The Existence and Perception of Redundancy in Consumer Information Environments

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ABSTRACT. Two studies are reported which examine the existence of attribute redundancy as well as consumers’ ability to perceive attribute redundancy in consumer information environments. The results of the first study suggest that attribute redundancy varies widely from product category to product category. The results of the second study suggest that consumers' ability to perceive attribute relationships improves with product knowledge. Unexpected was an observed U-shaped relationship between consumers' perceptions of attribute redundancy and attribute knowledge. Together the results suggest a number of policy implications regarding the value of consumer information programs.

The redundancy of product attributes is an important dimension of consumer information environments. Both decision and consumer researchers recognize that an increase in attribute redundancy, or the correlation among product attributes, decreases the marginal value of gathering and processing information (Einhorn & Hogarth, 1981; Einhorn, Kleinmuntz, & Kleinmuntz, 1979; Hagerty & Aaker, 1984). When attributes are redundant, knowing a product’s value on one attribute may provide information on a number of other decision relevant attributes. For instance, knowing that a television has a large screen suggests that the television is, at the same time, both expensive and heavy. Information search in such cases may be quite limited and still yield extremely satisfactory product choices.

Yet it is unclear whether consumers are able to perceive the redundant or nonredundant nature of product information. The mixed results in the psychological literature suggest that as experience and knowledge grow, consumers may learn to distinguish redundant from nonredundant information (Alloy & Tabachnik, 1984) or perceive redundancy independent of any actual attribute relationships (Crocker, 1981; Einhorn & Hogarth, 1978). Whether or not consumers accurately perceive attribute redundancy is an empirical question of considerable importance to marketing and public policy. If consumers perceive or expect relationships that simply do not exist, they may underestimate the value of gathering and processing product information.

The goal of this study is to examine two important questions regarding attribute level redundancy and consumers. First, to what degree is product attribute information redundant? Second, does the accumulation of product knowledge and experience result in more accurate perceptions of attribute redundancy? We begin by describing existing research and perspectives on the existence and perception of attribute redundancy and then develop our research hypotheses. Two empirical studies are then presented. The first study explores actual attribute redundancy within sixty-five product categories. The second study examines consumer perceptions of redundancy within a subset of these categories.

THE EXISTENCE AND PERCEPTION OF ATTRIBUTE REDUNDANCY

Previous consumer research on redundancy has focused on the use of price as a means of judging or explaining overall product quality (cf. Geistfeld, 1982; Gerstner, 1985; Monroe, 1973; Riesz, 1978, 1979).

Generally these studies find little to no systematic correlation between prices and quality rankings. This does not, however, imply that product information environments lack redundancy. Overall quality rankings may obscure the true level at which redundancy operates. It may be at the attribute level where redundancy exists, is perceived, and has an effect on consumer information processing.

Consumer researchers have begun to examine the correlation structure of product attribute information. Hjorth-Andersen (1984), for example, found 38 percent of a sample of 122 US Consumer Reports studies to contain redundant attribute ratings. Curry and Faulds (1986), in a subsequent study, analyzed attribute ratings from 385 studies conducted by the German testing agency Stiftung Waren- test and published in test. The results revealed that 20 percent of these studies contained all positively correlated attributes, 2 percent contained all negative attribute correlations, and 2 percent contained uncorrelated attributes, while the majority of the studies, 76 percent, contained some mix of positively correlated, negatively correlated, and uncorrelated attributes. Both of these studies focused only on the attribute ratings that testing agencies use as the basis of overall quality scales. Objective attribute information, such as size, weight, and price, was not studied. However, the studies do suggest that the correlation structure of product attribute information may be complex.

Given this complexity, consumer perceptions of attribute redundancy may or may not be an accurate reflection of actual redundancy. Early studies of our ability to perceive redundancy were far from encouraging. Smedslund (1963), for example, found that subjects (nurses) without training in statistics had little to no concept of the correlation among patients’ symptoms. Subjects with training in statistics, moreover, consistently overestimated these correlations (see also Jenkins & Ward, 1965). In an early review of this literature, Peterson and Beach (1967) note that the often observed result of studies using binary attributes or cues as stimuli is overconfidence in the judging of relationships. This overconfidence results from subjects focusing on a biased subset of information, such as only those instances where both attributes are present. One conclusion is that people do not generally appreciate negative evidence and, therefore, overestimate relationships. Other studies, however, reveal that perceptions of correlation are much improved when continuous variables, with more than two values, are used (Beach & Scopp, 1966; Erlick, 1966; Erlick & Mills, 1967). Peterson and Beach conclude that “statistical man” may do much better when placed in a more natural, complex environment.

More recently, consumer researchers have begun to explore perceptions of attribute relationships. In an initial study, Bettman, John, and Scott (1984) found that subjects could distinguish between high and low levels of attribute correlation. In a subsequent study, Bettman, John, and Scott (1986) again report relatively accurate perceptions of both attribute level and price/quality covariation. However, the subjects in both of these studies were provided with the relevant information and given instructions regarding the concept of a correlation. In a third study, John, Scott, and Bettman (1986) suggest how expectations of price/quality relationships may bias the information that consumers gather and use. Those consumers holding expectations of a positive relationship between price and quality were more likely to sample only high priced products. As described below, such limited search strategies may result in inflated perceptions of attribute redundancy (Einhorn & Hogarth, 1978).

The mixed results regarding peoples' ability to judge redundancy or covariation among attributes prompt two related questions. When are perceptions likely to be an accurate reflection of inherent, environmental redundancy, and when are perceptions likely to be inflated?

Expectations and Redundancy Perceptions

A number of researchers believe that our generalized expectations regarding the existence of relationships are a major cause of inaccurate, inflated perceptions (cf. Bettman et al., 1986; Crocker, 1981; Einhorn & Hogarth, 1978). These expectations are themselves viewed as by-products of individuals' organized representations of prior knowledge, often referred to as knowledge schemas (Alloy & Tabachnik, 1984). According to this view, the knowledge representations that facilitate our perception and information processing also contain expectations that systematically bias and distort our perceptions of attribute redundancy. Expectations regarding relationships, once formed, may be further reinforced or inflated during subsequent information processing.

