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Including the consumer in garment quality evaluation

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Abstract. Textile and fibre quality has traditionally been defined in terms of mechanical properties. To evaluate garment quality, this definition may be extended by inclusion of the dimension of consumer evaluation. This paper discusses the development and application of an extended methodology for defining garment quality in terms of consumer response.

Evaluation of consumer response requires accurate measurement of qualitative and quantitative individual responses. However garment retailers are interested in a population rather than an individual response as well as quantitative specification of any change in consumer evaluation of quality.

In this context, a consumer-based methodology, developed to examine changes in consumer response to garment quality brought about by changing fibre properties is described in this paper. This four stage methodology (known as the Design For Comfort (DFC) garment methodology) extends traditional fabric evaluation methods to examine consumer response to fabric as garment in changing environments.

The DFC methodology utilises responses from screened untrained participants selected using a flexible screening process. This process has been designed to focus on responses in the particular market segment into which the garment would be sold. Results from the use of this methodology in testing a lightweight single jersey knitted long sleeved t-shirt made of different fibre types and properties are presented. Mapping and analysis of the comparative fabric responses in terms of sensory response (tactile, moisture and thermal) and the ability of participants to detect differences between garments in changing environments is discussed. A Population Acceptance Rate (PAR) based on sensory score distributions is also estimated.

The ongoing research described establishes the basis for development of a multi-dimensional garment quality evaluation model.

Keywords: Garment, wool, fibre specifications, comfort, prickle, consumer response, population response

1.0 Introduction

Developments in textile and garment technology have long been designed to improve consumer response to the retail garment. Many developments aim to change a mechanical property that has been measured using an international standard.

There are at least two cases where "mechanical" developments fail to produce advantages in the retail product, where (a) the mechanical advantage is not detectable or (b) the mechanical change in one characteristic is offset by antagonistic changes in other characteristics. There is also the case where there is no single mechanical test to estimate or predict the change in the consumer response to a garment.

This last scenario is faced by wool producers who change the wool fibre specifications in anticipation of improving the response to the wool garment. A strongly held view is that a change in the wool fibre specification will modify the mechanical properties of the yarns or fabrics, and any change in consumer response is due to the yarn or fabric properties, not the fibre properties.

Various studies have been undertaken where one fibre type or fibre treatment (such as finishing) has been substituted for another (for example Fuzek 1981; Demartino et al. 1984; Wong, Li, and Yeung 2005). The first case involves changes due to the morphology of the fibre and differences are often found, but this is not relevant when changes are made to fibre specifications of the same fibre type. The second case can be viewed as a masking of fibre effects, and thereby avoiding the issue of changes due to fibre specification, should they exist.

1.1 Can changes in fibre specifications be detected in garment?

This is an important issue for wool producers: do consumers respond to changes in fibre specifications, or do they respond to the mechanical properties of the fabric or garment?

The most obvious answers are (a) the consumer response cannot be measured (usually because individuals disagree on the definition of the sensation being measured), (b) people cannot detect the changes in the garment (either the change is too small, or the sensitivity of the people is too low), and (c) people differ in how they respond to the detect or respond to the change. There is also the option that no difference exists in the garments after changing fibre specification.

Experimental designs for studying this problem of fibre specification change would have to deal with the possibility of finding very small changes in response to garments, in one or more sensations, the identity of which is also unknown at this stage. The design would also have to deal with the possibility of overwhelming errors that surround a possible change. And of course, it must accommodate the possibility that there is a zero effect due to the fibre change.

Faced with these design restrictions, and the importance of being able to relate changes in consumer response to changes in wool fibre specifications, it was decided to put together a process of consumer testing designed to find very small changes in consumer responses to a garment. The problem then is also one of accurate and "widespread" observations to record the changes that occur.

One advantage of such an approach is that any combination of changes, at the fibre, yarn or fabric level can be the subject of the test. These changes can be tested individually or as interactions.

This paper will describe a detailed garment testing protocol that was designed to have the required scale and sensitivity to find small changes in the consumer response to a garment. The results from early testing are presented.

2.0 Method

Many of the elements of this protocol can be found throughout the literature (for example Hollies 1971; Hollies et al. 1979; Fuzek 1981; Hollies et al. 1984; Demartino et al. 1984; Li 2001; Lau et al. 2002; Goldman 2005). A review was undertaken to see how the various elements could contribute to this protocol. For example when the issue of time was reported in the literature, it was assumed here that longer test duration may be better in exposing differences. The number of participants in the tests also varies widely, from 4 to over 40 persons. An increase in the number of people appeared attractive provided there was a difference to be detected, and that the error levels could be reduced with increasing number of people.

