

FACTORS SELECTED BY A NUMBER OF KANSAS STATE
UNIVERSITY STUDENTS FOR WARM CLOTHING

by

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CHAPTER I

INTRODUCTION

One of the many factors that determine the acceptance or rejection of a particular article of clothing by a consumer is its comfort. Therefore, a knowledge of how garments are constructed for comfort is important. Black and Matthew (8) stated that good clothing should permit and maintain the following conditions: (1) be light, comfortable, and of pleasing appearance; (2) not cling when wet, or feel cold; (3) be capable of repeated cleanings without damage or change of shape; (4) keep the body temperature normal; (5) protect the skin from excessive radiation from the sun. The purpose of this study was to establish the criteria that college students consider when selecting a warm garment.

Physical, organismic, and reciprocative factors interact to determine the comfort of clothing on the body. Rholes (35) indicated that the physical factors consist of area-volume, radiation, inspired air, atmospheric pressure, force field, air movement, temperature, and humidity. He also noted that organismic factors consist of age, diet, rhythmicity, and basic metabolism rate. Finally, the reciprocative factors he mentioned consisted of activity, clothing, exposure, and the social elements. Because of the great number and complexity of those variables, most studies exclude the human element to measure the transfer of heat through necessary textile systems.

The absence of any unpleasant sensations of being too cool or too warm, or of having too much perspiration on the skin is considered thermally comfortable (19). The thermal insulating property of clothing depends upon the establishment of equilibrium between the heat production of the body and the loss of heat by the body to its environment. When the human body is at a higher temperature than its surroundings, heat will flow from the body to the surroundings. The body attempts to regulate this loss of warmth through the process of conduction, convection, radiation, and evaporation of perspiration. These processes account for about 90 per cent of the heat dissipated from the body (12). The other 10 per cent is carried away in the warmed, exhausted breath and other body secretions including perspiration that evaporates from the body.

The layers of air next to the skin provide most of the insulation (19). From the standpoint of thermal comfort, the major function of clothing is to control the amount of heat loss from the skin by keeping the air layers next to the skin relatively motionless, yet allow perspiration to escape. Fiber content, fabric thickness, and compactness of fabric construction have a great influence on the amount of evaporation that can take place.

The chief factor that determines the thermal insulating value of a fabric is its thickness, excluding its projecting fibers (8). Since wool is used for making thick fabrics it is considered a warm fabric; silk is used for making thin fabrics, so it is believed to be a cool fabric. However, this is not necessarily true (19). It would be possible to make a fabric of any given insulating value from any of the

textile fibers. Yarn construction and fabric construction greatly affect the thickness of a fabric. Other factors influencing the thickness of a fabric are density, permeability, and finishes.

The consumer has no quantitative means for judging the factors that contribute to the thermal comfort of a garment (16). Then, what are the factors the consumer looks for when he chooses a warm garment? The following hypotheses were adopted as the bases that underlie the concept and methodology used:

(1) Kansas State University students consider the following factors when selecting a warm garment: fiber content, yarn and fabric construction, thickness, density, texture, finish, design, fit, color, climatic conditions, activity to be engaged in when wearing the garment, and cleanability.

(2) There is no difference in the opinions of male and female Kansas State University students concerning the criteria that constitutes a warm garment.

(3) There is no difference in the opinions of the freshmen, sophomores, juniors, seniors, or graduate students attending Kansas State University concerning the criteria that constitutes a warm garment.

CHAPTER II

REVIEW OF THE LITERATURE

Clothing is a development of such ancient practices as tattooing and the raising of ornamental scars on the flesh of human beings. Rees (36) stated that men originated in tropical or subtropical latitudes and then migrated to the areas with increasingly colder climates. As the temperature in man's environment became cooler, a new function was acquired by clothing, that of protecting the body of the wearer. Climate thus plays an important role in the evolution of clothing. As one travels from the tropics towards the poles the decorative value of clothing becomes of secondary importance to its protective value. The farther one gets from the tropics the greater the amount of clothing necessary to maintain the body in a comfortable state. There are some exceptions to this statement, for example, the Arabs who are fully clothed yet live in an extremely hot region. Holley (27) stated that in a series of questions concerning fashion and warmth, two-thirds of a sample of sophomore/junior students at Kansas State University considered warmth a more important factor in the selection of wearing apparel than fashion.

Marsh (31) stated that the difference in thermal insulation among fabrics has been recognized for centuries. Two main classes of clothing have developed, one based on the skirt known as the tropical type and the other based on the trouser known as the arctic type. Those

two forms of dress often can be seen within the limits of one region because of climatic changes.

The addition of clothing to the body complicates the heat exchange between man and his environment. Although the same physical processes of conduction, convection, radiation, and evaporation are involved, the properties of the fibers and the textile system worn influence these processes. The major factors of clothing affecting the heat transfer are: fiber content; yarn and fabric construction; fabric density and thickness; textures and finishes; and garment design.