Crocker (1981) describes five possible steps in the covariation assessment process that highlight, more specifically, how expectations of redundancy may be created and reinforced as people gather and process information. In Step One, we decide on the universe of relevant data. If we unnecessarily limit this universe of data, inaccurate expectations may develop (Einhorn & Hogarth, 1978). For example, a consumer who only experiences higher priced televisions may falsely expect relationships between price and many nonprice television attributes. In Step Two, we sample from the available or perceived relevant cases. Unfortunately people have a well documented tendency to focus on cases that confirm rather than disconfirm their hypotheses and expectations (cf. Einhorn & Hogarth, 1978; Wason & Johnson-Laird, 1972). Our bias toward the use of confirming information is also evidenced in studies of illusory correlations, where people's expectations endure despite being confronted with data to the contrary (Chapman & Chapman, 1967, 1969; Golding & Rorer, 1972).

In Step Three, we classify the sampled cases as confirming or disconfirming some hypothesized relationship. People may, however, treat confirming cases as evidence for a relationship and disconfirming cases as the result of chance (Einhorn & Hogarth, 1978). In Step Four, we recall the frequency of confirming and disconfirming cases. A number of studies find people better able to recall information that is consistent rather than inconsistent with their knowledge structures or expectations, again suggesting a bias. Similar biases in the processing of positive and negative information can be seen in studies on the "Pollyanna Principle," where pleasant or positively valued information is processed more accurately or effectively (Fornell & Westbrook, 1984; Matlin & Stang, 1978). Finally, in Step Five, the assembled evidence must be combined to make a judgment. Given the biases inherent in the availability, perceived relevance, sampling, processing, and recollection of information, attribute redundancy may become both expected and reinforced, perhaps inaccurately, as knowledge and experience grow. (For more detailed discussions see Crocker, 1981, and Einhorn & Hogarth, 1978.)

Situational Information and Perceptions

Why, then, do some studies find subjects quite accurate in their perceptions of redundancy? Alloy and Tabachnik (1984) offer a different perspective on the role of expectations and available information in perception. They argue that the mixed results in the literature can be explained by looking at the interaction between the availability of objective, situational information and our expectations regarding that information. People may perceive true (environmental) relationships or correlations when available information is more salient than prior expectations. When expectations are relatively strong, available information may be used more to confirm than to discount expectations.

This interactive framework helps explain the earlier mentioned consumer research results of Bettman et al. (1984, 1986) and John et al. (1986). When available information was very salient, either because prior expectations were controlled for (Bettman et al., 1984) or subjects were given detailed instructions on the use of available information (Bettman et al., 1986), subjects’ perceptions of redundancy or covariation were quite accurate. When, however, subjects had expectations regarding redundancy, John et al. (1986) found them sampling only a subset of the available information that is necessary to accurately judge attribute relationships.

Consumer Knowledge, Experience, and Perceived Redundancy

A consumers’ experience and resulting product knowledge should play a central role in affecting perceived redundancy. (The Bettman et al. studies focus only on consumer perceptions of experimentally provided attribute information.) One very straightforward prediction is that consumers’ ability to perceive attribute relationships increases with experience and resulting knowledge. The more consumers interact with products and learn about their attributes the more accurate their perception of attribute relationships. This prediction is very consistent with Alloy and Tabachnik’s (1984) framework in which salient, experience-based information and resulting knowledge may drive perceptions.

An alternative prediction is that, assuming expectations and processing biases dominate consumers’ product knowledge and experience, consumers perceive redundancy across categories as their knowledge and experience grow. As suggested by Crocker (1981) and Einhorn and Hogarth (1978), expectations of attribute redundancy may develop as a by-product of knowledge and, in turn, be reinforced in subsequent product experiences and information processing. A third possibility is that both predictions are correct; they are not mutually exclusive. Experienced, knowledgeable consumers may learn to distinguish between more or less redundant product categories while, at the same time, systematically overestimate redundancy across categories.

Although knowledge and experience are usually related (Howard, 1977; Bettman, 1979), there may be cases where they are quite different and should be treated separately. Bracks (1985) argues that knowledge and experience are conceptually distinct; while experience reflects a consumer's interaction with a product, knowledge may or may not result from this interaction. Given this possibility, one of our empirical studies shall test predictions regarding two qualitatively different though related independent variables, experience-based product knowledge (a combined knowledge/experience measure) and pure experience. We shall refer to these variables simply as knowledge and experience respectively.

Hypotheses

The preceding discussion suggests a number of testable hypotheses regarding consumer perceptions of product attribute redundancy. An implicit assumption in our discussion is that consumers perceive systematic differences in redundancy across product categories. This assumption is explicitly stated as our first hypothesis:

H1: Consumers perceive systematic differences in attribute redundancy across product categories.

The remaining hypotheses explore two levels of consumer perception in order to fully examine the possible effects of knowledge and experience on attribute perceptions. These two levels are referred to here as perceived redundancy and pair-level accuracy. Perceived redundancy is the consumers' general or average perception of redundancy across attributes within a product category. Pair-level accuracy is more specific and refers to the consumers' ability to judge the direction and magnitude of the relationship between any given pair of attributes within a product category. Hypotheses Two and Three predict changes in perceived redundancy with knowledge and experience. Hypotheses Four and Five make similar predictions for pair-level accuracy.

Assuming consumers learn about attribute redundancy as knowledge and experience grow, we make a very straightforward prediction:

Perceived redundancy should increase with actual or environmental redundancy, depending on the consumers’ knowledge and experience. More knowledgeable or experienced consumers should perceive more redundancy within more redundant information environments (product categories). Naive or inexperienced consumers should perceive the same base-level of attribute redundancy across environments. In other words, we predict a significant interaction between consumer knowledge (experience) and inherent or actual redundancy on perceived redundancy. This prediction constitutes separate hypotheses for knowledge and experience:

H2: Perceived attribute redundancy increases with consumer knowledge within inherently more redundant categories.