However there could be difficulties when increasing the number of people if the difference between people (for whatever reason) is large.

The test method is a refinement of that used by Hollies and Goldman (1977) and Barker (2002). At the start of the test, the participant is allowed to rest at a comfortable temperature for 30 minutes prior to putting on the test garment. After 15 minutes in this "change room" scenario, the participant is taken into the high temperature environment, initially inactive (standing and sitting), and then 15 minutes walking on a treadmill, before returning to the standard temperature room for 15 minutes. The total time of the test is 90 minutes. During this period, a set of psychometric questions are asked at 5 minute intervals to track changes in tactile, thermal and moisture sensations. At the end of the test protocol, the participant is asked a series of exit questions about the garment they are wearing, and the previous garment they tested.

The following description of the protocol elements is provided to illustrate the measures undertaken to detect this potentially very small change in consumer response.

2.1 Participants

One aim of the project was to obtain the response from potential consumers of the garments. This required development of a detailed market demographic, in part to reduce between people variance in the test. A series of focus groups were run to record the group responses to a set of related garments across age groups. Garment descriptions and attributes from each group also provided guidance on the words used in describing the garment and how the wearer would feel when wearing the garment. Information from the focus groups assisted in assembling the list of sensations to be recorded. The focus groups also provided information on the delineation in age ranges needed for testing.

Recruiting of the participants from the urban population was undertaken by a market research company using a set of screening questions to identify the target demographic. The target group was female, 25-35 years, medium to high income levels, healthy and fits into particular buying patterns.

The recruits were introduced to the program, and shown through the test procedure. Those that agreed to participate in testing were taken thought one 2 hour test session for orientation, but the test results from this session were not used in this analysis.

2.2 Test facilities

Test facilities were purchased and adapted for the trial. These included a controlled environment chamber (4.5m x 3.8m, capable of operating between 10 and 40 deg C, 10 to 90% RH within a range of 0.1 deg C and 0.5% RH. The conditioned air enters the chamber through a perforated 10 m^2 wall which supplies a laminar air flow into the room at air velocities up to 1M/sec. For this trial, the chamber was held at a constant temperature and RH of 39 deg C and 24% RH. The chamber was equipped with a treadmill.

A set of three "change rooms" held at 23 deg C and 45% RH were provided for testing before and after the stages in the high temperature environment.

The participants' well being was monitored during the tests (heart rate and blood pressure were measured and a McGinnes thermal scale was recorded). Temperature and humidity sensors were placed on the hand, shin, neck and scapula to allow measurement of mean skin temperature and RH%. Sensors were also positioned on the neck and scapular to monitor the inside surface of the garment for temperature and RH during the tests.

2.3 Test garments and fabrics

A set of garments were prepared which were the same except for the wool fibre diameter used in the production of the yarn. Yarn specifications, fabric weight and construction and garment weight and construction were made to the same specification.

The garments were black single jersey long sleeve T-shirts which had a garment weight of 135 gms in the medium size and a fabric weight of 160 gms/m^2.

Three sets of test garments were made from three wool specifications which were identical except for average fibre diameter (16.5µm, 18.5µm and 20.5µm). These diameters were selected to cover the commercial range of wool types that would be used in this garment type.

The garments were tested as a base layer garment, designed to trigger changes in each of components of comfort; moisture, temperature and tactile.

A fourth garment was prepared from cotton to the same specifications. This garment was used as a control garment in the study of prickle responses in these garments.

The sizing of the garments for the participant was done by the technician, ensuring adequate contact between the garment and the body, without constricting the movement of the wearer, and to apply a consistent sizing protocol to all participants.

2.4 Test procedure

The test procedure was designed to provide information for various components of a retail consumer model:

(a) Fabric appraisal; undertaken in part because of the potential contribution of the "rank" feel (Goldman 2005) to the evaluation of the garment. These tests covered handle, soft/hard, smooth/rough, firm/limp.

(b) Change room testing; included a 2:5 test comparison between garments (Meilgaard, Civille, and Carr 2007) to see if participants can detect differences between garments in the change room conditions. Participants are then given the test garment and records of the initial responses to the test garment were made.

(c) Wearing experience; recorded through 4 stages, change room, hot inactive, hot active and on return to the change room. These periods were used to mimic the range of conditions a wearer might experience in active/sport or active/casual activities.

