AMRL-TR-71-81

AD 746658

APPLICATIONS OF TEXTURE PERCEPTION IN THE ANALYSIS OF COMPLEX OPTICAL IMAGERY

RONALD M. PICKETT, PhD

HARVARD SCHOOL OF PUBLIC HEALTH

MAY 1972

AEROSPACE MEDICAL RESEARCH LABORATORY
AEROSPACE MEDICAL DIVISION
AIR FORCE SYSTEMS COMMAND
WRIGHT-PATTERSON AIR FORCE BASE, OHIO

91

NOTICES

When US Government drawings, specifications, or other data are used for any purpose other than a definitely related Government procurement operation, the Government thereby incurs no responsibility nor any obligation whatsoever, and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data, is not to be regarded by implication or otherwise, as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

Organizations and individuals receiving announcements or reports via the Aerospace Medical Research Laboratory automatic mailing lists should submit the addressograph plate stamp on the report envelope or refer to the code number when corresponding about change of address or cancellation.

Do not return this copy. Retain or destroy.

Please do not request copies of this report from Aerospace Medical Research Laboratory. Additional copies may be purchased from:

National Technical Information Service
5285 Port Royal Road
Springfield, Virginia 22151

AIR FORCE: 3-8-72/100

Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) Harvard School of Public Health 665 Huntington Avenue Boston, Massachusetts 02115	2a. REPORT SECURITY CLASSIFICATION Unclassified 2b. GROUP

3. REPORT TITLE

APPLICATIONS OF TEXTURE PERCEPTION IN THE ANALYSIS OF COMPLEX OPTICAL IMAGERY

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

Final Report - January 1968 - July 1971

5. AUTHOR(S) (First name, middle initial, last name)

Ronald M. Pickett, PhD

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
May 1972	91	11

8a. CONTRACT OR GRANT NO. F33615-68-C-1147	9a. ORIGINATOR'S REPORT NUMBER(S)
b. PROJECT NO 7183	
c.	9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report) AMRL-TR-71-81
d.	

10. DISTRIBUTION STATEMENT

Approved for public release; distribution unlimited.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY Aerospace Medical Research Laboratory Aerospace Medical Div., Air Force Systems Command, Wright-Patterson AFB, Ohio

13. ABSTRACT

These studies examine the feasibility of using texture perceptions in scientific or technical analyses of complex optical imagery. Section I illustrates that reliable quantitative data can be derived from texture perceptions, provided appropriate psychometric techniques are employed. The perceptual data have to be standardized and scaled, and then pooled and averaged over several independent observations. Section II illustrates, in the context of medical imagery screening, a procedure which may often be required to translate the idiosyncratic visual assessments of expert observers into standardized psychometric procedures, some of which might then be carried out by untrained observers. The language used by cytotechnicians in prescreening Pap smears for evidence of cancer is surveyed. Dimensions of description are abstracted and incorporated in psychometric scaling tasks. Section III reports studies of reliability and validity when observers follow psychometric procedures in measuring the over-all appearance of Pap smears. The results show that several of the texture measures obtained are reliable, and that at least one of the measures may be a valid discriminator of cancer. In addition to presenting evidence that texture perceptions may be effective, other considerations of cost and administrative convenience are presented which indicate that texture perceptions may be of practical value for routine screening operations. The report suggests that applications of texture perception could be made in a wide range of situations requi[illegible] scientific or technical analyses of complex imagery, particularly where automated a[illegible]sment is not available or prohibitively expensive. A thesaurus of descriptors of complex optical imagery with 1707 entries is attached.

DD FORM 1 NOV 65 1473

Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
imagery						
complex imagery						
texture						
visual pattern recognition						
visual pattern perception						
visual texture perception						
airborne visual reconnaissance						
imagery screening						
biomedical imagery screening						
solar imagery screening						
cancer						
pap smears						
psychometric methods						
language						
visual description						
subjective scaling						

FOREWORD

This study was initiated by the Human Engineering Division of the Aerospace Medical Research Laboratory. The research was conducted by the Harvard School of Public Health under Air Force Contract F33615-68-C-1147. Ronald M. Pickett, PhD, was the principal investigator for the Harvard School of Public Health. Julian O. Morrissette, PhD, of the Systems Effectiveness Branch, was the contract monitor for the Aerospace Medical Research Laboratory. The research sponsored by this contract was started in January 1968 and was completed in July 1971.

Appreciation is expressed to Dr. Tilde S. Kline and Dr. Robert L. Ehrmann for their advice and support, and to Dr. James Bradley and Dr. Thomas Triggs for their helpful criticisms of the manuscript.

This technical report has been reviewed and is approved.