H3: Perceived attribute redundancy increases with consumer experience within inherently more redundant categories.

These predictions are very consistent with Alloy and Tabachnik’s framework, in which salient information rather than expectations and biases may drive perception as knowledge and experience grow. An alternative prediction is that knowledge and experience lead to greater levels of perceived redundancy independent of inherent or actual redundancy. If the biases in information search and processing described earlier dominate perceptions, knowledge and experience should have a general positive effect on perceived redundancy within both redundant and nonredundant categories. Assuming these predictions are not mutually exclusive, a third possibility is that knowledge and experience lead to significant increases in perceived redundancy across categories as well as significantly greater increases in perceived redundancy within more redundant categories.

Looking only at perceived redundancy does not, however, address the question of whether consumers perceive the direction and magnitude of attribute-pair relationships. An initial, straightforward prediction is that pair-level accuracy, or the consumers' ability to perceive particular attribute relationships, should increase with knowledge and experience. This prediction, which is again consistent with Alloy and Tabachnik’s framework, provides Hypotheses Four and Five:

H4: Consumers' ability to perceive product attribute relationships increases with product knowledge.

H5: Consumers’ ability to perceive product attribute relationships increases with product experience.

Two studies are now described which, taken together, provide a test of these hypotheses. Study One looks at actual attribute redundancy across a number of product categories. Study Two looks at consumer perceptions of attribute redundancy within a subset of these categories, and how knowledge and experience affect these perceptions.

STUDY ONE: ENVIRONMENTAL REDUNDANCY

Method

The goal of this first study is to examine attribute level redundancy across several consumer information environments. The data for the study were sixty-five usable brand by attribute matrices taken from the *US Consumer Reports 1985 Buying Guide Issue* (1984). Usable matrices included those with more than one product attribute. Not included as attributes were overall quality rankings, general comments, and attributes that were a direct function of (i.e., calculated from) two or more other attributes already included (e.g., cost per roll of toilet paper is a direct function of price and number of rolls). While the attribute information in such reports is not unquestionably “true,” it is the best and most objective available. The use of these data is also consistent with past methodological practice (Hjorth- Andersen, 1984; Gerstner, 1985; Riesz, 1978, 1979). (See Morris & Bronson, 1969, for a discussion of the shortcomings of such data and Curry & Faulds, 1986, and Yamada & Ackerman, 1984, for analyses of similar data from Germany and Japan, respectively.)

Although US *Consumer Reports* is an objective source of attribute information, a downward bias may exist with respect to redundancy. Inasmuch as Consumers Union is a consumer service organization, product categories may be selected based on perceived information need. In highly redundant environments such need may be minimal. Certain attributes presented by Consumers Union may also represent combinations of several redundant attributes (e.g., “comfort”). Finally, an attribute may be so redundant that it is simply mentioned in the discussion and not included in the brand/attribute matrix. However, this downward bias should be relatively constant across product categories. For these reasons the redundancy measures derived below are felt to be objective albeit conservative.

Two general types of attributes were included in the study, purely objective, quantitative attributes (e.g., size, weight, capacity) and product ratings (e.g., convenience, energy efficiency). (Recall that because of their interest in overall quality scales, Hjorth-Andersen and Curry & Faulds only examined product ratings.) Objective attributes were coded verbatim. Product ratings, reported on a five point scale from better to worse, were given corresponding quantitative scores from one to five. Where available, the number of advantages and disadvantages listed in the matrices were independently summed to provide additional attributes.

Analysis and Results

Attribute correlation matrices were obtained for all sixty-five product categories. Attribute pairs were chosen as the unit of analysis because they are the most basic level at which redundancy can be measured and perceived. (Other, more general measures can be derived from attribute pairs.) The correlation between each attribute pair was squared to provide a measure of redundancy (R2). There are two reasons for using R2 to measure redundancy. First, whereas R2 indicates proportional reduction in the variation of one attribute provided by the information in a second attribute, a simple correlation coefficient has no such clear-cut interpretation (Neter & Wasser- man, 1974, p. 90). Second, all the redundancy measures become unidirectional. Table I reports the mean R: across the attribute pairs, the number of attributes in each matrix, the number of brands involved, the low and high R2, and their standard deviation. The mean R2, which is equivalent to the average amount of information contained in any one attribute regarding all other attributes in the category, is the overall redundancy index on which the product categories are compared. To facilitate comparison, the categories have been ranked on this index from high to low.

Table I reveals both significant levels and ranges of attribute redundancy. On average, each attribute explains 22 percent of the variance in every other attribute across the sixty-five categories. The average variance explained within categories ranges from a low of 0.035 for Long Nose Pliers to a high of 0.826 for Type C Batteries. Except for the three categories at the extreme high end of the index, redundancy changes gradually from category to category. There were no significant differences between any general groups of product categories (i.e., durables v. nondurables or high priced v. low priced products). Another important observation is the variance in redundancy across attribute pairs within many of the categories. The attribute pair R2 measures for Juice Extractors, for example, which had a standard deviation of 0.33, ranged from 0.86 between “ability to make good tasting juice” and “pulp capacity” to 0.00 between “pulp capacity” and “ease of cleaning.”

The basic finding of this first study is simply that a considerable range of attribute redundancy exists across consumer product categories. Even within categories there is often considerable variance in redundancy across attribute pairs. The complex nature of this aspect of product information environments underscores the nontrivial perceptual task facing consumers.