(d) Evaluation and preferences; collected at the end of the test protocol before the test garment was removed. This information related to the question of liking the garment (yes/no), preferring the garment to the last one they tested (yes/no and why), and their response to fit, the tactile, thermal and moisture components of comfort, and the overall comfort of the garment.

Time between tests for a participant averaged 5 days, ranging from 1 to 32 days.

2.4.1 Subjective evaluation of garments

The participant's response to the garment is recorded every 5 minutes for the duration of the test, and immediately on entering and leaving the chamber. The sensations recorded were *absorbent, sweaty, muggy, clingy, damp, cold, scratchy, prickly, itchy, heavy,* and *uncomfortable*. Comfort was recorded as the degree of discomfort. Definitions of each sensation were provided at each session.

When the test is completed, and while they were still wearing the garment, the participant was asked a set of post-test questions centred on liking this garment, and if they preferred this or the previous garment they tested.

2.4.2 Physiological changes during testing

Changes in skin temperature and humidity were logged for the duration of the individual tests.

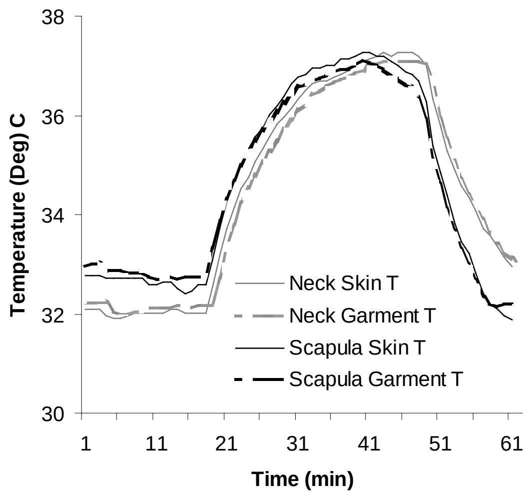

FIGURE 1. Change in temperature at the skin and at the inner garment surface at the neck and the lower scapular.

The results in Figure 1 show the temperature profile for a single participant in a single garment test, from the time the garment was put on, to the time it was removed one hour later. The period in the climate chamber is evident from the increased skin and inner garment temperature.

The results in Figure 2 show the water vapour pressure profile from the same test. The rapid rise detected soon after entering the high temperature chamber suggested the onset of sweating. The inner surface of the garment at the same time showed a small change in water vapour pressure.

These results illustrate the range and timing of physiological changes experienced by the participants in the test protocol. So the sensations recorded during the test relate to both passive and stressed physiological states. The thermal and moisture components of comfort were tested by the protocol.

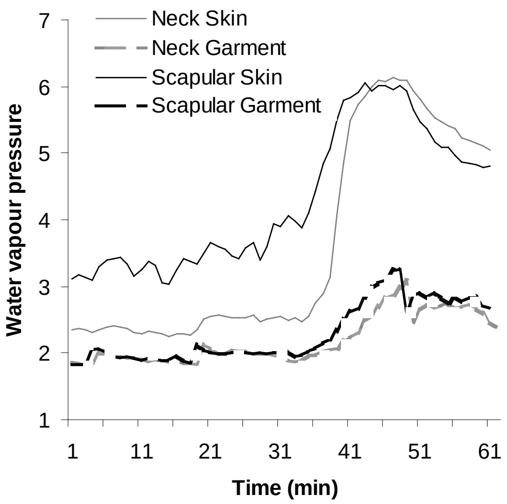

FIGURE 2. Change in water vapour pressure at the skin and at the inner garment surface at the neck and lower scapula.

2.4.3 Subjective evaluation of fabric handle

Interest in fabric handle in this test protocol was centred on its role in garment selection, and its potential link to establishing garment preference.

At the end of each garment test, the participant ranked fabrics from the test garments for handle, and bipolar components of handle (*soft/hard, smooth/rough, firm/limp*) and coolness to touch.

2.5 Linking of consecutive tests

The test protocol is designed to link subsequent tests through some of the participants from the first trial wearing garments in subsequent trials. Similarly garments from the first trail would be tested again in subsequent trials as link garments. The objective of linking trials would be to increase the effective size and precision of the test program in the statistical analyses.

3.0 Results

Differences were found between garments in comfort, where the only difference between the garments was a change in fibre specification (average fibre diameter). Significant differences were also found between garments in the prickle sensation which is interpreted here as one tactile component of comfort.