Fiber Content

Cassie (11) stated that the requirements for warmth of clothing fibers are: (1) a fine diameter to give a large total fiber surface to which heat insulating air can cling, to give rapid absorption of water vapor by the fibers, and give flexible fabrics; (2) irregularity and crimp so that the fibers do not pack together in a yarn to destroy the effects of their fine diameter; (3) large elastic moduli, preferably without plasticity to maintain the separation of the fibers in the yarn during wear and laundering; (4) large regain changes with relative humidity changes; and (5) water repellency. He evaluated the natural and the man-made fibers with respect to the above criteria. He found that silk is supreme among all the fibers so far as factors 1 and 3 are concerned and is adequate with respect to factors 2, 4, and 5. Wool is adequate with respect to factors 1 and 3 but is supreme in 2, 4, and 5. Cotton has a fine performance for factors 1, 2, 3, and 4 but fails in factor 5. Man-made fibers can fulfill factor 1 and possibly factor 2, but those fibers fail in the vital requirements for factors 3 and 5.

Yarn Construction

The American Society for Testing and Materials (5) defines a yarn as the generic term for a continuous strand of textile fibers, filaments, or material in a form suitable for knitting, weaving, or otherwise intertwining to form a textile fabric. Yarns are composed of short, staple length fibers or of long filament fibers. Staple yarns are made from the natural fibers and the man-made fibers are cut to staple length. Yarns made of staple fibers usually have projecting fibers along the yarn that gives them a fuzzy appearance. Filament yarns are long and smooth. Hollies (21) and Andreen (2) found that marked chill sensations were experienced in wearing a continuous filament fabric next to the skin. The same fabric using yarns cut to staple length showed no chill sensations when worn next to the skin.

Yarns can be singles that separate into fibers, plied yarns that are two or more singles twisted together, or a cord that is two or more plied yarns twisted together. The type of yarn used will aid in determining the density and thickness of a garment.

Yarns are twisted either in the S or Z direction. The more turns per inch the stronger the yarn becomes up to an optimum point, then the yarn becomes brittle and breaks easily. Several authors (16, 11, 8) found that flexibility in the yarns was a desirable characteristic. The fibers in a yarn spiral around one another, and an individual fiber in the yarn will have the shape of an open spring spiral. If this spiral spring is stretched as happens when one wears a garment it may elongate either by uncoiling or by twisting about the axis of the fiber forming the spring. To obtain the maximum surface area to aid

heat retention the fibers should uncoil rather than twist. If a fiber twists about its own axis any elongation packs the fibers together more closely. This packing is an enemy to warmth. Cassie (12) stated that the simplest method of obtaining flexibility is to reduce the diameter of the rods, or use fine diameter fibers.

Fabric Construction

Knitting and weaving are the two most common methods of constructing a fabric. However, Rees (38) stated that the most efficient construction for heat insulation is not a knitted or woven fabric, but a structure formed by a lap of well-opened fibers spread evenly between two layers of thin muslin that are then quilted together. Another good heat insulator is felt formed by pressure, heat, moisture, and agitation of a mass of fibers. The major disadvantage of felt is that it may be made in many thicknesses. As the felt becomes thicker the insulative value decreases (12).

A textile system must not only prevent great heat loss, but it must be light weight so as not to fatigue the wearer. The approach of industry to the problem of light weight warmth is the use of bonded fabrics. Two classes of polyurethane foams are used in the production of laminates--polyether and polyester. Bonding the woven or knitted fabric is affected either by using adhesives or by flame-lamination in which one surface of the foam is heated by a gas flame until it becomes tacky before being pressed onto the fabric (12).

There is a thickness loss of 20 per cent on lamination using either process (35). The loss is partly attributed to the stretching of the materials and the interlocking of the fabric and foam under

pressure in the lamination process. These fabrics are made in different densities, but they are all low. Rees (36) found no significant difference between the insulating properties of the polyether and the polyester foams. Both processes are superior in this respect to the knitted and woven fabrics.

Density and Thickness

Since one purpose of clothing is to restrict heat flow in cold climates, materials having a low thermal conductivity must be used. Rees (38) defined thermal conductivity as the rate of flow of heat by all possible modes across a unit area of a slab of the material under a unit temperature gradient. Still air is a good heat insulator having a low thermal conductivity. The thermal conductivity of all textile fabrics is greater than that of air by a factor of 10 to 20. Thus, the less dense the fabric the lower should be the thermal conductivity. This is true only to a point. For maximum heat insulation there is an optimum density that should be about 0.03 to 0.06 gram/cc. (36). Below this point the conductivity rises sharply because of convection and radiation.

Fiber orientation has an influence on the thermal conductivity of a textile system. When the fibers are all parallel to the direction of heat flow, they exert their maximum effect on the total heat flow. Fibers arranged at right angles to the heat flow exert their minimum effect. Random orientated fibers conduct heat from the body by a value between those two extremes. As the density of the mass is increased, the effect of the fiber increases as well as an increase in the thermal conductivity (11).

The thermal conductivity of fabrics is caused by air entrapped in the fabric. The drag or resistance to air movement through a mass of fibers comes from the solid surfaces of the fibers. Air immediately in contact with a solid surface is always at rest. If air is moving over the surface, there is a velocity gradient from the surface to the moving air. This velocity gradient exerts a drag on the moving air tending to bring it to rest. Cassie (12) stated that the greater the solid surface, the greater the drag on any air movement, and the greater the entrapped air.