STUDY TWO: PERCEIVED REDUNDANCY

Stimuli

Consumer perceptions of redundancy were examined within six of the original sixty-five product categories from Study One in order to test the research hypotheses. Categories were chosen that: (a) represented the range of average redundancies in Table I; (b) the test consumers were likely to vary in their knowledge of and experience with; (c) involved a minimum of three and a maximum of eight attributes (to keep the task reasonable); and (d) were likely to be at least minimally interesting to consumers (e.g., no long nosed pliers). Naturally some of the categories chosen meet these criteria better than others. The chosen categories represent three levels of estimated, inherent redundancy. These categories included exercise bicycles and juice extractors at a high level of redundancy, disk cameras and blow dryers at an intermediate level, and microwave ovens and telephones at a low level of redundancy. Three of these categories, exercise bicycles, microwave ovens, and telephones, initially included number of advantages and number of disadvantages as attributes (see Study One). Disk cameras also contained one particularly subjective attribute (i.e., convenience). Given their ambiguity when taken out of context, these attributes were not included. This resulted in average R2 measures of 0.390 (n = 7) for exercise bicycles and 0.351 (n = 5) for juice extractors at a high level of redundancy, 0.226 (n = 6) for disk cameras and 0.219 (n = 3) for blow dryers at an intermediate level of redundancy, and 0.134 (n = 7) for microwave ovens and 0.094 (n = 8) for telephones at a low level of redundancy.

TABLE I
Attribute to Attribute Variance Explained by Product Category

Product Category	Mean	A	N	Min.	Max.	SD	Product Category	Mean	A	N	Min.	Max.	SD
AVERAGES	0.218	7	19	0.052	0.592	0.163	Cylinder Locks	0.190	6	22	0.014	0.549	0.166
Type C Batteries	0.826	7	16	0.539	0.990	0.115	Stuffing Mixes	0.190	5	21	0.001	0.651	0.212
Dish Liquids	0.813	2	31	0.813	0.813	0.000	Lawn Mowers*	0.188	12	23	0.001	0.658	0.173
Type AA Batteries	0.790	7	15	0.441	0.964	0.143	Toothpaste	0.181	5	27	0.001	0.472	0.150
Exercise Bicycles*	0.417	9	15	0.130	0.762	0.144	Steam Irons*	0.176	11	26	0.000	0.783	0.186
Freezer Thermometers	0.405	3	10	0.217	0.510	0.163	Elec. Clothes Dryers*	0.167	12	11	0.000	0.769	0.175
Slide Projectors*	0.380	7	15	0.011	0.874	0.284	Toilet Paper	0.166	8	37	0.002	0.712	0.175
Juice Extractors	0.351	5	6	0.000	0.857	0.328	Washing Machines*	0.160	19	15	0.000	0.845	0.182
Standing Mixers*	0.342	4	14	0.001	0.716	0.357	Blenders*	0.156	5	25	0.022	0.340	0.118
Manual Pasta Makers	0.333	3	2	0.000	1.000	0.577	Attache Cases	0.148	6	37	0.052	0.334	0.083
Razors and Blades	0.331	6	10	0.018	0.723	0.212	Camera Flash Units*	0.142	14	30	0.000	0.757	0.161
Pasta Makers (Auto.)	0.307	5	5	0.001	0.572	0.233	Smoke Detectors	0.140	5	24	0.000	0.359	0.122
Electric Woks	0.289	5	5	0.028	1.000	0.348	Dishwashers*	0.138	8	13	0.000	0.835	0.182
Water Filters	0.282	6	14	0.000	0.806	0.214	Electric Fry Pans	0.137	7	11	0.000	0.476	0.153
Toaster Ovens	0.273	2	11	0.273	0.273	0.000	Kitchen Scales	0.133	5	29	0.003	0.570	0.208
Shaving Creams	0.265	2	24	0.265	0.265	0.000	Perimeter Alarms*	0.131	7	10	0.000	0.426	0.131
Knife Sets	0.265	5	15	0.073	0.527	0.127	Gas Clothes Dryers*	0.131	12	8	0.000	0.674	0.165
Disk Cameras	0.262	7	12	0.002	0.734	0.271	Microwave Ovens*	0.130	9	17	0.003	0.379	0.101
Aerosol Paints	0.248	4	18	0.008	0.557	0.219	Dead Bolt Locks	0.126	7	50	0.000	0.384	0.134
Picnic Jugs*	0.234	5	10	0.001	0.782	0.256	Macaroni and Cheese	0.123	8	34	0.002	0.679	0.159
Sleeping Bags*	0.225	13	27	0.001	0.716	0.174	Thermos Bottles*	0.116	6	19	0.012	0.389	0.136
Cameras (35mm)*	0.221	9	29	0.000	0.763	0.182	Color TV's (19")	0.099	12	18	0.000	0.797	0.147
Blow Dryers	0.219	3	28	0.026	0.484	0.238	Telephones*	0.098	10	16	0.000	0.486	0.105
Compact Stereos*	0.215	8	8	0.004	0.819	0.225	Cassette Decks*	0.096	10	21	0.000	0.382	0.105
Broiler Ovens	0.214	2	9	0.214	0.214	0.000	Kitchen Timers	0.093	5	10	0.001	0.358	0.221
Interior Alarms*	0.209	8	7	0.000	0.669	0.205	Gas BBQ Grills*	0.089	10	17	0.000	0.402	0.097
Gas Ranges*	0.206	5	12	0.000	0.684	0.190	Wood Stains*	0.086	8	19	0.000	0.480	0.105
Console Humidifiers*	0.204	12	21	0.000	0.929	0.224	Walkaround Stereos*	0.077	10	22	0.000	0.441	0.098
Saber Saws*	0.202	11	20	0.000	0.731	0.208	Clock Radios	0.069	17	15	0.000	0.440	0.098
Dehumidifiers*	0.199	10	11	0.000	0.895	0.101	Stereo Receivers*	0.048	15	20	0.000	0.228	0.057
Portable Mixers*	0.197	4	25	0.068	0.531	0.177	Shampoos	0.044	2	62	0.044	0.044	0.000
Electric Ranges*	0.196	6	16	0.001	0.672	0.218	Drip Coffee Makers*	0.039	4	28	0.001	0.104	0.038
Slip Joint Pliers	0.193	4	13	0.060	0.367	0.114	Long Nose Pliers	0.035	4	13	0.002	0.069	0.026

A = Number of Attributes in the Category.
N = Number of Alternatives in the Category.
* Number of Advantages and Disadvantages Used as Attributes.