3.1 Appraisal of comfort and prickle

Differences were observed in the comfort and prickle appraisal between the garments, and the differences existed across the protocol stages. Figure 3 shows prickle increased when temperature and humidity increased. The prickle result for the cotton garment showed a very low prickle response and very small changes in the prickle response across the test periods.

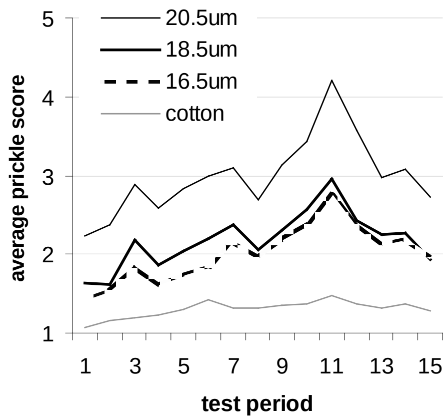

FIGURE 3. Average prickle response to each garment in each period.

3.2 Differences between garments

Statistical analysis of the comfort and prickle scores showed that significant differences existed between the average score of each garment (see Table 1).

TABLE 1. Average prickle score for each garment, and the least significant difference at the 5% level.

Garment	Average prickle score
20.5μm	2.83
18.5μm	1.88
16.5μm	1.69
Cotton	1.27
LSD at 5%	0.15

The prickle response for the different garments is related to the average fibre diameter used in each garment.

3.3 Precision in the participant's response

Each test made by a participant was separated by an average of 5 days. Their responses in each test were used to examine their repeatability over time and between garments. The response to the "like/not like" question at the end of the test was linked to the average comfort score for each garment. The results are shown in Figure 4.

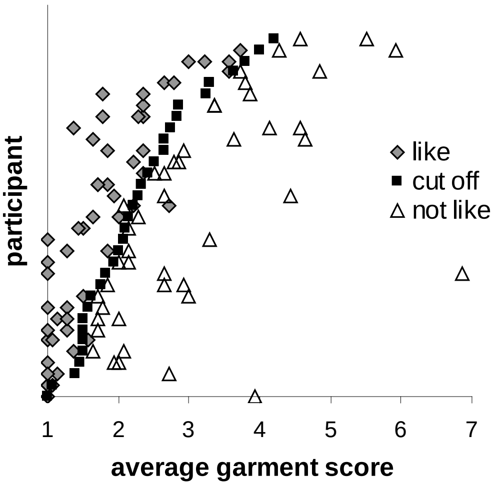

FIGURE 4. Average (dis)comfort response to each garment from each participant for the duration of the trail.

Each row of points represents the average comfort scores for individual garments for a single participant. The results show a delineation (shown as the cut off score for each participant), below which the participant reliably will report "liking" the garment, and above which they did "not like" the garment. There were very few errors made by the participants using this analysis.

3.3 Population response to garments

The use of untrained screened participants allows the results to be aggregated into an estimate of a population response to the individual garments. Figure 5 shows that 65% of the population would give the 20.5μm garment a score of 3 or less.

4.0 Discussion

This paper outlines a test protocol designed to detect very small changes in consumer responses to garments. The protocol was successfully applied to a set of identical wool garments to show that differences in fibre diameter produce significant differences in average comfort scores, and in average prickle scores, where prickle is one tactile component of comfort.

The use of untrained participants selected from an urban population allowed estimates to be made of a population response to the garments.

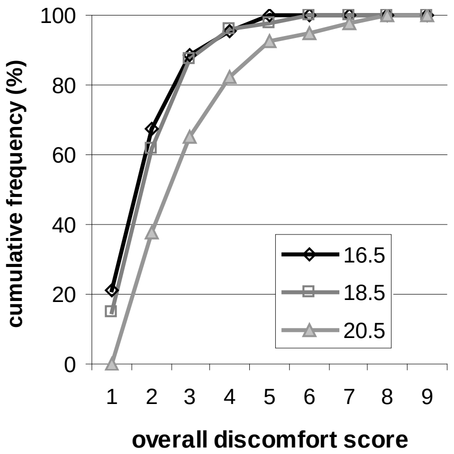

FIGURE 5. Population response to the garments in terms of average (dis)comfort score.

There is also an interesting response to the simple binary question of "did you like the garment?" which is answered with very high repeatability. The precision with which the response relates to average garment score suggests that potential for comfort testing is not limited because participants are insensitive or unable to define comfort. Differences between participants with respect to how they score comfort can be addressed using this method of analysis.

5 Acknowledgements

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