CLINTON L. HOLT, Colonel, USAF, MC
Commander
Aerospace Medical Research Laboratory

TABLE OF CONTENTS

	Page
SECTION I. INTRODUCTION AND RATIONALE	1
1. AN ILLUSTRATION OF TEXTURE PERCEPTION IN SOLAR IMAGERY ANALYSIS	2
2. DEVELOPING PSYCHOMETRIC METHODS FOR IMAGERY DESCRIPTION	5
SECTION II. STUDIES OF THE LANGUAGE OF TEXTURE PERCEPTION IN MEDICAL IMAGERY SCREENING (Pap Smear Description)	8
1. STUDY I. A SURVEY OF THE ADJECTIVES USED BY CYTOTECHNICIANS TO DESCRIBE THE OVERALL APPEARANCE OF PAP SMEARS	9
a. Subjects	9
b. Method	9
c. Selection of Adjectives	10
d. Results	10
e. Discussion	10
2. STUDY II. A SURVEY OF ADJECTIVES USED BY NAIVE OBSERVERS TO DESCRIBE THE OVERALL APPEARANCE OF PAP SMEARS	12
a. Observers	12
b. Method	12
c. Stimuli	12
d. Results	13
e. Discussion	13
SECTION III. PSYCHOMETRIC STUDIES OF TEXTURE PERCEPTION IN MEDICAL IMAGERY SCREENING (Prescreening Pap Smears)	16
1. GENERAL METHOD	16
a. Stimuli	17
b. Data Reduction and Analysis	17
2. STUDY III. A PSYCHOMETRIC EVALUATION INVOLVING SIX DIMENSIONS OF TEXTURE ASSESSMENT MADE BY NAIVE OBSERVERS	17
a. Observers	18
b. Method	18
c. Instructions	18
d. Results	18
3. STUDY IV. A PSYCHOMETRIC EVALUATION INVOLVING FOUR DIMENSIONS OF TEXTURE ASSESSMENT MADE BY NAIVE OBSERVERS EQUIPPED WITH RUDIMENTARY PERCEPTUAL OPERATIONS AND SCALING ANCHORS	23

a. Observers 23
b. Method 23
c. Instructions 23
d. Results 24

4. STUDY V. A PSYCHOMETRIC EVALUATION OF FOUR DIMENSIONS OF TEXTURE ASSESSMENT MADE BY CYTOTECHNICIANS BEFORE AND AFTER TRAINING 28

a. Observers 28
b. Method
c. Results of Test 1 29
d. Results of Test 2 29

SECTION IV. SUMMARY OF RESULTS AND DISCUSSION 37

APPENDIX I CHECKLIST USED TO SURVEY DESCRIPTORS OF TEXTURE IN 100X VIEWS OF PAP SMEARS 43

APPENDIX II A THESAURUS OF DESCRIPTORS OF COMPLEX OPTICAL IMAGERY 45

1. GENERAL DESCRIPTION AND SUGGESTED APPLICATIONS 45

2. SPECIFIC DESCRIPTION AND METHOD OF PREPARATION 45

3. THESAURUS WITH BASE WORDS ARRANGED ALPHABETICALLY 49

4. THESAURUS WITH SUBHEADINGS ARRANGED ALPHABETICALLY 67

REFERENCES 85

LIST OF FIGURES

Figure		Page
1	Examples of Markov Texture Generated in a 120 x 120 Matrix.	3
2	Response Probability.	3
3	Psychometric Evidence of a Visible Change in the Texture of Active Regions Shortly Before Occurrence of a Solar Flare.	6
4	A Microscopic View of a Papanicolaou Smear of Uterine Tissue.	9
5	Potentially Useful Decision Boundaries for Identifying Suspicious Smears in Prescreening. (Study III)	22
6	Potentially Useful Decision Boundaries for Identifying Suspicious Smears in Prescreening. (Study IV)	27
7	Potentially Useful Decision Boundaries for Identifying Suspicious Smears in Prescreening. (Study V, Test 1)	32
8	Potentially Useful Decision Boundaries for Identifying Suspicious Smears in Prescreening. (Study V, Test 2)	36

LIST OF TABLES

TABLE		Page
I	RESULTS OF A WORD SURVEY ON A SAMPLE OF CYTOTECHNICIANS	11
II	RESULTS OF A WORD SURVEY ON A SAMPLE OF NAIVE OBSERVERS	14
III	FORMAT FOR SCALING TEXTURES (STUDY III)	19
IV	MEAN SUBJECTIVE SCALE VALUES (STUDY III)	20
V	SPEARMAN RANK ORDER CORRELATIONS BETWEEN DIMENSIONS (STUDY III)	21
VI	FORMAT FOR SCALING TEXTURES (STUDY IV)	24
VII	MEAN SUBJECTIVE SCALE VALUES (STUDY IV)	25
VIII	SPEARMAN RANK ORDER CORRELATIONS BETWEEN DIMENSIONS (STUDY IV)	26
IX	MEAN SUBJECTIVE SCALE VALUES (STUDY V, Test 1)	30
X	SPEARMAN RANK ORDER CORRELATIONS BETWEEN DIMENSIONS (STUDY V, Test 1)	3[illegible]
XI	RELIABILITY OF MEAN SCALE READINGS BETWEEN STUDY IV AND STUDY V, Test 1	31
XII	MEAN SUBJECTIVE SCALE VALUES (STUDY V, Test 2)	33
XIII	SPEARMAN RANK ORDER CORRELATIONS BETWEEN DIMENSIONS (STUDY V, Test 2)	34
XIV	RELIABILITY OF MEAN SCALE READINGS BETWEEN STUDY V, TEST 1 AND STUDY V, TEST 2	34
XV	SUMMARY OF SIGNIFICANT CORRELATIONS BETWEEN DIMENSIONS FOUND IN EACH STUDY	37
XVI	SUMMARY OF SEPARATIONS IN 2-SPACE FOUND IN EACH STUDY	40
XVII	LIST OF VISUALLY RELEVANT REFERENCE WORDS FROM MARCH'S THESAURUS	47

SECTION I
INTRODUCTION AND RATIONALE

This program was designed to study the role of texture perception in complex imagery analysis. It was aimed at developing techniques whereby texture perception can be used in imagery analysis in a wide variety of scientific and technical contexts; including contexts as diverse as medical imagery screening, aerial surveillance, and solar observing.