<u>Method</u>

Using a questionnaire format, three types of information were collected from each subject within each of the six categories:

(1) judgments of the redundancy relationship between each pair of attributes;

(2) experience-based product category knowledge; and

(3) three measures of product category experience.

The questionnaire contained two sections. Section one contained the ninety-eight attribute-pair redundancy questions organized by relationship between the attributes (-5) to no relationship (0) to a perfect positive relationship (5). The end points of the scale correspond to R2 = 1 while the midpoint of the scale corresponds to R2 = 0. The subjects’ instructions included descriptions of the two end-points, denoting perfect negative or positive relationships, and the zero point, denoting no relationship. The resulting scale measures both the perceived magnitude and direction of each attribute pair relationship. Here is a sample question used in the instructions for the study:

If you know that an electric range is high priced, how likely is it to have either a large or small oven?

Certain to have   Certain to have

a small oven   a large oven

-5   -4   -3   -2   -1   0
1   2   3   4   5

The design of the question format was borrowed from implicit personality theory. The justification is quite simple. Implicit personality theory (Schneider, 1973) focuses on the same question of interest as here albeit in a different context. Implicit personality theory focuses on peoples’ beliefs about the attributes of people while our interest is in peoples’ beliefs about the attributes of products. Schneider (1973) discusses several methods for assessing personality trait redundancy. According to Manis and Platt (1975), the most common technique for assessing redundancy of this sort is to have respondents assess the likelihood of co-occurrence for various trait pairs (e.g., if someone is honest, how likely is s/he also to be friendly?). The question format used here follows this basic format. (John et ah, 1986, use a similar format for measuring perceptions of price/quality relationships.) Pilot testing revealed that consumers had a good understanding of the questions. The only problems occurred when attributes were included that were not very intuitive or well understood by many subjects (e.g., camera “flare”). To correct for this, a brief, one sentence layman’s definition of each problematic attribute was developed and included in the first question containing the attribute. The test subjects had no apparent trouble understanding the resulting test questions.

A total of four questionnaires were used to counterbalance both the way in which each question was stated and the order of the questions and categories. Two versions of the questionnaire contained questions using the same attribute within each pair of attributes as the focus, or subject, of the question (i.e., the attribute on which the consumer knows the product is high or low). Consumers rated their perceived level of the other attribute in each pair on the rating scale below each question. Within each question, the wording of the attribute levels as high or low was randomly assigned. In the other two versions of the questionnaire, the “given” attribute and the “to be rated” attribute were switched. The random wording of the attribute levels in the first two versions (e.g., high v. low) was also reversed in the second two versions of the questionnaire. Finally, within each pair of questionnaires containing the exact same questions, the order of the questions was counterbalanced. All questions were presented by category. In one version, the categories and questions within the categories appeared in one random order. In the other version, the order of both the categories and the questions within the categories was reversed.

Section two of the questionnaire used Johnson’s (1984) knowledge scale to assess the consumers' own perceived level of knowledge within each category. The twenty-one point scale reflects increasing levels of product experience and resulting knowledge of the product’s attributes and functions (see Johnson, 1984, p. 746). It is important to note that subjective or self-reported knowledge may differ from objective knowledge. Park and Lessig (1981) emphasize that subjective knowledge, unlike objective knowledge, likely reflects both actual knowledge and consumer confidence. Brucks (1985), meanwhile, finds some empirical support for the difference in the two measures. However, given the number of categories studied, it would be very difficult to keep the task manageable using lengthier albeit more objective knowledge tests (cf. Sujan, 1985).

Three objective measures of category experience were collected to provide a measure of pure experience. These included the number of times the consumer had bought a product in each category (a five point categorical scale ranging from “None” to “Four or more”), when the consumer's last purchase in the category occurred (a five point categorical scale ranging from “Never” to “In the last month”), and how frequently the consumer uses each product (a five point categorical scale ranging from “Never” to “At least once a day”). As each of these three measures captures a different aspect of consumer experience, the five point scales were equally weighted and combined to create a single, thirteen point experience measure. (The three individual experience measures were all significantly, $p < 0.001$, positively correlated across consumers.)

Subjects were classified into low, medium, and high knowledge and experience groups based on a three-way split of the subjects' knowledge and experience ratings within each category. Although the hypotheses posit unidirectional relationships, recent studies by Bettman and Park (1980) and Johnson and Russo (1984) suggest that product knowledge or familiarity may have nonmonotonic effects on some dimensions of consumer information processing. The three-level knowledge and experience variables were used here in order to detect any such nonmonotonic relationships.

Procedure

The four versions of the questionnaire were randomly administered to small groups of subjects (approximately twenty to a group). The subjects included an approximately equal number of graduate and undergraduate business administration students at the University of Michigan (total n = 114) who were paid for their participation. These subjects were chosen because they were likely to understand and to be able to answer the questions as well as to vary in their knowledge of and experience with the products in question. The questionnaire took anywhere from one-half hour to fifty minutes to finish. Subjects were instructed to answer every question. Of the 114 subjects, 9 failed to complete the entire questionnaire and were excluded from subsequent analysis. The data from the remaining 105 subjects were used to test the hypotheses.

Recall that the order and form of the questions (including the response scale) were counter balanced across the four versions of the questionnaire. Given these counterbalances, showing consistent perceptions across subjects would indicate that the subjects understood and answered the questions sincerely. Subjects' perceptions were, in fact, remarkably similar. After coding all the subjects' responses to the same directional scale values (i.e., reverse coding the original counter balances), each judge's responses were intercorrelated. Out of the 5460 possible interjudge correlations, 3205, or 59 percent, were significantly positive ($p < 0.05$). Moreover, only 245 of these correlations, or 4.5 percent, were negative, only 5 of which were significant. Therefore, in the analyses that follow, the results cannot easily be attributed to the questionnaire instrument used to measure perceptions.

