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Designing cycling and running garments to increase conspicuity

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ABSTRACT

Poor conspicuity increases the risk of cyclists and pedestrians being involved in collisions with vehicles under low light conditions. Retroreflective strips in biomotion configuration significantly increases conspicuity. This study explored how to design biomotion garments that will appeal to cyclists and pedestrians. Nine focus groups involving 50 participants who ran/cycled under low light conditions. Participants discussed their experiences of choosing and wearing garments for cycling/running, and barriers to wearing biomotion garments. Using thematic analysis, we identified three themes. Design describes how biomotion garments should be attractive and practical. Function describes how they should be comfortable and convenient. Promotion describes participant's beliefs regarding cost and how to best explain the safety benefits of biomotion garments. Our user-centre research identified how to make biomotion garments appealing. Safety should not compromise design and function: users are unlikely to wear poorly designed and uncomfortable biomotion garments regardless of how much they increase conspicuity.

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1. Introduction

Exercise is recognised as being a major health-protective activity, yet nearly one-third of adults globally are underactive (World Health Organisation, 2018b). Both cycling (Bauman et al., 2008; Hartog, Boogaard, Nijland, & Hoek, 2010; Leyland, Spencer, Beale, Jones, & van Reekum, 2019) and walking (Hamer & Chida, 2008; Hanson & Jones, 2015; Murphy, Nevill, Murtagh, & Holder, 2007) can improve health and well-being and help to reduce obesity and inactivity. Choosing to cycle or walk instead of driving has many benefits both for individuals, including an 11% decrease in cardiovascular disease risk (Hamer & Chida, 2008), and for the community, in terms of reduced air pollution and reduced congestion (Maizlish, Linesch, & Woodcock, 2017)

However, there are also negative implications of walking and cycling, with pedestrians and cyclists accounting for 26% of all road deaths globally (World Health Organisation, 2018a). Under low light conditions, such as during dawn, dusk and at night, cyclists, runners and pedestrians are much more vulnerable to being involved in a fatal collision with a vehicle (Uttley & Fotios, 2017), due to poor conspicuity (Hagel et al., 2014; Owens & Sivak, 1996; Wood, 2020). Collisions between pedestrians and vehicles are overrepresented in low light conditions, with pedestrians being 3–7 times more likely to be killed by a vehicle at night than in the day (Sullivan & Flannagan, 2002). Similarly, cyclists are 2–6 times more likely to be involved in a collision with a vehicle at night compared to in the day (Dozza, 2017). Reduced pedestrian and cyclist visibility under the low light levels present on night-time roads are believed to be key factors contributing to their increased safety risk, to a greater extent than driver fatigue and alcohol consumption (Owens & Sivak, 1996; Sullivan & Flannagan, 2002). Importantly, it has been reported that perceived on-road danger can discourage pedestrians from exercising and acts as a barrier to active travel (Jacobsen, Racioppi, & Rutter, 2009). Therefore, it is imperative that safety, and perceptions of safety, of cyclists and pedestrians are increased to facilitate more exercise and travel on road.

One potential strategy to improve the safety of pedestrians, runners and cyclists at night is to wear performance garments that increase their conspicuity to other road users. A Cochrane review (Kwan & Mapstone, 2006) identified that while fluorescent materials are effective in increasing conspicuity of vulnerable road users during the day, lights and retroreflective materials are most effective at night. Importantly, research has demonstrated that the placement of retroreflective