In visual screening of imagery, the observer usually has the option either of scanning the display in a highly focused search for critical details, or of looking more casually at the display to gain an impression of its general configuration and texture. Which option he chooses depends on the situation, which may often require a combination of the two. For example, in screening a smear of exfoliated cells for evidence of cancer, a cytotechnician will follow both options. The whole configuration and texture of a smear may provide relevant information because it can have in it residual evidence regarding histological structure of the parent tissue, which may be significantly altered if the tissue is malignant.

The textural analysis is followed by a search for critical details, such as an occasional cell with a very large nucleus. The textural analysis may serve mainly to set the tone of the detailed scan, affecting the intensity and pattern of scanning. It can make the observer more or less suspicious that the parent tissue is malignant and more or less suspicious that certain regions in the smear may contain critical signs of disease.

A two-stage approach to imagery screening is probably also common in aerial surveillance tasks as well, although not yet tested. Here, the critical details sought in the imagery may be such features as tanks or trucks, but the search for these details may be toned by impressions of the overall configuration and textures in broad regions of the display.

The same combination of diffuse and detailed analysis may occur in solar observing as well (Pickett, 1971). The solar observer scans a very complex telescopic display of the sun, trying to predict, or at least quickly detect, occurrence of a solar flare. His attention is focused on such critical cues as the shape and position of a filament lying close to an active sunspot region. But, he may also rely on diffuse impressions of the configuration of the active region as a whole. Here, however, the combined strategy may not be deliberately chosen. The observer may fall into it with experience, without being able to justify it or even articulate what he is doing. As Firor and Liliequist (1965) phrase it, the experienced observer may ultimately rely on "a certain feeling," on a recognition of characteristics of the active region that "often go unrecorded except in his mind."

Our concern in this study is the possibility of harnessing these diffuse textural and configurational analyses in a more positive way, so that they can contribute to imagery analyses, not just in setting the tone of the search for critical details, but in providing information in their own right, information that can be separately interpreted and related to other parameters of the phenomena under study. There is ample evidence that the human observer can sense shifts in a wide variety of texture variables (Pickett, 1968, 1970). When psychometrically tested, he can produce discriminating and reliable assessments. Further, by pooling subjective reports over a number of observers, the assessments can be made more precise, and in many situations the grouped data may be useful in detecting and scaling a texture quality which individual observers would never confidently report.

The degree of precision that can be achieved in subjective assessments of texture is illustrated in a study by the author (Pickett, 1967). Figure 1 shows the computer-generated texture that the observers had to assess. The quality of coarseness that obviously varies over the three samples is controlled and specified in terms of the transition probability of a Markov process that assigned dots or spaces to adjacent cells across the rows of the matrix.

The observer's task was to assess the texture in individual samples generated at various values of transition probability (TP), and to indicate whether the texture was more or less EVEN than the criterion generated at TP=.5. The observers were told nothing about the generating process but were simply shown the criterion (MEDIUM) and the two extremes (COARSE and EVEN), as shown in Figure 1, and then allowed to work. Typically they took less than 2 seconds to process each sample, and from that fact alone we can suspect that they relied on a casual impressionistic analysis. The results, pooled over 20 observers, are shown in Figure 2. The relationship that it shows between probability of the response "EVEN" and transition probability is remarkably sensitive and systematic.

Immediately relevant to the present discussion, though not the aim of that study, is the possibility of using response probability as a subjective measure of texture. If, for example, we lost the label from one of the test samples and needed to find out what its transition probability was, we could have put it in front of our subjective measuring devices (our 20 observers) and had them make repeated independent assessments of its evenness within the confines of that psychometric task. Then, if the response probability turned out to be, say .85, we could have concluded, with a practical degree of confidence, that the transition probability of the patch was close to .56. Such is the potential for precise psychometric assessment of a texture variable.

Clearly, subjective measures of texture with this degree of precision could be scientifically and technically useful. For those many situations where automated texture analysis is beyond the state of the art, or economically prohibitive, the human observer might serve very well as the texture analyzer. For any particular problem area, it would take exploratory studies to determine whether observers could see any textural properties in the imagery that might contribute to the analysis. Then, where that was the case, psychometric tasks would have to be developed that focused assessments on the texture qualities of interest and provided appropriate response media for reading out the resulting impressions.

1. AN ILLUSTRATION OF TEXTURE PERCEPTION IN SOLAR IMAGERY ANALYSIS.

The psychometric approach is illustrated in some studies of texture perception in the context of solar observing, recently reported by the author (Pickett, 1971). The aim of these studies was to determine whether there were any