If the fibers in a fabric are tightly packed from surface to surface yarns are not available to resist the general movement of air through the fabric and air will not be entrapped. The fabric will then conduct heat away from the body. Fibers differ more extensively in this packing property than any other (13). Wool seems to have a unique resistance to close packing. Cotton fabric has the opposite characteristic and frequently contains 80 per cent cotton fiber and 20 per cent air. Continuous filament yarns are automatically close packed. Only the yarn surfaces of these fibers are available for air drag. One could increase the air drag by making a denser fabric, but this would increase the weight of the garment, decrease its porosity, and increase its thermal conductivity. The requirements for good heat insulation, therefore, are low fabric density to give a low thermal conductivity, and the exposure of every fabric surface to the air so that the large total fiber surface in the fabric is effectively used to entrap air.

Rees (32) stated that layering of textile fabrics provides good insulation because there are air spaces between each layer. The heat

transfer from one layer to another is by radiation and transport through free air. The surface resistances of neighboring fabrics will contribute as much to the insulation provided by the clothing as do the thermal resistance of the fabrics themselves. The thermal conductivity of layered fabrics depends on the transfer of heat from one fabric to another. Fabrics of low surface emissivities will give clothing of low heat loss. Smooth surfaced fabrics with their large surface emissivities will give good heat transfer from fabric to fabric and from the skin to the fabric. This results in clothing of large heat transfer and cold feel.

Textures and Finishes

Texturizing yarns is a method of achieving a varied appearance and adding to the thermal insulation of a garment. Man-made textured yarns are filament or spun yarns that have been given a greater apparent volume than conventional yarn of similar count and denier. The fibers are either looped, curled, or crimped to give them bulk without weight.

Morton (32) stated that texturized surfaces may be divided into three groups as affected by light: those that absorb, reflect, or reflect and absorb light. The amount of light absorbed, reflected, or both will affect thermal conductivity. A napped fabric, one where the loose fibers are pulled from within the fabric to the surface to form a randomly oriented layer of fibers, both reflects and absorbs light. The top fibers hold a substantial amount of air also increasing the insulative value of the fabric (35). The opposite technique of producing fabrics with hard, clean, smooth surfaces provides a good conductor of heat from the body.

Black and Matthew (7) and Gregory (21) found that the chief factor concerning absorption and evaporation of moisture is the finish of the cloth, this being of even more importance than the structure of the fabric. The chemicals forced between the yarns and fibers tend to clog the air spaces in the fabric, thus, reducing the space for air and water to pass through. The severity of this restriction will depend on the type of finish applied.

Finishes change, or alter, the appearance or the desired behavior characteristics of the fabric. The finishes that alter the performance of the fabric are those that can prevent air permeability. These finishes are called functional and are divided into two groups, the external finishes and the internal finishes.

External finishes are applied to the surface of fibers, yarns, and/or fabrics and do not combine chemically with the fiber. They include softening agents, film forming agents such as starches, thermosetting resins, thermoplastic resins, surface deposits such as delustrants, slip-resistant finishes, hygroscopic agents, and corrective finishes such as water repellents, fire inhibitors, moth repellents, and bacteriostatic agents (28).

Internal finishes are deposited within the fiber and chemically combine with the fiber. These finishes usually are applied to fibers with porous surfaces. Internal finishes include thermosetting resins used for dimensional stabilization and crush or wrinkle resistance, weighting agents such as metallic salts, and chemical modifiers that alter the chemistry of a fiber, for example cyanoethylation and acetylation of cotton (28).

Garment Design

Garment design aids the escape of moisture from the fabric interstices through design features by the process of ventilation. Gregory (21) defined ventilation as a mode of transfer of moisture by which the air under the fabric is constantly desaturated by a mixture with the air from outside the fabric. Convection currents produce a bellows action when the body moves forcing air through the fabric and ventilation paths that are caused by the garment design. If a garment is sleeveless air and water vapor are free to move unrestricted in and out of this opening without going through the fabric. Other design features of a garment such as a low neck and openings at shirt collars produce the same effect.

The fit of a garment, whether it be loose or tight, affects thermal conductivity. Angus (3) found that in still air the loose parts of a garment often had from 10 to 40 per cent higher insulation than the tight parts. Yet, when the wind factor was introduced the greater thermal insulation was given by the tight fitting parts of a garment.

Fit also aids in determining the permeability of a garment. Perspiration must escape from the skin and the layer of air next to the skin if comfort is to be maintained (7). The permeability of a fabric to air is defined as the quantity of air that will pass through a known area of cloth of definite thickness, in a definite time, when there is a known pressure difference on the two sides of the cloth (7).

Textile fabrics contain moisture in two ways; hygroscopic moisture and moisture that is mechanically held. Hygroscopic moisture is absorbed naturally if the fabric is dried and placed in a humid

atmosphere. The amount of water absorbed varies with the humidity and temperature of the air. Textiles vary in their degree of hygroscopic water absorption. At any atmospheric condition wool absorbs more moisture than linen; linen absorbs more moisture than cotton; and both linen and cotton absorb their moisture quickly, whereas wool absorbs its moisture slowly (7). When only hygroscopic moisture is present the rate of evaporation is not constant, but decreases. It is proportional to the liquid content. The smaller the rate of hygroscopic moisture present the greater the lowering of the vapor pressure.