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materials has a significant impact on conspicuity: retroreflective material on the moveable joints (wrists, ankles, knees and elbows) greatly enhances drivers' ability to recognise both pedestrians (Wood, Tyrrell, & Carberry, 2005) and cyclists (Wood et al., 2012) from a safe distance. This configuration of retroreflective material is termed 'biomotion' (biological motion), enabling the viewer to quickly recognise the object as a human form (Johansson, 1975; Stapleton & Koo, 2017; Tyrrell, Wood, Owens, Whetsel Borzendowski, & Stafford Sewall, 2016). When comparing the effect of retroreflective material as a vest or in a biomotion configuration, where the total surface area of retroreflective material was equal, drivers recognised night-time pedestrians wearing biomotion at three times longer distances compared to the vest and 26 times longer than for all black clothing (Wood et al., 2005). Similarily, drivers recognised night-time cyclists wearing the biomotion configuration at three times longer distances than a retroreflective vest and six times longer distances than cyclists wearing all black (Wood et al., 2012). However, only a third (32%) of cyclists wear reflective garments or strips during low light conditions (Wood, Lacherez, Marszalek, & King, 2009) and some do not use bicycle lights or reflective garments at all (Hagel et al., 2007). Similarly, pedestrians overestimate the ability of drivers to see them at night and underestimate the safety benefits of sports garments that incorporate biomotion (Sewall, Borzendowski, Fekety, & Tyrrell, 2014).

Because biomotion garments comprise reflective elements on the **W**rists, **A**nkles, **K**nees and **E**lbows, we have coined the acronym 'WAKE' to describe this clothing. The acronym may have the potential for future safety awareness campaigns based around variants such as 'WAKE-UP to Cycle Safety'. Understanding the factors that increase the appeal of WAKE garments is important as decisions about wear are not made solely on the basis of safety. For example, cyclists who perceive helmets as unattractive and uncomfortable are less likely to wear them (Ross, Ross, Rahman, & Cataldo, 2010), and the style of athletic garments is more important than visibility to pedestrians when exercising at night (Sewall et al., 2014). Involving users in designing sports performance garments can increase their appeal (Tian et al., 2020). The current research involved visual scientists, road safety researchers, fashion designers, and users in identifying what would make WAKE garments more attractive and wearable to cyclists and runners, which has the potential to increase the safety of these vulnerable road users.

2. Methods

A qualitative approach was employed, in which a series of focus groups explored participants' experiences of choosing and wearing garments for exercise, barriers to wearing garments that increase conspicuity, and how to design WAKE clothing to overcome these barriers. Focus groups provide a means of gaining an in-depth understanding of a topic in a group setting, where the dynamics of the group lead to participants disclosing and discussing their thoughts and feelings in a way that they may not do in a one-to-one interview in which they might believe the interviewer does not have shared experiences. To explore the effect of climate, we conducted the focus groups in two cities with different climates: Leeds (England) and Brisbane (Australia). The same dataset was used for a separate analysis of attitudes towards conspicuity on roads under low light conditions (Fylan et al., 2020).

2.1 Participants

There were 50 focus group participants (mean age = 39.5 ± 14.0 years, 20 female, 30 male); 34 from Brisbane, 16 from Leeds. Participants were adults who ran/cycled on the roads in low light conditions, lived or worked locally in each city and were recruited through advertisements through workplaces, social media groups and through emails to cycling and running groups. Four groups comprised participants who solely or mostly cycled, three groups were with participants who solely or mostly ran, and three were with participants who both cycled and ran (mixed). Further details are shown in Table 1. All participants were offered an AU$50 gift voucher (Australia) or £30 (UK) for their participation in the focus group.

2.2 Procedure

Nine focus groups were held: six in Brisbane and three in Leeds. A semi-structured topic guide was used to

Table 1. Participants in each focus group.