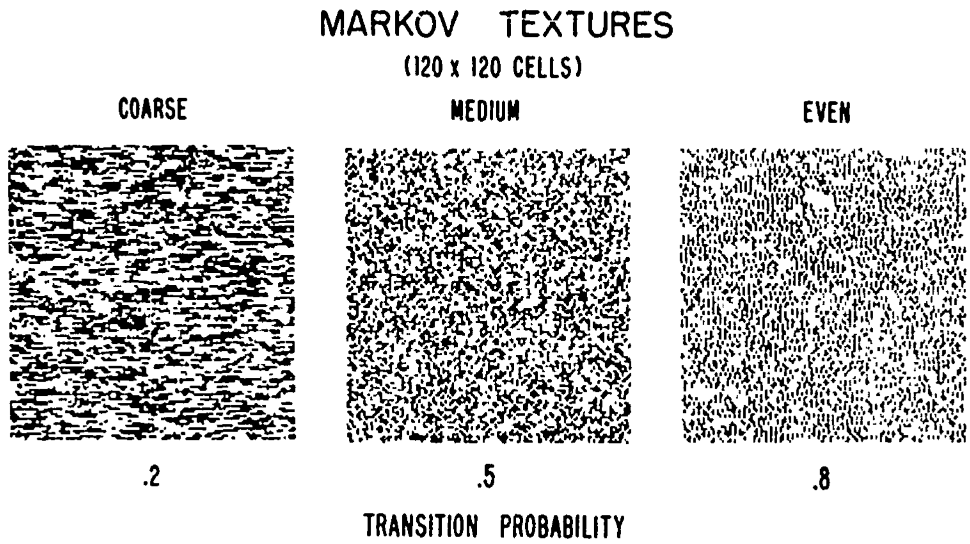

Figure 1. Examples of Markov Texture Generated in a 120 x 120 Matrix. The actual displays used were negatives of this and had considerably less sharpness of detail. (From Pickett, 1967).

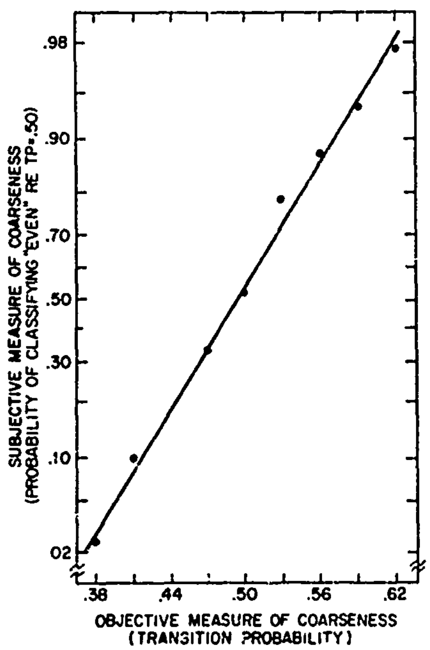

Figure 2. Response Probability. Group performance function showing the probability of EVEN responses as a function of TP for discriminations of Markov texture in a 120 x 120 matrix. (From Pickett, 1967).

visible changes in the texture of active solar regions related to the imminence of a solar flare. The observers were college students, untrained in solar physics, unaware of the problem of flare prediction, and unaware that they were examining pictures of the sun. They were shown pictures of active sunspot regions at three points in time; 9, 5 and 1 minute prior to the occurrence of a flare. In exploratory studies, conducted in a classroom setting, observers were asked to assess the texture of the active region along three dimensions, called: ABRASIVENESS, PACKABLENESS, AND SWIRLINGNESS. These dimensions were selected arbitrarily,[1] to serve simply as a way of getting the observers to assess the texture in a variety of ways, one of which might prove relevant.

One of the requirements in this psychometric approach to imagery analysis is to program each observer to carry out as nearly as possible the same perceptual task. What we seek is a situation in which precision is gained by pooling the responses of individual observers so that a desired level of precision is converged upon as the number of pooled observations is increased. If the observers are not well-coordinated, the number of observations required to achieve a discrimination at a desired level of precision may be economically prohibitive for routine screening operations. It is important, therefore, to sharply focus the analysis of each individual observer and to devise an explicit standardized task so that pooled responses converge quickly to the desired level of precision. Hence, we attempted to make explicit perceptual operations[2] for each observer to follow in making his judgments of the solar imagery.

In judging the three texture qualities, the observers were instructed to consider that the object they saw in the pictures (the solar disc) was actually about two feet in diameter, thus guiding each of them to see the object at the same scale. With regard to ABRASIVENESS, they were asked to imagine rubbing their fingers over the surface in the active sunspot region, and to estimate from the way it looked how abrasive it would feel in that tactual operation. Then they were to rank order the three time samples for each flare sequence in terms of that anticipated tactual sense of abrasiveness. To assess PACKABLENESS, they were asked to imagine dipping their hands into the material in the region of the sunspot, withdrawing a handful, and packing it like a snowball. The quality of SWIRLINGNESS was not operationally defined. They were simply asked to judge that quality based on their own individual operations.

The data showed that the observers, as a group, could sense a change in texture between nine and five minutes prior to a flare. The same statistically significant pattern of ranking was found with respect to all three qualities,

---

1. In this situation as well as most others, there may be some nonarbitrary approaches. One approach is to look to theoreticians for suggestions about relevant textural dimensions. Another approach is to get hunches from experienced observers.

2. This term was chosen to suggest an analogy between operational definitions of objective measures and operational definitions of subjective ones. Every subjective measure would have to have an operational definition to be scientifically useful.

leading to the added conclusion that the observers were probably responding to a shift in the same underlying property, perhaps to a shift in a quality akin to photographic clarity or SHARPNESS.

Data from a subsequent study (Pickett, 1971) aimed specifically at the assessment of image SHARPNESS reveal statistically significant effects consistent with those earlier conclusions. The results from that study, shown in Figure 3, provide evidence that detail in active regions tend to sharpen between nine and five minutes prior to a flare and then return to a duller state just before a flare occurs.