Analysis

Recall that the research hypotheses predict systematic changes for two dependent variables: (a) perceived redundancy, or the consumers' general perception of redundancy within a product category, and (b) pair-level accuracy, or the consumers' ability to perceive the direction and magnitude of each attribute-pair relationship within a category. Perceived redundancy was operationalized by averaging the absolute values of each subject's responses to the redundancy questions within each category. This provides a measure of perceived redundancy for each subject in each category ($n = 630$) on a zero to five scale. Pair-level accuracy was operationalized by correlating each subject's responses for the attribute-pairs within each category against the corresponding estimates of actual R2 for those pairs obtained in Study One. These actual R2s were signed (+ or –) to indicate the direction of each attribute-pair correlation and thus correspond to the consumers' response scale. (Recall that the responses to the questions in section one of the questionnaire correspond to directional, perceived R2s for each attribute pair.) This provides a measure of pair-level accuracy for each subject in each category ($n = 630$).

There is a problem with using these correlations as measures of pair-level accuracy. The product information environments used to estimate the attribute-pair relationships in Study One most likely do not correspond exactly to those faced by the test consumers. The estimated relationships are likely based on a more exhaustive set ot brands and attributes than what consumers actually face. This makes for a very conservative benchmark against which to compare the consumers' responses. For the same reason, error variance is likely high for our three-level operationalization of actual redundancy. The overall effect is relatively conservative tests of Hypotheses Two through Five.

As described above, the subjects' responses to the knowledge and experience questions were collapsed into three-level knowledge and experience measures to test Hypotheses Two through Five. A comparison of the 630 (category by subject) knowledge and experience measures (on their original scales) reveals a significant positive relationship ($r = 0.60$) between these variables. Given the natural confound between the knowledge and experience measures, separate tests were conducted to determine the effects of these variables on perceived redundancy. In hindsight, the test subjects did not vary sufficiently in their experience with juice extractors to allow a three-level operationalization of experience. The remaining five categories were used to test the experience hypotheses (Three and Five).

Hypothesis One

Hypothesis One predicts systematic differences in perceived redundancy across product categories. Because each subject responded to all attribute pairs and, hence, all six categories, a repeated measures analysis of variance model was used to test the hypothesis. The model used perceived redundancy as the dependent variable and subjects (105 levels) and categories (6 levels) as the independent variables.

Both subjects ($F = 9.63$, $p < 0.001$) and product categories ($F = 15.71$, $p < 0.001$) significantly affected perceived attribute redundancy. Exercise bicycles were perceived as most redundant (1.87) followed by microwave ovens (1.70), blow dryers (1.59), cameras (1.56), telephones (1-47), and juice extractors (1.26). The significant differences in perceived redundancy across categories supports Hypothesis One as well as the discriminant validity of the perceived redundancy measure. The next question is whether or not this perceived redundancy increases for knowledgeable or experienced consumers within inherently more redundant categories.

Hypotheses Two and Three

Hypotheses Two and Three predict that higher knowledge and experience subjects perceive greater redundancy within the more redundant categories. Recall that the exercise bike and juice extractor categories were classified as highly redundant, the disk camera and blow dryer categories were moderately redundant, and the microwave oven and telephone categories were least redundant. Preliminary analysis revealed that both the knowledge and experience measures varied significantly across categories. Our dependent variables, perceived redundancy for Hypotheses Two and Three and pair-level accuracy for Hypotheses Four and Five, were thus standardized within each category in order to test the hypotheses. This removes the effects of any systematic differences in knowledge and experience by category from the tests.

Hypotheses Two and Three were tested using mixed effects analysis of variance models. The dependent variable in each case was perceived redundancy. The independent variables in the first model included knowledge (three levels) and a knowledge by actual redundancy interaction. The independent variables in the second model included experience (three levels) and an experience by actual redundancy interaction.

The results are presented in the top half of Table II. Overall there is both a significant main effect for knowledge on perceived redundancy ($F = 3.77$, $p < 0.05$) and a marginally significant knowledge by actual redundancy interaction effect ($F = 2.28$, $p < 0.10$). Particularly interesting is the nonmonotonic relationship between knowledge and perceived redundancy. Overall, perceived redundancy equaled

TABLE II

Actual redundancy	Product category	Perceived Redundancy: Knowledge Low	Knowledge Medium	Knowledge High	Experience Low	Experience Medium	Experience High
Low	Telephones	−0.091	0.057	0.002	−0.023	0.038	−0.023
	Microwaves	−0.109	−0.053	0.180	−0.270	0.006	0.210
Medium	Blow Dryers	0.032	−0.072	0.026	0.051	0.156	−0.164
	Cameras	0.046	−0.086	0.044	0.086	−0.299	0.195
High	Juice Extractors	0.141	−0.345	0.191	—	—	—
	Exercise Bicycles	0.122	−0.362	0.296	0.279	−0.259	0.170
Across-category averages		0.018	−0.145	0.120	0.020	−0.088	0.078

Actual redundancy	Product category	Pair-Level Accuracy: Knowledge Low	Knowledge Medium	Knowledge High	Experience Low	Experience Medium	Experience High
Low	Telephones	−0.127	−0.104	0.236	−0.221	0.037	0.239
	Microwaves	−0.045	−0.009	0.065	0.244	−0.072	−0.117
Medium	Blow Dryers	−0.075	−0.070	0.109	−0.037	0.129	−0.053
	Cameras	0.049	0.008	−0.049	0.104	−0.086	−0.017
High	Juice Extractors	−0.323	−0.085	0.415	—	—	—
	Exercise Bicycles	0.025	0.051	−0.079	0.305	0.009	−0.253
Across-category averages		−0.084	−0.036	0.114	0.052	−0.002	−0.048

0.018, —0.145, and 0.120 respectively for the low, medium, and high knowledge groups (based on standardized, within category measures). Contrasts of the factor level means reveal a marginally significant decrease in perceived redundancy from the low to medium knowledge groups ($p < 0.10$) and a very significant increase from the medium to high knowledge groups ($p < 0.01$). (There was no difference between the low and high knowledge groups.) A highly pronounced U-shaped relationship between perceived redundancy and knowledge for the highly redundant categories is driving these results. This relationship is depicted in Figure 1. Perceived redundancy differed significantly across knowledge levels within the juice extractor and exercise bicycle categories ($p < 0.05$). Perceived redundancy did not vary significantly with knowledge within any of the remaining four categories.