Spaces between the fibers or between the yarns may become filled with excess water. The amount of water mechanically held will depend on the pressure applied and on the structure of the fabric. The rate at which water will evaporate from the surface of a wet textile system depends on how quickly the layer of saturated vapor which is always present can escape (7).

CHAPTER III

METHODS OF PROCEDURE

Research for the American Society for Heating, Refrigeration, and Air Conditioning (ASHRAE) was conducted at Kansas State University to determine the role of various types of clothing on the thermal sensations of sedentary human subjects. The ASHRAE Study, RH 118, under the direction of Frederick Rohles may be obtained from the Department of Mechanical Engineering, Kansas State University.

Development of the Questionnaire

Data from the above study were the basis for a questionnaire to determine specifically:

- (1) what factors Kansas State University students consider when selecting a warm garment.
- (2) if there is a difference between male and female Kansas State University students in the factors they believe contribute to the warmth of a garment.
- (3) if the academic classification of Kansas State University students created a difference in the factors they believe contribute to the warmth of a garment.

Factors studied were: fiber content as found in questions 1-4; yarn construction (5-7); fabric construction (8-9); thickness and density (10-13); texture and finish (14-17); design and fit (18-22); color (23-26); climatic conditions (27-28); activity (29-31); and the cleaning of garments (32). The number of questions concerning the above factors varied because of the knowledge of the "average" student concerning textiles.

The questionnaire was given to twenty graduate students who were ineligible to participate in the study. Their answers were tabulated and changes were made according to their suggestions. The revised questionnaire as administered is in Appendix A, page 35.

Sampling and Administering Questionnaire

The size of the sample was determined after consultation with the statistician. On the basis of his advice and suggestions, a random sample of 99 students presently enrolled at Kansas State University during the spring semester of the 1971-72 academic year were surveyed. There were 14,591 students enrolled when the survey was conducted. The ratio of men to women was approximately three to two. The questionnaire was given individually to each person selected to participate in the study and was collected immediately after completion.

Methods of Analysis

The subjects responses were recorded according to the factor selected for each question. Only one score per question was recorded. The factors under investigation were given equal weight, though there were more questions appearing under one factor than under another. The responses of each student to the questionnaire were transferred to coding sheets. Data cards were punched according to the information on the coding sheets. The method employed to analyze the data was the chi-square computed separately for 99 responses for each of the three hypotheses under investigation.

CHAPTER IV

DISCUSSION OF FINDINGS

The results of this study will be discussed separately for Hypothesis I, Hypothesis II, and Hypothesis III (page 3) which were the basis for the questionnaire. Responses to questions are grouped according to the factors under consideration in Tables I through IV. Each question (Appendix A, page 35) had a choice of answers identified in the tables by numbers 1, 2, 3, 4, and 5. If there was no response by a student to answers to a question that is indicated by 0. Data in Table I are the number of responses to each answer to a question; data in Tables II through IV are presented on the basis of percentage of responses to each answer to a question.

Hypothesis I

Responses to the factors believed by students to determine the warmth of a garment are given in Table I. Responses to questions (1-4) concerning fiber content revealed that students believe the fiber content and the source of the fiber affects the warmth of a garment. Of the natural fibers, wool was rated the warmest. Of the man-made fibers, no one fiber was most often selected as warmer than the other. This might be because the students were not familiar enough with the properties of man-made fibers.

Students believed that the type of yarn and fabric construction (questions 5-9) makes a garment warmer. The fabric construction

TABLE I
FACTORS STUDENTS (N = 99) BELIEVED DETERMINE
THE WARMTH OF A GARMENT

FACTOR	QUESTION NUMBER	#					NUMBER OF RESPONSES				
		0	1	2	3	4					
FIBER CONTENT	1	ALL	95	--	4	--	--	--	--	--	--
	2	3	7	1	2	86	--	--	--	--	--
	3	12	7	16	23	27	--	--	--	--	14
	4	ALL	62	22	15	--	--	--	--	--	--
YARN CONSTRUCTION	5	ALL	87	3	9	--	--	--	--	--	--
	6	ALL	64	16	19	--	--	--	--	--	--
	7	32	35	22	10	--	--	--	--	--	--
FABRIC CONSTRUCTION	8	ALL	94	2	3	--	--	--	--	--	--
	9	4	14	45	16	20	--	--	--	--	--
THICKNESS & DENSITY	10	1	40	49	9	--	--	--	--	--	--
	11	ALL	93	3	3	--	--	--	--	--	--
	12	ALL	83	9	7	--	--	--	--	--	--
	13	ALL	85	8	6	--	--	--	--	--	--
TEXTURE & FINISHES	14	ALL	48	44	7	--	--	--	--	--	--
	15	48	14	20	17	--	--	--	--	--	--
	16	ALL	69	15	15	--	--	--	--	--	--
	17	27	17	48	3	4	--	--	--	--	--

TABLE I (CONTINUED)

FACTOR	QUESTION NUMBER	NUMBER OF RESPONSES				
		0	1	2	3	4
DESIGN & FIT	18	ALL	83	11	5	--
	19	8	82	--	1	8
	20	8	90	--	--	1
	21	ALL	91	7	1	--
	22	8	35	56	--	--
COLOR	23	ALL	46	46	7	--
	24	53	10	4	30	2
	25	ALL	79	15	5	--
	26	17	9	1	68	4
CLIMATIC CONDITIONS	27	ALL	94	3	2	--
	28	3	20	74	2	--
ACTIVITY	29	1	63	7	3	25
	30	1	19	59	20	--
	31	1	34	40	24	--
CLEANING	32	1	47	34	17	--

0---no response to any part of the question

1---1st answer

2---2nd answer

3---3rd answer

4---4th answer

5---5th answer

considered warmest was a quilted fabric. Flexibility of yarns was considered to contribute to fabric warmth, but the responses did not indicate a preference for flexible or semi-flexible yarns.