2. DEVELOPING PSYCHOMETRIC METHODS FOR IMAGERY DESCRIPTION.

Our studies of the application of texture perception in solar imagery analysis provide some evidence that the move can be made from theory to practice. They also help to point out two steps that have to be taken. The first is to find a language of textural description appropriate to the specific application. In the exploratory studies mentioned above, we chose the descriptions arbitrarily, but as we pointed out, there are some nonarbitrary ways, one of which is to get hunches of relevant textural descriptions from experienced observers. The next step is to carry out psychometric tests to determine the reliability, validity, manipulability, and cost of the proposed subjective texture analyses. We consider points relevant to each step here in brief general discussions. In the other two sections of this report we show how we have taken each step in applying subjective texture analysis to a specific problem in medical imagery screening.

As we undertook the work described in Section II, we had in mind several ideas about the role of language in pattern perception. We had first in mind that there is abundant evidence to support the view that language affects what a person sees (Gibson, 1969). The usual explanation is that the observer rarely abstracts all the information in a pattern in the process of recognizing or discriminating it, that language can affect which part he takes and, accordingly, affect what he sees. Descriptive labels presumably bias the way the observer looks at the pattern, how he scans it and what feature he notices.

Another explanation of the effect of language, perhaps more pertinent to the present discussion, is that language may affect how the optical information is processed. Processing the information in a pattern may be compared to processing the information in a table of numbers. There are obviously many ways that the data in the table can be processed to obtain a descriptive abstract. Even if the observer were to take into account the great bulk of features in an image, as we suggest in the process of texture perception, he may have alternate ways of processing that data that are determined by language. In our solar imagery studies, we considered such a possibility, and attempted to program the observers to process the same texture data; one way with the ABRASIVENESS instruction, and another way with the PACKABLENESS instruction.

Another point we had in mind was that language may affect perception by keeping the observer's descriptions more or less close to his phenomenal experiences. For example, the author has been fascinated to find solar observers describing a change in brightness of a feature on the solar disc as a movement. What they mean is that the change in brightness is due to a Doppler shift which,

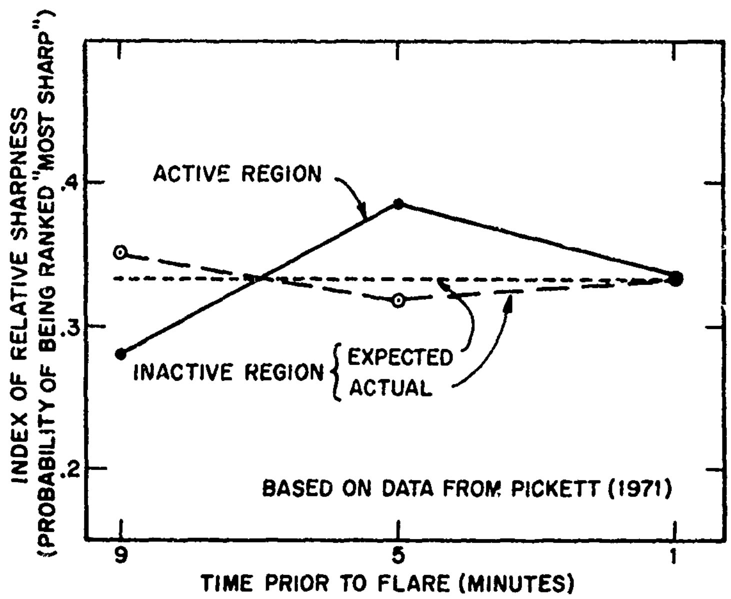

Figure 3. Psychometric Evidence of a Visible Change in the Texture of Active Regions Shortly Before Occurrence of a Solar Flare. Data from subjective impressions of image SHARPNESS at three points in time preceding a flare, for: (a) active regions; and (b) inactive regions on the same frame of the film record. Also shown is the expected index, if SHARPNESS varies randomly over time and is unrelated to flare occurrence. Based on data from Tables 5 and 7 in Pickett (1971).

in turn, indicates that the feature is moving vertically. This is a good example of a situation that is probably very common in many scientific and technical contexts where language of theory displaces the language of phenomenal experience. In this particular example from solar observing, it poses no problem beyond confusing neophytes, but in other situations such translations may pose serious problems; for example, problems in training. Instruction about relevant dimensions and features of the imagery could become so steeped in theoretical language that teachers and students alike might lose some capacity to talk about what the display really looks like in phenomenal terms.

The translation could be ultimately problematical, of course, if the theory underlying the theoretical descriptions was wrong. For psychologists, this problem is perhaps most succinctly described by referring to the classical issue of the stimulus error, i.e., describing the stimulus in terms of its logically expected properties as opposed to describing the actual phenomenal experience.

Another important consideration was selecting languages compatible with the basic functions of texture perception. In previous reports (Pickett, 1968,

1970) the author has suggested that texture perception may serve the basic purpose of providing impressions of substance, structure, and perspective in the terrestrial visual world. If so, then the most efficient way to harness texture perception may be to frame the imagery processing task into some kind of substantive or structural description of the image. This view has tempered, but not dominated, the otherwise empirical approach.