Focus group	Location	Participants
L1	Leeds	Three males, three females, all cyclists, a mix of leisure and commuters, and all occasional runners.
L2	Leeds	Two males, three females, all runners, all cycle for leisure, four occasionally and one frequently.
L3	Leeds	Three males, two females, a mixed group of cyclists and runners. Three were leisure cyclists and three both leisure and commuter.
B1	Brisbane	Three males, one female, all cyclists, a mixed group of cyclists and runners.
B2	Brisbane	Five males, two females, all cyclists, a mix of leisure and commuters.
B3	Brisbane	Two males, four females, a mix of casual and serious runners.
B4	Brisbane	Four males, two females, all serious runners.
B5	Brisbane	Three males, two females, a mix of leisure and commuter cyclists and all runners.
B6	Brisbane	Five males, one female, a mix of leisure and commuter cyclists.

facilitate discussions, developed by the researchers to include hedonic and eudaimonic principles (Lee, Carswell, Miller-Spillman, & Sublette, 2015) and Functional, Expressive and Aesthetic elements of the Consumer Needs Model (Lamb & Kallal, 1992). Discussions started by exploring what participants like and dislike about garments worn when running/cycling, and things that are important to people when they purchase garments for night-time running/cycling. The focus group facilitators explained and demonstrated the biomotion phenomenon using a series of reflective strips attached to black running pants and tops. The strips were produced in a range of widths (2 and 5 cm), and either plain or patterned (dots, stars, or chevrons). Participants then discussed how reflective strips could be used in garments for running, cycling or as a pedestrian and how garments could be designed to make them most appealing. Finally, they discussed whether they would be interested in purchasing clothing that increases their conspicuity. The same questions were used in both locations.

Focus groups were led by one of two facilitators (FF, LB), lasted one hour and were audio recorded and transcribed verbatim. The study followed the tenet of the Declaration of Helsinki and ethics committee approval was obtained from Queensland University of Technology. All participants were given a full explanation of the nature of the study, what taking part would involve, and how to withdraw from the research. Written informed consent was obtained.

2.3 Data analysis

Transcripts were analysed thematically using the methods of Braun and Clarke (2006). Transcripts were coded using the research question: 'How could biomotion performance apparel be made attractive to runners and cyclists'. An inductive approach was taken in which the codes were generated from the data rather than by applying a pre-determined framework (Braun & Clarke, 2019). Each segment of the transcripts that was relevant to the research question was labelled with a code. A code could apply to a single word, a whole sentence or a series of sentences, so that the code captured the essence of the meaning of each segment. The first author (FF) independently coded the transcripts and grouped codes with others of similar meaning. A second author (LB) cross-checked the coding and any differences in coding were discussed and resolved. The groups of codes were then sorted into a thematic structure that best described the data. The criteria for a theme were that it was internally homogeneous, i.e. the sub-themes it contained all shared a certain perspective, and that it was externally heterogeneous, i.e. that the themes were fundamentally different from one another. During the coding process sub-themes merged until a grouping was identified that provided that provided a simple data structure while capturing the full set of codes.

3. Results

Three main themes were identified in the data, each containing two sub-themes:

- **Design** highlights the importance of visual *appearance* and garments being *practical*;
- **Function** describes how WAKE garments should be *comfortable* and *convenient;*
- **Promotion** describes how best to promote the benefits of WAKE garments based on *evidence* and *cost*.

These themes are described in detail below and are illustrated using quotes from each of the focus groups. Quotes were selected on the basis that they best illustrate each sub-theme and were labelled with the city that the focus group took place (Brisbane (B) or Leeds (L)), the focus group number and the gender of the participant.

3.1 Design

This theme describes how the design of WAKE performance apparel is important for uptake: it should have a desirable appearance, fit well, and be practical to wear.

3.1.1. Appearance

Participants discussed how it is important that WAKE garments have a desirable appearance so that they don't feel self-conscious about wearing them. Many participants initially assumed that garments that increase their visibility would resemble roadworkers vests, which they would not be interested in wearing

> Safety clothing is not flattering. I wouldn't wear it on my weekend ride with other people but for my commute to work it doesn't bother me. (Female, L1)

> If it's done in a way that is not just screaming hi vis, in a way that it is still designed well and it's still a nice piece of clothing you're more likely to go, it's still a nice piece of clothing and I might take into consideration. Otherwise the association's going to be with construction industry and that's not the stuff that I want to wear when I exercise. (Female, B3)