Responses indicated that a garment could be both light weight and warm. The layering of one or more garments was considered warmer than a single garment, but warmth wasn't considered to increase with thickness. The majority of students believed that the density of a garment affected its warmth (questions 10-13).

Approximately one-half of the students indicated that the surface texture of a garment (questions 14-15) made it warm, and the other one-half indicated that it did not. Of those students who believed surface texture affected warmth no one texture was selected as the warmest. The majority however, believed that the finish on a fabric (questions 16-17) affected warmth. A thermal coated finish was selected as the warmest.

The turtle neck and long sleeves were considered the warmest styles of garment design (questions 18-20). Fit (questions 21-22) affected warmth, but responses did not indicate which type of fit, loose or tight, was considered the warmer.

One-half of the students believed color affected the warmth of clothing worn indoors (questions 23-24) and outdoors (questions 25-26). Black was selected as the color making a garment warm both indoors and outdoors.

Responses to questions 27-28 indicated the students believed that climatic conditions influence the warmth of clothing, and that

wind makes one feel colder than any type of moisture, for example rain or snow.

Students believed that the more activity engaged in, the less clothing needed to maintain warmth (questions 19-31). Most students stated that they wear the warmest clothing when watching television as opposed to playing cards or working indoors.

Respondents believed that creating a tension on a garment such as putting heavy objects in the pocket does not make it warmer. Responses did not indicate if the students thought that a new garment is warmer than one that has been worn a number of times, or if repeated cleaning (question 32) affects the warmth of a garment.

Based on the factors of what constituted a warm garment students believed fiber content and the source of the fiber, yarn and fabric construction, density, finish, design and fit, color of a garment worn outdoors, climatic conditions, and activity engaged in when wearing the garment were determining factors influencing the warmth of a garment. Therefore, hypothesis I was accepted.

Hypothesis II

There was no difference of opinion between the 53 male and the 46 female students surveyed except for questions: 3, 9, 12, 15, 24, and 29 as given in Table II. Both sexes held similar opinions relative to how the type of yarn construction, design and fit, climatic conditions, and cleanability affect the warmth of a garment.

The difference in opinion between males and females for question 3 concerning the warmest man-made fiber was attributed to the fact that 36 per cent of the females chose acrylic as the warmest of those fibers,

TABLE II
 DIFFERENCE OF OPINIONS BETWEEN MALES (N = 53) AND FEMALES (N = 46)
 CONCERNING THE FACTORS AFFECTING THE WARMTH OF GARMENTS

FACTOR	QUESTION NUMBER	1#									
		2		3		4		5			
PER CENT OF RESPONSES											
		male	female	male	female	male	female	male	female	male	female
FIBER CONTENT	1	92	100	0	0	8	0	--	--	--	--
	*2	6	9	0	2	4	0	90	89	--	--
	3	7	9	0	36	37	16	37	25	19	14
	4	58	67	25	20	17	13	--	--	--	--
YARN CONSTRUCTION	5	83	93	4	2	13	4	--	--	--	--
	6	70	59	11	22	19	20	--	--	--	--
	7	60	41	30	37	10	22	--	--	--	--
FABRIC CONSTRUCTION	*8	96	93	2	2	2	4	--	--	--	--
	9	12	18	38	58	20	13	30	11	--	--
THICKNESS & DENSITY	10	37	46	50	50	13	4	--	--	--	--
	*11	92	96	2	4	6	0	--	--	--	--
	12	81	87	15	2	4	11	--	--	--	--
	13	79	93	11	4	9	2	--	--	--	--
TEXTURE & FINISHES	*14	55	41	38	52	8	7	--	--	--	--
	15	32	20	48	25	19	55	--	--	--	--
	16	64	76	19	11	17	13	--	--	--	--
	17	28	19	56	78	8	0	8	3	--	--

TABLE II (CONTINUED)

FACTOR	QUESTION NUMBER	PER CENT OF RESPONSES									
		1		2		3		4		5	
		male	female	male	female	male	female	male	female	male	female
DESIGN & FIT	18	85	83	11	11	4	7	--	--	--	--
	19	85	95	0	0	2	0	13	5	--	--
	20	98	100	0	0	0	0	2	0	--	--
	21	94	89	4	11	2	0	--	--	--	--
	22	40	37	60	63	--	--	--	--	--	--
COLOR	23	42	52	49	43	9	4	--	--	--	--
	*24	4	39	9	9	83	48	4	4	--	--
	25	79	80	13	17	8	2	--	--	--	--
	26	4	19	2	--	87	78	7	3	--	--
CLIMATIC CONDITIONS	27	91	100	6	0	4	0	--	--	--	--
	28	24	17	72	83	4	0	--	--	--	--
ACTIVITY	*29	52	78	8	7	2	4	38	11	--	--
	30	25	13	62	59	13	28	--	--	--	--
	31	35	35	33	50	33	15	--	--	--	--
CLEANING	32	48	48	33	37	19	15	--	--	--	--

1--1st answer
 2--2nd answer
 3--3rd answer
 4--4th answer
 5--5th answer

* Significant at 0.05 level

whereas no males selected acrylic. Also, 37 per cent of the males selected nylon as the warmest of those fibers whereas only 16 per cent of the females chose nylon.