These results support Hypothesis Two, albeit only over the upper two-thirds of the knowledge levels. The predicted interaction between knowledge and actual redundancy is clearly evident when contrasting the medium and high knowledge subjects. (A separate analysis involving only the medium and high knowledge subjects reveals the significant interaction, $F = 3.26$, $p < 0.05$, predicted by Hypothesis Two.) We did not predict the initial decrease in perceived redundancy from the low to medium knowledge levels within the more redundant categories. The overall nonmonotonic relationship

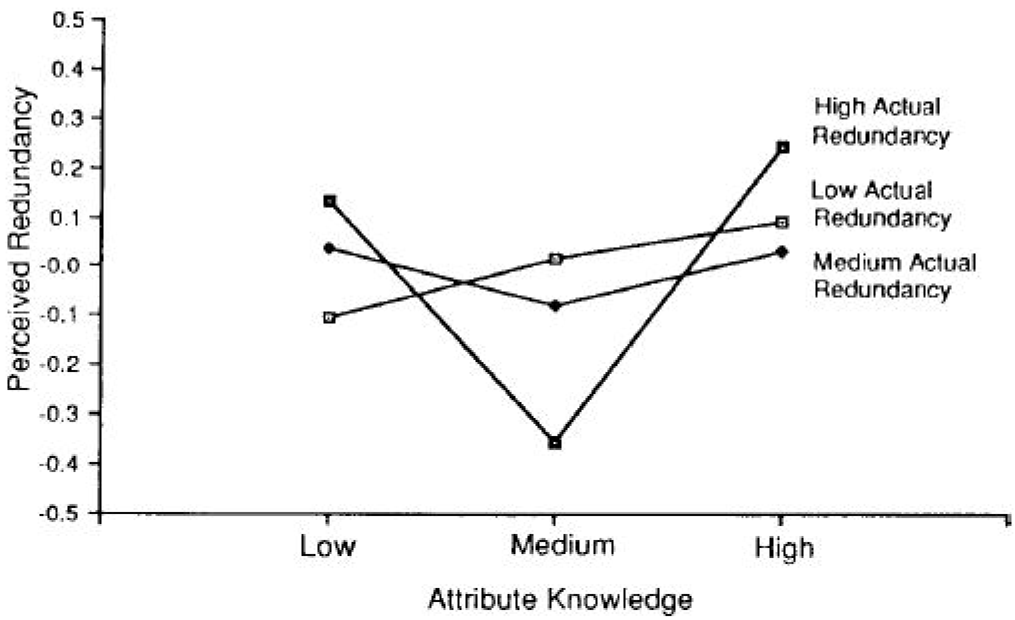

Fig. 1. Perceived redundancy, actual redundancy, and attribute knowledge.

between perceived redundancy and knowledge suggests that perceived redundancy may be quite complex. We speculate on the nature of this relationship in the discussion section of the paper.

Turning from knowledge to experience, we see the same general pattern of results. Average perceived redundancy equaled 0.020, –0.088, and 0.078 for the low, medium, and high experience levels respectively. Perceived redundancy decreased from low to medium experience levels and increased from medium to high experience levels. However, the overall experience main effect and experience by actual redundancy interaction were not significant. Contrasts of the factor level means did reveal a marginally significant ($p < 0.10$) increase in perceived redundancy from the medium to high experience subjects. A separate analysis also revealed a marginally significant ($p < 0.10$)

experience by product category interaction. Finally, there were significant differences across experience levels within the two most inherently redundant categories (exercise bikes, $F = 3.17$, $p < 0.05$, and cameras, $F = 2.41$, $p < 0.10$). These were the only two categories with significant differences and both show a U-shaped relationship between perceived redundancy and experience. (As mentioned earlier, experience did not vary sufficiently for juice extractors and, as a result, this highly redundant category could not be included in the analysis.)

These results provide only limited support for Hypothesis Three. Similar to the knowledge results, this support is only over the upper two-thirds of experience levels. Overall there is consistency between the knowledge and experience results. Both knowledge and experience show a U-shaped relationship with perceived redundancy. In each case this relationship is driven by knowledge or experience differences within inherently more redundant product categories.

Hypotheses Four and Five

Hypotheses Four and Five predict that consumers' ability to perceive the direction and magnitude of relationships among product attributes should increase with knowledge and experience, respectively. Analytical models identical to those used to test Hypotheses Two and Three were used here, with the exception of substituting pair-level accuracy for perceived redundancy as the dependent variable of interest. The hypotheses predict increases in pair-level accuracy with knowledge and experience (i.e., simple main effects). The results are presented in the bottom half of Table II.

Pair-level accuracy increased with knowledge, equaling –0.084, –0.036, and 0.114 for low, medium, and high knowledge levels respectively. This increase was marginally significant overall ($F = 2.38$, $p < 0.10$), and a contrast of the factor level means reveals a significant increase in pair-level accuracy from the low to high knowledge groups ($p < 0.05$). Analysis of the results within categories shows accuracy increasing significantly with knowledge for the juice extractor category ($p < 0.01$). There was no overall knowledge by actual redundancy interaction. These results support Hypothesis Four.

Hypothesis Five was not supported. Pair-level accuracy actually decreased from low to high experience levels, equaling 0.052, –0.002, and –0.048 respectively. This difference was not, however, significant, nor were there significant differences within any of the five product categories involved.

DISCUSSION AND POLICY IMPLICATIONS

Study One: Actual Redundancy

In Study One, attribute redundancy was estimated within each of sixty-five product categories. The results suggest that consumer information environments contain significant levels of attribute redundancy and that attribute redundancy varies widely both across categories and across attributes within categories.