Appearance was more important for the cyclists than the runners, as many talked about how a social meeting

is an important part of their ride, and they don't want to feel embarrassed by what they are wearing. While some participants also talked about socialising after their run, they talked about the importance of clothing being versatile enough to wear before, during and after a run, rather than the importance of appearance

> If you look like a dag [shabby/scruffy] you'd get hounded at the coffee shop! (Male, B2)

Participants expressed surprise when they saw that the reflective strips could look attractive. They discussed how, rather than disguising them, the strips could be used to emphasise different design features of the garments. Several participants discussed how the strip patterns could display the manufacturer's or their sports club logo. A few suggested the opportunity to buy personalised garments with names or contact details on the reflective strips

> If the reflective bits look really good when reflected on that would encourage me to buy it. (Female, L1)

> People would be interested in these if you like gimmick them a bit. So, you know, when you personalise them and when you put them on you can put your emergency contact details on it. (Male, L3)

Most preferred the narrower (2 cm) strips rather than the wide (5 cm) ones, because they look less like safety wear. Participants varied in their preference for patterns on the strips: many thought the patterned strips were more attractive, while some preferred the solid ones. Our participants wanted a range of colours for WAKE garments, and there were discussions around how the reflective strips could also be different colours rather than the traditional and widely used silver retroreflective material. Many talked about how this would be advantageous when they commute in their work clothes and so don't want to wear very obvious reflective elements throughout the day.

3.1.2. Practicality

This sub-theme describes participants' discussions about how WAKE garments need to be designed to be practical to wear. Cycle jackets need to be aerodynamic and long enough at the back to reach the seat. Cycle shorts need to have sufficient padding, and running jackets need to allow ease of movement and be versatile: suitable for a range of conditions. Arm warmers should be long enough and tight fitting to offer either wind chill or sun protection. All garments need to be lightweight

> The jacket I have for winter is designed for running and it's also designed to be rain proof and wind proof. I'd pay a bit more money because this is just not a normal jumper that I put on. I want something that is designed for what I want to use it for. (Male, B3)

> You wouldn't go cycling in a jacket that was massive and heavy. You want something that's going to keep you out of the elements but quite light weight. (Male, L3)

Participants in all the groups highlighted the importance of having zipped pockets that are large enough to securely store valuables or snacks, with a common concern being that sports garments often don't have secure pockets

> A zip pocket as well is always something I think about for my key. (Female, L1)

> Women's running bottoms are rubbish for storage. Most of them like you say have a little key thing on the back but apart from that, nothing. (Female L2)

> If you can give it a function: whack a zipper in there and you could put in your travel card or something or your $20 note or your coffee money for the end of the run. (Male, B4)

Participants discussed how there should be a range of garments in the WAKE design, rather than a single garment that provides all the reflective strips, which was viewed as being less practical. For example, they suggested that short-sleeved tops could provide strips above the elbow at the base of the sleeve, whereas arm warmers, gloves or wrist bands could provide the wrist strips. Similarly, rather than being required to wear long pants, shorts could be coupled with reflective socks. They suggested that incorporating WAKE strips in garments such as arm warmers could provide versatility as they could be worn with different sets of clothing. In cold climates, overshoes could provide the reflective elements. Particularly in Leeds, participants talked about the need to layer clothes: to start a run or a ride with several layers which are then removed during the run or ride.

3.2. Function

This theme is about how participants wanted WAKE garments to be comfortable and convenient as well as making them safer by increasing their conspicuity.