Question 9 was concerned with the type of construction (bonded, quilted, knitted, woven) for fabric warmth. The major factor in determining a difference between the male and female vote was that 30 per cent of the males chose a woven fabric to be the warmest, whereas only 11 per cent of the females thought a woven fabric was warmer than fabrics with other types of construction.

Two per cent of the females believed that wearing two or more garments at the same time made one feel warmer, whereas 15 per cent of the males believed that to be true; thus the difference in opinions for question 12. Also, 11 per cent of the females had no opinion while only 4 per cent of the males chose the answer no opinion.

The difference between males and females for question 15 was because 55 per cent of the females believed that a raised surface makes a garment warm, whereas only 19 per cent of the males believed as the females. Also, 25 per cent of the females selected the rough surface while 48 per cent of the males chose a rough surface as the warmest.

The difference between males and females in opinion expressed to question 12 may be attributed to the 39 per cent of the females who chose red, yellow, and orange as warm colors, but only 4 per cent of the males believed those colors to be warmest. Also, 48 per cent of the females chose black as the warmest color, whereas 83 per cent of the males selected black.

Finally, a difference of opinion for question 29 was because 78

per cent of the females believed that they would wear the warmest garment while watching television, whereas 83 per cent of the males believed they would. Also, 91 per cent of the females answered no opinion, whereas only 38 per cent of the males answered no opinion.

Responses to only 20 per cent of the questions showed a significant ($P < 0.05$) difference between males and females concerning factors that affect the warmth of clothing. Therefore, the hypothesis that there is no difference in the opinions of male and female Kansas State University students concerning the factors that constitutes a warm garment was accepted.

Hypothesis III

The academic classification of students (freshmen and sophomores Table III, juniors, seniors, and graduate students Table IV) did not create a difference in opinions concerning the factors that constitute a warm garment, except for question 19. Question 19 was concerned with the effect of neck style on warmth. The major factor contributing to a difference in opinions was that 92 per cent of the sophomores and 82 per cent of the freshmen selected the turtleneck style as warm, whereas all of the juniors and seniors and only 57 per cent of the graduate students selected the turtle neck. Also, contributing to a difference in opinions regarding the effect of neck style on warmth was that 18 per cent of the freshmen and 43 per cent of the graduate students selected the convertible collar as the warmest neck style, whereas no sophomores, juniors, or seniors selected the convertible collar.

Answers to only 3.1 per cent of the questions gave a significant

TABLE III
 OPINIONS OF FRESHMEN (N = 31) AND SOPHOMORES
 (N = 21) FOR WARM GARMENTS

FACTOR	QUESTION NUMBER	1#									
		2		3		4		5			
		PER CENT OF RESPONSES									
		Fr.	Soph.	Fr.	Soph.	Fr.	Soph.	Fr.	Soph.	Fr.	Soph.
FIBER CONTENT	1	100	83	0	0	0	17	--	--	--	--
	2	0	18	0	9	0	9	100	64	--	--
	3	7	20	17	30	24	20	31	10	21	20
	4	52	75	32	8	16	17	--	--	--	--
YARN CONSTRUCTION	5	87	92	6	0	6	8	--	--	--	--
	6	52	58	29	25	19	17	--	--	--	--
	7	29	38	47	38	24	25	--	--	--	--
FABRIC CONSTRUCTION	8	97	92	0	0	3	8	--	--	--	--
	9	10	8	55	50	13	17	23	25	--	--
THICKNESS AND DENSITY	10	45	58	48	25	6	17	--	--	--	--
	11	94	83	3	8	3	8	--	--	--	--
	12	81	83	13	8	6	8	--	--	--	--
	13	90	83	3	0	6	17	--	--	--	--
TEXTURE AND FINISHES	14	52	50	42	42	6	8	--	--	--	--
	15	29	29	29	29	41	43	--	--	--	--
	16	74	58	10	33	46	8	--	--	--	--
	17	25	13	67	75	4	13	4	0	--	--

TABLE III (CONTINUED)

FACTOR	QUESTION NUMBER	PER CENT OF RESPONSES									
		1		2		3		4		5	
		Fr.	Soph.	Fr.	Soph.	Fr.	Soph.	Fr.	Soph.	Fr.	Soph.
DESIGN AND FIT	*18	84	83	13	8	6	8	--	--	--	--
	19	82	92	0	0	0	8	18	0	--	--
	20	100	92	0	0	0	0	0	8	--	--
	21	97	75	3	17	0	8	--	--	--	--
	22	40	30	60	70	--	--	--	--	--	--
COLOR	23	39	33	52	58	10	8	--	--	--	--
	24	27	0	9	0	45	100	18	0	--	--
	25	84	67	13	25	3	8	--	--	--	--
	26	8	0	0	0	88	78	4	22	--	--
CLIMATIC CONDITIONS	27	94	92	3	0	3	8	--	--	--	--
	28	17	25	83	67	0	8	--	--	--	--
ACTIVITY	29	70	67	3	8	0	17	27	8	--	--
	30	20	8	53	67	27	25	--	--	--	--
	31	23	50	47	42	30	8	--	--	--	--
CLEANING	32	40	42	33	50	27	8	--	--	--	--