As far as the work covered in Section III is concerned, the general considerations were largely traditional for the kind of psychometric studies reported there. With the language work completed and the observers equipped with appropriate perceptual operations, the next step is to evaluate their performance. This is done in the same general sense that one would test an objective measuring device. First, there is the need to establish whether the observers can discriminate variations in the imagery under study and do that reliably. Next is the need to determine whether their discriminations are valid, in the sense of relating to properties of the phenomenon being displayed that are of scientific or technical interest. Then, it would be important to see whether their analyses can be finely tuned or focused in systematic ways to maximize sensitivity to the relevant textural variations. Finally, there is the need to check on effects of several factors peculiar to the human observer, namely: learning, motivation and fatigue. Each of these aspects of performance can be evaluated in appropriately designed psychometric studies, and several are, in fact, considered in the work reported in Section III.

SECTION II
STUDIES OF THE LANGUAGE OF TEXTURE PERCEPTION IN MEDICAL IMAGERY SCREENING
(Pap Smear Description)

Detection of disease through microscopic inspection of smears of exfoliated tissue has been recognized as an invaluable clinical technique (Koss, 1968). Its increasing routine use in medical examinations accounts for a large part of the phenomenal growth in the workload of medical laboratories over the last 20 years. This technique capitalizes on the fact that dead cells, shed from tissue, can provide evidence of disease in the tissue from which they were shed. To study the cells under a microscope, they are smeared over a microscope slide and then stained and fixed in a variety of ways, most commonly by the Papanicolaou (1954) method (Pap smear).

What is particularly valuable about Pap smears is that they provide a way to study the condition of internal organs without surgical exploration because exfoliated cells accumulate in accessible body fluids that derive from a number of organ systems. This technique is particularly valuable in searching for evidence of cancer, and while it is useful in detecting that disease in a number of organ systems, including the stomach and lungs, it has proved to have its greatest use in the detection of uterine cervical cancer. The screening of Pap smears for this purpose alone has become a task of enormous and growing proportion.

Pap smear screening is primarily a matter of visual assessment of the cellular specimens under a microscope. They appear as masses of cellular designs characterized by various qualities of coloring, shape and arrangement (see Figure 4). Through extensive training and on the job experience, cytotechnicians learn how to scan and interpret such visual patterns to detect and identify disease in the sampled tissue. The technique may have its personalized variations, but typically the screener starts with comprehensive analysis of the display, which we refer to here as prescreening, and then goes on to more detailed and localized analyses.

Prescreening serves two multifaceted functions. One function is to provide a basis for tempering subsequent detailed interpretations of the display by taking into account the conditions under which the specimen was taken and prepared. Variations in the conditions may have effects on the appearance of the specimens that are unrelated to the presence or absence of disease and so detailed interpretations have to be tempered by taking those normal variations into account. The other function is one of gaining some general feelings or hunches about whether the sampled tissue is normal or abnormal. The basis for such hunches may be very difficult for the screener to express in purely visual terms, let alone justify in terms of medical theory. Yet those hunches may have a practical degree of validity in themselves, and undoubtedly have effects on the detailed scanning that follows.

Our concern in the ensuing work here, and in Section III, was to see whether we could sharpen and enrich the prescreening assessment through appropriate psychometric techniques. The aim of Study I was to determine whether cytotechnicians had a consistent language for describing background qualities relevant to the presence or absence of disease. In Study II we asked naive observers to describe the appearance of Pap smears to check whether cytotechnicians were describing properties of the image as they saw it or whether their

Figure 4 A Microscopic View of a Papanicolaou Smear of Uterine Tissue, Photomicrographed at 100x.

descriptions were based on other scientific and technical knowledge privy to them as professionals.

1. STUDY I. A SURVEY OF THE ADJECTIVES USED BY CYTOTECHNICIANS TO DESCRIBE THE OVERALL APPEARANCE OF PAP SMEARS.

a. Subjects. The subjects were 38 cytotechnicians (including 10 students) working in hospital laboratories in the Boston area who served voluntarily and without pay. Forty cytotechnicians were contacted; two declined taking the test.

b. Method. The test was administered in the form of a questionnaire consisting of a checklist of 62 adjectives. The subjects were asked to work on the questionnaire independently, checking each adjective as a visible or nonvisible quality in the overall appearance of a smear seen at 100x magnification. For an adjective checked as visible, the format called for an additional categorization with respect to whether: (a) it suggested the smear was negative, (b) it made them suspicious or (c) it suggested the smear was positive. The questionnaire is included with this report as Appendix A. The data were tabulated to determine for each adjective the number of subjects who checked each of the possible categories. (The data from categories b and c were pooled.) We then identified each adjective in which there was a statistically significant preponderance of votes in one or another of the categories.

c. Selection of Adjectives. Several of the adjectives were suggested in prior discussions with a cytologist. Most of them, however, were chosen from a much longer list of adjectives; an early version of the lexicon included with this report as Appendix B. We tended to choose adjectives that would be descriptive of apparent substantive and mechanical properties of the material. This tendency was largely dictated by the consideration, mentioned in Section I, of the basic function of texture perception. We assume that one of the natural and reflexive responses of the visual system to any complex display is to provide immediate impressions of its substantive and mechanical meanings. These impressions, we assume, are what provide the observer in the normal terrestrial environment with a physical sense of objects in his immediate field of view and which provide, in real time, a basis for safe and efficient physical behavior. Textural impressions, we assume, are answers to implicit questions raised and answered automatically in a context of chronic uncertainty about the immediate physical environment, an uncertainty which is shared by all observers, scientifically sophisticated and naive alike, and which is largely unaffected by an intellectual understanding that the display has no environmental significance (see Pickett, 1968, 1970 for further discussion).

d. Results. The results are shown in Table I. Listed are each of the adjectives which received a statistically significant majority of votes by a Binomial test ($p < .05$, two-tailed) in each of the possible categories.