3.2.1. Comfort

Participants discussed the importance of WAKE garments being comfortable. For many, the primary goal was to purchase garments that are comfortable, particularly for runners, who frequently talked about problems of chafing

> I am more focused on chafing than I am on visibility. (Male, B4)

> The most important thing with a running vest is if it's nice and soft and thin and no seams which are going to rub and hurt. (Female L2)

Participants discussed it being essential that the reflective strips in WAKE garments do not cause chafing and have a similar feel and 'stretchiness' (elasticity of the fabric) as the rest of the garment. They also did not want the strips to restrict their movement, such as around their knees. Several gave accounts of other conspicuity aids they had tried but rejected because they were uncomfortable

> If it [reflective strips] were part of a soft fabric and it didn't hinder the movement or anything like that then I think it would be quite good. (Female, L2)

The reflective strips should not affect thermal comfort by reducing how breathable the apparel is or its sweat wicking properties. Differences in participants' concerns were largely due to climate, with participants in Brisbane being concerned about over-heating and those in Leeds about the reflective material being waterproof and not reducing the garment's warmth

> I think it's more about comfort. I choose that over colour and if it feels right and it fits right and it doesn't rub if it's wicking or keeps you warm then I would choose that over the colour. (Female, L3)

> Well those placements [of the reflective strips] seem okay the only thing I would be concerned about would be if it's covering that much skin if it would be uncomfortable to wear in warmer weather. (Female, B5)

> Yeah it's mainly comfort and sweat wicking is a big one especially in Brisbane and especially with the humidity and how hot it is because otherwise you're just like this is hot enough as it is I don't want to feel like I'm drowning in my own sweat! (Female B3)

3.2.2. Convenience

Participants were clear that WAKE garments need to be convenient to wear. For this reason, nearly all participants preferred that the reflective strips be an integral part of the garment. They did not want to have the inconvenience of having to add 'stick on' or 'slap on' reflective strips. While they acknowledged that it would be cheaper to purchase a single set of strips that could be added to any garment, they believed that they would find this too inconvenient, and would not wear the strips. Several discussed how they already have reflective bands that they can add to their shoes, ankles or arms, but very few ever bothered to wear them. They also talked about how slap-on strips would be yet another thing they need to carry with them, therefore taking up storage space

> You either lose them or spend half your run fiddling to try and get it comfortable. Yeah I've tried some ones that are meant to go around your shoes and I lost them on the first go. (Male, L2)

A few participants talked about having tried garments which incorporated LED lights but they were a 'hassle' to remember to turn on or off or to charge and so no longer use them. They also wanted to be able to return home from a run or ride and put garments directly into the wash, rather than to have to remember to remove strips, remove lights or remove batteries, or to need to wash garments with WAKE strips separately. The garments need to be as easy as possible to use, maintain/clean and re-use

> It needs to be easy. Clothes with lights embedded that need charging are not easy – you may forget to charge them. (Female B5)

3.3. Promotion

This theme is about how best to promote the benefits of WAKE garments to others. There are two sub-themes that explore the evidence that participants believed would be most effective in convincing people to wear the garments and how they are likely to respond to any potential increase in cost.

3.3.1. Evidence

While a few participants talked about accepting marketing claims or staff recommendations about a garment's performance, most wanted some evidence of how it performs. The most common suggestion was to show a video in which a standard and a WAKE garment are shown side-by-side from the perspective of an approaching car driver at night-time, as this would help viewers appreciate just how much difference WAKE garments make to their conspicuity

> I think if you had some stats to back it or some evidence then I think that would convince me more - I'm a bit of a data geek anyway. So having some evidence to say if you wore this and you hit these points on your body then you'd be safer on the roads. (Male, L1)

> So if you had a video of two people, one without the clothes and one with it, saying that's without it, that's with it and it's visible. Because saying it's 80% more visible I don't think anyone really grabs that [understands]. (Male, L3)

Some suggested that it would be best to provide statistics on how much sooner, in terms of distance, they are

visible to an approaching driver (or cyclist). Others thought that it would be better to provide the information on the additional time that drivers (or riders) have to react and move out past the wearer. A few suggested they would be most influenced by information on how much practical difference it will make, e.g. in terms of how much extra space drivers give cyclists

