways triggered by placebos in medicine are also triggered by social cues. One such social cue is what we term a placebo. By altering the perceived costs (e.g., the consequences of resource depletion) and benefits (e.g., winning an Olympic medal) of physical exertion, social information gleaned from competitors,teammates, and practitioners can change the optimal physical output strategies for athletes and exercisers.

The idea that placebo effects can be elicited without a placebo is controversial. It perhaps calls into question the status of any such effects as a placebo effect *per se*. In this paper, however, we have tried to draw links between various elements of these effects, and we hope that this synthesis may enable future researchers in sport to look at the phenomena in question through a different lens. If nothing else, studying placebo effects enables us to understand the way the brain processes various aspects of social and environmental information. Research on the importance of this social information in determining physical outputs in both laboratory and naturalistic settings is in its infancy, and the ideas presented here offer important considerations for extant lines of research, as well as new lines of inquiry for researchers interested in the determinates of performance in sport and exercise.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

This work was supported by a Clarendon Scholarship, University of Oxford to A. J. Davis .

Note

1. Note that in both studies the placebo treatment followed pre-conditioning trials with the drugs in question.

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