e. Discussion. Perhaps most informative is the surprisingly large number of qualities which the observers claim are visible (32 out of 62) and relate to the presence or absence of cancer (21 out of 32). Also of possible significance is the fact that there are a greater number of positive than negative descriptions. But, perhaps most relevant to the present aim is the possibility of abstracting several qualitative dimensions for psychometric study. The approach was to make several obvious pairings between the positive and negative lists in the visible category, e.g.:

	Negative	Positive
Qualitative dimension	Calm	- Explosive
	Clean	- Dirty
	Consistent	- Variable
	Dull	- Bright
	Loose	- Tight
	Transparent	- Opaque

In this way several dimensions of textural description presented themselves for psychometric study. Others, like the quality Pliable-Extrudable, which placed in neither the visible nor the nonvisible category, were chosen by the author for psychometric study on the basis of his own hunches.

TABLE I

RESULTS OF A WORD SURVEY ON A SAMPLE OF CYTOTECHNICIANS

	Agreed on, by the majority of those who said they were visible, to suggest: NEGATIVE	POSITIVE	Not agreed by those who said they were visible to suggest either positive or negative
Qualities Agreed* on by the Majority as VISIBLE	Calm	Bright	Cohesive
	Clean	Clumped	Compact
	Consistent	Dirty	Fatty
	Dull	Enmeshed	Filmy
	Loose	Explosive	Fragile
	Regular	Fibrous	Granular
	Transparent	Lumpy	Lustrous
		Matted	Shrunken
		Opaque	Shiny
		Pearly	Spongy
		Puffy	Waxy
		Thick	
		Tight	
		Variable	
Qualities Agreed* on by the Majority as NOT VISIBLE		Gummy	Creamy
		Leathery	Doughy
		Pulpy	Droopy
		Ropy	Slippery
			Starchy
Qualities Not Agreed on by a Statistically Significant Majority as either visible or not visible	Firm	Crumbly	Brittle
	Pliable	Extrudable	Elastic
	Silky	Gluey	Floating
	Soft	Hard	Milky
	Velvety	Raw	Oily
		Slimy	Pasty
		Soapy	Rubbery
		Stiff	Sticky

*Significant at the 5% level assuming equiprobability of assignment to the two alternative classifications.

2. STUDY II. A SURVEY OF ADJECTIVES USED BY NAIVE OBSERVERS TO DESCRIBE THE OVERALL APPEARANCE OF PAP SMEARS.

The aim of this study was to give a test to naive observers, equivalent to that administered to cytotechnicians, so that we could compare their descriptive languages. As noted in Section I, it is probable that professional observers contaminate descriptions of their phenomenal experiences with descriptions based on other theoretical and technical knowledge of the phenomenon under study.

a. Observers. The observers were 47 undergraduates in two psychology classes at Northeastern University, 24 in one class and 23 in the other. They participated in the survey as a class exercise.

b. Method. The 24 students in one class were shown views only of negative Pap smears while 23 students in the other class saw similar views, only of positive smears. Each of the observers was given a checklist containing the same 62 adjectives used in Study I, but in this case the format called only for classifications of visible and nonvisible. They were asked to study the pictures that were shown, and then to check those adjectives only with respect to whether they were descriptive of visible or nonvisible qualities. The subject matter of the pictures was not described to them in any way, and they were asked to avoid any discussions among themselves about the pictures. Inquiries after the test revealed that many of the students felt sure they were looking at microscopic displays, and some were sure they were looking at biological specimens of some kind. None mentioned any knowledge of Pap smears or Pap smear screening.

The observers were told that their performance was going to be compared to that of a large number of professional observers, very experienced from looking at thousands of such pictures, who also had taken this test. They were also told that the professional observers had selected about half of the words as describing a visible quality in pictures of this kind. Then they were told that they would be paid, on the basis of their individual performance, 2¢ for each case where their classification was in agreement with the professional observers. They were actually scored in terms of their agreement with the statistically significant classifications shown in Table I. The data were analyzed in the same way as in Study I.

c. Stimuli. The stimuli were color photomicrographs taken from selected regions on 20 different Pap smears obtained from one of the local teaching hospitals. They had been previously screened in the cytology laboratory for evidence of uterine cancer with 10 of the smears classed as positive (squamous carcinoma) and 10 negative. The smears were standard preparations on microscope slides, photographed in color at 100x magnification. Photographs were made of 10 systematically selected areas on each smear according to the plan shown below:

ID#	1	2	3	4	5
	6	7	8	9	10

Thus, there was a working sample of 100 negative and 100 positive images which were prepared as 35mm projection transparencies, and used for all the studies described in this report. From one study to the next the same smears were used, but the particular views were varied. In this study views 3, 4, 5, 6, 7 and 8 were used. The 60 images (six views of 10 negative or 10 positive smears) were shown two at a time on a screen at the front of the classroom, by use of two Kodak Carousel projectors. The sequences were arranged such that a different smear was represented in each of the paired views, and the 10 smears were represented on each sequence of 10. The 60 images were cycled continuously as the test proceeded, with each pair displayed for approximately 10 seconds. The test was completed in one class hour.

d. Results. Wherever the majority of the observers in both groups agreed on the same word, we pooled their data. If the majorities did not agree, we treated their data separately. If a word received a statistically significant majority ($p < .05$, two-tailed) in one way or another, it is listed in Table II. In the top row of Table II are those words agreed upon by a majority in both the positive and the negative group to be visible qualities of the Pap smears. There was one word, "creamy," where the majorities did not agree but where the separate and oppositely voting majorities were statistically significant.