The fact that redundancy varies widely is important from a policy standpoint. Recall that the redundancy of product attributes directly affects the marginal value of gathering and processing information (Hagerty & Aaker, 1984). A consideration of the value of information is important for policy makers or consumer groups who provide consumers with information and face limited resources. Naturally these resources should be used to provide consumers with the most valuable information possible. Consumer groups might, for example, take a closer look at attribute redundancy as one criterion for selecting products to test and report. More information might be provided for products that lack redundant attributes while less information might be provided for products whose attributes are very redundant. As mentioned earlier, information search and processing in redundant categories may be quite limited and still allow consumers to make good purchase decisions.

A second important policy implication concerns the use of overall quality rankings. Understanding the correlational structure of product attribute environments is critical when evaluating whether to provide consumers with overall rankings. Both Hjorth-Andersen (1984) and Curry and Faulds (1986) focus directly on this issue. Hjorth-Andersen argues that, because the value or weight of particular attributes varies from consumer to consumer, overall quality rankings are only appropriate when attribute ratings are positively correlated. Meanwhile, Curry and Faulds argue that the most critical factor determining the appropriateness of an overall quality ranking is the interaction between attribute weights and attribute correlations. Quality rankings lose their value when weights vary widely from consumer to consumer and attribute ratings are negatively correlated. Given the wide range of attribute correlations observed in Study One, testing agencies should carefully consider these issues. Overall quality rankings may not be appropriate for certain products and may cause some consumers to make relatively poor choices.

Study Two: Perceived Redundancy

In Study Two, subjects' perceptions of attribute redundancy were examined within six of the sixty-five categories from Study One. The six categories were chosen to represent a range of estimated redundant to nonredundant information environments. Consistent with Hypothesis One, consumers perceived systematic differences in attribute redundancy across product categories. Hypotheses Two and Three predicted an increase in perceived redundancy within more redundant product categories with increases in knowledge and experience, respectively. Hypothesis Two was supported, albeit only over the medium and high ranges of self-rated product knowledge. There was similar though more limited support for Hypothesis Three over the medium and high ranges of product experience. At least from an intermediate to a high level of knowledge and experience, our consumers perceived greater redundancy within inherently more redundant product categories. Hypothesis Four predicted that consumer perceptions of the direction and magnitude of attribute relationships would improve at higher levels of knowledge. Pair-level accuracy did, in fact, increase with knowledge supporting Hypothesis Four. Our high knowledge subjects had a better understanding of attribute relationships than our low knowledge subjects.

These results, based on existing perceptions of actual products, demonstrate that consumers do appear to learn attribute relationships. This is consistent with Alloy and Tabachnik's (1984) framework. By no means do we suggest that knowledgeable consumers are completely accurate in their perceptions. Systematic expectations and biases likely have some effect on perceived redundancy. In fact, the unpredicted U-shaped relationship observed between knowledge and perceived redundancy suggests that a complex set of perceptual issues may be involved. However, our respondents did not perceive redundancy independent of actual redundancy. This does suggest that expectations and processing biases do not dominate consumer perceptions.

Hypothesis Five was not supported. Product experience did not affect pair-level accuracy. This nonsignificant result, as well as the relatively weak support for Hypothesis Three, may be due to the fact that our subjects did not vary sufficiently in experience within some product categories.

The major unexpected result that we observed was the U-shaped relationship between knowledge and perceived redundancy within our more redundant product categories, juice extractors, and exercise bicycles. In hindsight, the decrease in perceived redundancy from low to medium knowledge levels for these categories, while at odds with our hypothesis, is not that surprising. Our low knowledge juice extractor and exercise bicycle consumers probably had less knowledge, in an absolute sense, than our low knowledge telephone, microwave, blow dryer, and camera consumers. At very low levels of knowledge, consumers may only be able to infer most attributes from a few cues, or rely on general expectations. They may not have even understood many of the attributes in these categories, resulting in essentially random responses. At an intermediate level of knowledge, consumers acquire substantial insight into the multidimensionality of products (Howard, 1977) and redundancy perceptions may very well decrease. Finally, as knowledge continues to grow consumers may pick up on actual, accurate attribute relationships. In other words, a very plausible explanation of our U-shaped relationship is that naive perceptions or expectations are eventually replaced by more accurate perceptions as knowledge increases. This explanation is consistent with the observed monotonic relationship between knowledge and pair-level accuracy.

The U-shaped knowledge/perceived redundancy relationship observed here bears some resemblance to previous research results. Bettman and Park (1980) reported an inverted U-relationship between knowledge and the information consumers searched during choice. Johnson and Russo (1984) found a similar inverted U- relationship between self-reported knowledge and the information consumers could recall after making a choice. In these studies, consumers used and recalled more information at an intermediate level of knowledge than at either a low or high level. Although very speculative, there may be some connection between the lower perceptions of redundancy among our intermediate knowledge subjects and the greater use and recall of attribute information for similar subjects in the Bettman and Park and the Johnson and Russo studies.

Study Two is also important from a policy standpoint. Our results suggest that consumer perceptions of attribute relationships improve with knowledge. This reinforces the need for information programs aimed at improving knowledge. Consumers who gain an understanding of attribute relationships through information programs or reports, such as Consumer Reports or test, should more accurately perceive the value of gathering and processing information. Testing agencies may even consider including intuitive descriptions of the correlation structure of attribute information in their product reports.

A second, more speculative implication follows from the observed U-shaped relationship between perceived redundancy and attribute knowledge. As observed for juice extractors and exercise bicycles, consumers may enter product categories perceiving or expecting information to be redundant. Because of this perceived redundancy, it may be difficult to convince low knowledge or novice consumers that they need more information. These consumers may not understand that their perceptions are relatively inaccurate. As a result, they may underestimate the value of gathering and processing additional information. Recall that in the John et al. (1986) study, consumers who perceived a price/quality relationship were more limited in their subsequent information search.

The results reported here should be interpreted with caution. Other consumers' perceptions, or perceptions in other product categories, may be quite different. In particular, perceptions of more nondurable products, for which repeat purchases are more common and frequent, may be quite different from those found here.

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