> Probably the figure that would matter most to me would be like a difference in passing distance because when you've got the lights cars leave more room and even though it's not hurting me to have cars pass really close it scares the hell out of me. So if you could say this will get you an extra 10cm of passing space on average, I'd be like - hell yeah - I want that. (Male, B5)

Some participants were sceptical that narrower strips, and those with patterns cut out of the material, could be as effective in increasing conspicuity as wide solid blocks of reflective material, with a desire for deemed standards by a recognised authority. They suggested that providing information or a demonstration on this issue would be useful. A few talked about having noticed cycle couriers wearing jackets or carrying rucksacks made entirely of reflective material and assumed that this must be the most effective way of increasing conspicuity

> I quite liked the stars on the strips but it doesn't look as effective [as the plain ones]. (Female, L1)

3.3.2. Cost

Participants varied in the extent to which they would be prepared to pay extra for WAKE garments with integrated reflective elements, such as £10-£20 extra (A $20-A$40). They explained that they have multiple tops and shorts so even a small additional amount per garment would potentially lead to a large additional cost

> $40 more for a jersey is not a lot to pay to potentially reduce the chance of getting hit. But if you buy quite a few jerseys … . if I had to pay $40 more on an $80 jersey, I would be paying $120. It's how many times you have to spend that $120. You might only have one jersey whereas I have many. (Male, B2)

Many participants talked about how cost doesn't just mean the purchase cost: the reflective strips should be durable and should not decrease the useful life of the garments. Several discussed how they have noticed that reflective elements on their garments peel off over time so they do not last as long

> So it would have to be integral to the material that didn't sort of peel or degenerate with washing. (Male, B2)

> I have a pair of leggings that have reflective logos on them and every time I wash them they stick to themselves. (Male, B5)

4. Discussion

We used a qualitative approach to explore responses of cyclists and runners towards the design of novel exercise garments which incorporate reflective strips in a biomotion configuration, known to provide the highest level of conspicuity for approaching drivers at night-time (Stapleton & Koo, 2017; Wood et al., 2005, 2012; Wood, Lacherez, & Tyrrell, 2014; Wood, Marszalek, Lacherez, & Tyrrell, 2014; Wood, Tyrrell, Lacherez, & Black, 2017). Three themes were identified: Design, Function and Promotion. The first theme, Design, describes how performance apparel should have a desirable appearance but also be practical to wear. The second theme, Function, revealed that the WAKE garments should increase conspicuity without reducing comfort or convenience. The final theme identified was promotion, which describes the most effective strategies to promote the WAKE design and included two subthemes of evidence and cost.

The results demonstrate that the design of performance garments was of high importance. Specifically, the garments must have high visual appeal, fit well and be practical. This supports the Functional-Expressive-Aesthetic consumer needs model (Lamb & Kallal, 1992) and highlights how a garment developed for safety purposes cannot ignore other consumer requirements. Some participants believed that when the reflective strips incorporating patterns enhanced the garment's desirability and wearability. There was considerable discussion surrounding the importance of the garments not looking like stereotypical safety garments. While participants believed that being visible was important, there was an emphasis on not looking like a 'road worker'. This is consistent with previous qualitative research, where cyclists reported being teased at work when wearing high visibility clothing that is typically used in the construction and mining industries (Aldred, 2013). Moreover, it was discussed that the garments must be versatile and wearable across the day in various locations and settings. Previous research has demonstrated that appearance is an important aspect of cycling culture as it is reported that there is a competitive drive to have the newest performance apparel and accessories (O'Connor & Brown, 2007).