#

1--1st answer

2--2nd answer

3--3rd answer

4--4th answer

5--5th answer

+ Fr.--freshman; Soph.--sophomore

* Significant at 0.05 level

TABLE IV (CONTINUED)

FACTOR	QUESTION NUMBER	PER CENT OF RESPONSES									
		1		2		3		4		5	
		Jr.	Sr.	Jr.	Sr.	Jr.	Sr.	Jr.	Sr.	Jr.	Sr.
DESIGN & FIT	18	85	81	100	12	14	0	4	5	0	0
	*19	100	100	57	0	0	0	0	0	0	43
	20	100	100	100	0	0	0	0	0	0	0
	21	96	86	100	4	14	0	0	0	0	0
	22	38	61	0	63	39	100	--	--	--	--
COLOR	23	58	38	71	35	62	14	8	0	14	0
	24	20	25	20	13	13	0	67	63	80	0
	25	73	81	100	15	19	0	12	0	0	0
	26	19	6	14	0	0	14	81	88	71	0
CLIMATIC CONDITIONS	27	96	95	100	4	5	0	0	0	0	0
	28	23	15	29	73	85	71	4	0	0	0
ACTIVITY	29	54	67	71	12	5	0	4	0	0	0
	30	31	5	29	58	86	29	12	10	43	29
	31	38	29	57	38	43	14	23	29	29	29
CLEANING	32	58	43	71	27	38	29	15	19	0	0

1--1st answer

2--2nd answer

3--3rd answer

4--4th answer

5--5th answer

+ Jr.--junior; Sr.--senior; Gr.--graduate student

* Significant at 0.05 level

($P < 0.05$) difference of opinions among students in the several academic classifications. Therefore, the hypothesis that there is no difference in the opinions of the freshmen, sophomores, juniors, seniors, or graduate students concerning the factors that constitutes a warm garment was accepted.

CHAPTER V

SUMMARY AND RECOMMENDATIONS

This study was undertaken to establish the factors that college students consider when selecting a warm garment, and to investigate differences in opinions concerning warmth between the sexes and among students of varying academic levels.

A questionnaire was constructed and used to obtain the information. A random sample of 99 students enrolled at Kansas State University during the spring semester of 1971-72 was used. The factors under consideration were: fiber content; yarn construction; fabric construction; thickness and density; textures and finishes; design and fit; color; climatic conditions; activity; and the cleaning of garments. The questionnaire contained yes and no questions as well as multiple choice answers.

Students believed fiber content and the source of the fiber, yarn and fabric construction, density, finish, design and fit, color when worn outdoors, climatic conditions, and activity engaged in when wearing a garment are the factors that influence the warmth of a garment. Although those are the factors selected as affecting warmth, students could not select what particular factor made a garment warm indicating they did not consider the factor when they were in a retail establishment choosing a warm garment.

Significant ($P < 0.05$) differences of opinions were found

between the sexes for 20 per cent of the questions, and among the freshmen, sophomores, juniors, seniors, and graduate students for 3.1 per cent of the questions. For future studies a larger sample might be used to investigate the possibility of a greater percentage of differences between these groups.

It is suggested that fabric samples might be used with the questionnaire for further study. Also, all responses in the questionnaire might be labeled A, B, C, D, and E corresponding to the answers of a question. This would clarify any type of table, chart, or graph used to discuss the findings. It is recommended that the data obtained from the study conducted by the American Society for Heating, Refrigeration, and Air Conditioning at Kansas State University be compared with the results of this study to investigate correlations between the beliefs of students concerning warmth of clothing with their actual experiences in the environmental chamber during comfortable conditions.

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APPENDIX A

THERMAL COMFORT STUDY

This questionnaire is a study of opinions concerning the factors that make garments warm. There are no right or wrong answers to the questions. Each question is to be answered according to your beliefs. Check () only one answer per question.

CIRCLE ONE: FRESH., SOPH., JR., SENIOR., GRAD. MALE _____ FEMALE _____

1. Does the fiber content make a garment warmer?
☐ yes
☐ no
☐ no opinion
2. If you answered question number 1 YES which one of the following natural fibers makes the warmest garment?
☐ A. Cotton
☐ B. Linen
☐ C. Silk
☐ D. Wool
3. If you answered question number 1 YES which one of the following man-made fibers makes the warmest garment?
☐ A. Acetate
☐ B. Acrylic
☐ C. Nylon
☐ D. Polyester
☐ E. Rayon
4. Do you feel the source of the fiber makes a difference in the warmth of a garment?
☐ yes
☐ no
☐ no opinion
5. Can the construction of the yarns in a garment make it warmer?
☐ yes
☐ no
☐ no opinion
6. Does the flexibility of yarns in a fabric make it warmer?
☐ yes
☐ no
☐ no opinion
7. If you answered question number 6 YES which one of the following degrees of flexibility makes a garment warmest?
☐ A. Flexible
☐ B. Semi-flexible
☐ C. Stiff

8. In your opinion can the construction of a fabric make it a warmer garment?
☐ yes
☐ no
☐ no opinion
9. If you answered question number 8 YES which one of the following fabrics would be the warmest?
☐ A. Bonded fabric
☐ B. Quilted fabric
☐ C. Knitted fabric
☐ D. Woven fabric
10. Do you believe that the thicker a garment is the warmer it is?
☐ yes
☐ no
☐ no opinion
11. In your opinion can a garment of light weight still be warm?
☐ yes
☐ no
☐ no opinion
12. Does wearing two or more garments at the same time make you feel warmer?
☐ yes
☐ no
☐ no opinion
13. Can the compactness of the yarns in a fabric make a garment warmer?
☐ yes
☐ no
☐ no opinion
14. Do you believe the surface texture of a garment makes it warmer?
☐ yes
☐ no
☐ no opinion
15. If you answered question number 14 YES which one of the following surfaces makes a garment the warmest?
☐ A. Smooth
☐ B. Rough
☐ C. Raised
16. Does the finish on a garment make it warmer?
☐ yes
☐ no
☐ no opinion

17. If you answered question number 16 YES which one of the following finishes makes a garment warmest?
☐ A. Vinyl coated
☐ B. Thermal coated
☐ C. Water repellent
☐ D. Water proof
18. Does the design of a garment make it warmer?
☐ yes
☐ no
☐ no opinion
19. If you answered question number 18 YES which one of the following neck styles makes a garment warmest?
☐ A. Turtle neck
☐ B. V-neck
☐ C. Scoop neck
☐ D. Convertable collar
20. If you answered question number 18 YES which one of the following sleeve styles makes a garment warmest?
☐ A. Long sleeves
☐ B. Three-quarter sleeves
☐ C. Short sleeves
☐ D. Sleeveless
21. Do you believe the fit of a garment makes it warmer?
☐ yes
☐ no
☐ no opinion
22. If you answered question number 21 YES which one of the following types of fit make a garment warmer?
☐ A. Loose fit
☐ B. Tight fit
23. In your opinion does the color of a garment make it warmer indoors?
☐ yes
☐ no
☐ no opinion
24. If you answered question number 23 YES which one of the following groups of colors do you believe makes a garment warmest?
☐ A. Red, Yellow, Orange
☐ B. Blue, Green, Violet
☐ C. Black
☐ D. White

25. In your opinion does the color of a garment make it warmer when worn outdoors?
☐ yes
☐ no
☐ no opinion
26. If you answered question number 25 YES which one of the following do you believe makes a garment warmest?
☐ A. Red, Yellow, Orange
☐ B. Blue, Green, Violet
☐ C. Black
☐ D. White
27. Do climatic conditions influence the clothing you wear for warmth?
☐ yes
☐ no
☐ no opinion
28. If you answered question number 27 YES which one of the following conditions makes you feel less warm?
☐ A. Moisture as in the form of rain or snow
☐ B. Wind
☐ C. No opinion
29. When would you wear the warmest garment?
☐ A. Watching T.V.
☐ B. Playing cards
☐ C. Working indoors
☐ D. No opinion
30. Does creating a tension on a garment as putting heavy objects in your pocket make it warmer?
☐ yes
☐ no
☐ no opinion
31. Will a new garment be warmer than one that has been worn a number of times?
☐ yes
☐ no
☐ no opinion
32. Does repeated cleaning affect the warmth of a garment?
☐ yes
☐ no
☐ no opinion

FACTORS SELECTED BY A NUMBER OF KANSAS STATE
UNIVERSITY STUDENTS FOR WARM CLOTHING

by

KAY E. MURPHY

B. S., Kansas State University, 1971

AN ABSTRACT OF A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Clothing, Textiles, and Interior Design

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1972

This study investigated the factors Kansas State University students considered when buying a warm garment and determined differences in opinions between the sexes and among academic levels concerning the warmth of clothing. Ninety-nine students enrolled at Kansas State University during the spring semester of 1971-72 were randomly selected and surveyed. Both yes and no and multiple choice questions were used in the questionnaire. It was recommended that further investigation use fabric samples with the questionnaire.

The data obtained from the questionnaire indicated that fiber content and the source of the fiber, yarn and fabric construction, density, finish, design and fit, color when worn outdoors, climatic conditions, and the activity engaged in when wearing a garment were the factors students considered when selecting a warm garment. Answers to twenty per cent of the questions showed a significant ($P < 0.05$) difference of opinions between the sexes. Therefore, the hypothesis that there is no difference in the opinion of male and female Kansas State University students concerning the factors that constitutes a warm garment was accepted. Only 3.1 per cent of the questions showed a significant ($P < 0.05$) difference of opinions because of academic classification. The hypothesis that there is no difference in the opinions of the freshmen, sophomores, juniors, seniors, or graduate students concerning warmth was accepted. A larger sample was suggested for further study.

It was recommended that data from the study conducted by the American Society for Heating, Refrigeration, and Air Conditioning at Kansas State University be compared with this study for further investigation of thermal comfort.