Participants emphasised the importance of the garments being comfortable to wear. They indicated that it is essential that the WAKE strips do not cause chafing when riding or running and do not hinder their exercise

in any way. Several participants reported that they had tried other forms of conspicuity apparel but had rejected them as they were uncomfortable. This is similar to research on cycle helmet wearing compliance, whereby when a helmet is perceived as uncomfortable, cyclists are less likely to wear them (Ferraro, Orsi, Montomoli, & Morandi, 2018). Furthermore, in adults, the most common reason for not wearing a cycling helmet has been shown to be due to them being uncomfortable, annoying and generating too much heat when worn (Finnoff, Laskowski, Altman, & Diehl, 2001).

It was clear across all groups that it is critical that the garments are practical, including features such as zips and pockets. It was also clear that in different climates, multiple garment options would be beneficial, which has implications for where reflective strips are located. For example, in warmer climates runners and cyclists are less likely to wear long sleeved garments or long pants for the whole duration of the activity so a practical solution is to have the WAKE in multiple garments to create the biomotion effect. For example, on short-sleeved tops the reflective strip could be placed above the elbow and arm warmers/ sun shields or wrist bands could incorporate the reflective wrist strip. Similarly, instead of long pants, shorts with reflective strips around the hem area at approximately knee level could be coupled with reflective trimmed socks to provide knee and ankle reflectivity. Previous research on the biomotion garments found that the practicalities (Fylan et al., 2020) and appearance (Fylan et al., 2020; Sewall et al., 2014) of the garment outweigh the importance of visibility. This indicates the critical importance of user input when designing exercise garments: performance apparel won't be worn if it's not practical and aesthetically appealing, regardless of how much it increases conspicuity.

Similarly, garments must be convenient to wear. There was a clear consensus that the reflective strips must be integral to the garments themselves, rather than be separate accessories which require the user to manually place them on the moveable joints prior to their activity. Forgetfulness is cited as one of the primary reasons for poor treatment adherence (Lynch, 2019) and therefore restricting the amount of inconvenience for the user will help facilitate the uptake of biomotion garments.

Participants indicated that if people are to pay more for sporting garments, they require evidence of effectiveness. A common suggestion was to provide values on the visibility distance gained (in metres) when wearing the WAKE garments. For example 'WAKE garments mean that drivers see you 100 m further away' (Wood et al., 2012). More research is needed to determine how far away (in metres) drivers can recognise cyclists and pedestrians wearing the WAKE garments compared with a range of currently available sports garments. Participants suggested using a video to demonstrate the difference from the perspective of an oncoming driver. This video could include an explanation of biomotion and how it leads to faster recognition of an object as a cyclist (Stapleton & Koo, 2017). A common misperception was that larger, solid blocks of retroreflective material would provide better visibility than smaller strips, although this is not the case (Wood et al. 2005). Lastly, in terms of cost, some participants discussed that an additional £10–£20 (A $20–A$40) would be a reasonable premium for WAKE garments. Considering the simple design aspects of WAKE performance apparel, this financial estimate may be feasible to cover the additional manufacturing costs involved in these designs.

In summary, this study explored perceptions and attitudes in relation to the WAKE garments in a sample of cyclists and pedestrians. The next step in this research is to use the evidence gathered in this study to inform the design of WAKE prototype garments. The wearability and practicality of these garments will then be tested on a sample of both cyclists and runners to collect feedback on how to improve the garments and designs further. Ultimately, these garments are intended to be designed by wearers, maximising comfort and practicality, whilst also incorporating safety features that have the potential to improve conspicuity and hence safety on roads at night.

5. Conclusions

We have identified how to make WAKE garments attractive to potential wearers, which has the potential to increase their conspicuity and therefore reduce road casualties. The study shows how the placement, pattern, and texture of the reflective strips are central to whether the garments are acceptable, and that a range of garments, suitable for different climates, is preferable to a single all-purpose garment. Both cyclists and runners are prepared to pay more for garments that improve their safety, providing the safety features don't compromise durability, practicality or convenience. As evidence of effectiveness is important, future research should identify the safety benefits of WAKE garments compared with a range of currently available garments.

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