e. Discussion. Perhaps the most interesting finding is that there is considerable disagreement between the naive and professional observers. (The asterisked words in Table II are those on which they disagree.) The naive observers say, in disagreement with the cytotechnicians, that "doughy" and "slippery" describe visible qualities of Pap smears. This may only mean that the cytotechnicians see these qualities but use other words to describe them. On the other hand, there are interesting possibilities that the cytotechnicians do not see these qualities or, if they do, that for one reason or another, they inhibit describing them. If the latter situation is true, then the cytotechnician may be inhibiting descriptions of qualities that are potential discriminators. We have one possible example of that here with the quality, "creamy."

In row two of Table II we see that the naive observers claim that "consistent," "dirty," "dull," "lustrous," "regular," "tight," and "waxy" do not describe visible qualities, whereas the cytotechnicians say they do. Again, this may be due to differences in use or meaning of these words. On the other hand cytotechnicians may be reading into smears qualities which are not there but which they are led to believe are there from other knowledge acquired in their professional experience.

Our interpretation of these findings has to be tempered by at least three general considerations. Even if there were no real effects in the data, we would expect to find statistically significant effects at the 5% level about 5% of the time. Perhaps more important, the sample of positive and negative smears that the naive observers based their judgments on may be far from typical of the vastly larger sample of smears that the cytotechnicians based their judgments on. Finally we need to consider limitations on the adjective checklist. It certainly is not an exhaustive, nor even a representative list, of all adjectives which might be useful for describing smears. A thorough language inventory would require a comprehensive checklist and the approach would be to take a series of surveys beginning with a survey of general categories of description and ending with a survey of fine distinctions within

TABLE II

RESULTS OF A WORD SURVEY ON A SAMPLE OF NAIVE OBSERVERS

Qualities		
Qualities Agreed** on by the Majority as <u>VISIBLE</u>	Bright Clumped Cohesive *Doughy Enmeshed Filmy Floating Granular	Loose Opaque Pliable Slimy *Slippery Transparent Variable
Qualities Agreed** on by the Majority as <u>NOT VISIBLE</u>	Brittle *Consistent *Dirty Droopy *Dull Firm Hard Leathery	*Lustrous *Regular Ropy Stiff *Tight Velvety *Waxy
Qualities Agreed** on by the Majority of: (1) Those who viewed positive slides as VISIBLE; and (2) Those who viewed negative slides as NOT VISIBLE	Creamy	

*Opposite to the judgment of cytotechnicians.

**Significant at the 5% level assuming equiprobability of assignment to the two alternative classifications.

those categories found to be relevant. The development of a lexicon of visual descriptions would be the first step in that direction, which we have since attempted to take (see Appendix II). Despite the limitations, however, these studies exemplify a systematic approach to an inventory, and they did yield productive leads for the studies reported in Section III.

SECTION III
PSYCHOMETRIC STUDIES OF TEXTURE PERCEPTION IN MEDICAL IMAGERY SCREENING (Prescreening Pap Smears)

The studies reported below are an attempt to put into practice the ideas outlined in Section I. The immediate goal is to determine whether there is any potential for practical applications of texture perception in prescreening Pap smears for evidence of cancer.

There are several ways to carry out psychometric tests of subjective qualitative descriptions. A comprehensive treatise on psychometric methods is provided in Guilford (1954) and two approaches are illustrated in Section I of this report. Here we take yet a third approach employing a set of standardized subjective scaling tasks. The observers are instructed to focus their attention on the imagery in various ways to gain impressions of particular texture qualities. They then indicate the degree of the quality that each image has by assigning it a number on a scale from 0 to 9. Their subjective measures are then run through statistical analyses to evaluate reliability and validity. Some comparisons of effects across studies also provide evidence of the effects of instructions and training.

We report three studies, coded in the report as Studies III, IV, and V. In each study the observers make several individual textural assessments of the same set of positive and negative smears. In Study III, naive observers make six textural assessments. In Study IV, other naive observers make four assessments, two of which are the same as in Study III, except for minor variations in scale format and instructions. In Study V, the observers are student cytotechnicians who make the same judgments and carry out the same tasks as the naive observers did in Study IV. In Test 1 of Study V, we report assessments made by those students on their first day of training, so that, at that point, they too can be considered naive observers. In Test 2 of Study V, we report their assessments in an identical test made after six months of classroom and on the job training.

1. GENERAL METHOD.

Group testing techniques were employed. Where the observers were college undergraduates, they took the test as part of a classroom exercise. The general approach was to show pictures of smears in the form of 35mm slides, which were projected on a screen at the front of the group testing room. Each slide was a partial view of a smear photomicrographed at 100x. Over the series of slides, the observer saw several different views of 10 positive and 10 negative smears. Each slide was displayed for approximately 12 seconds, during which time the observer was required to make two separate texture appraisals, and mark the subjective scale number derived from those appraisals on an answer sheet. Depending on the study, the observer went through the whole set of slides two or three times to make all of the required appraisals which were counterbalanced to control the effects of fatigue, i.e., half of the appraisals of a particular quality were made in the first part of the test and half in the last part of the test.

a. Stimuli. The stimuli were the same ones described in Section II 2.

b. Data Reduction and Analysis. The general approach to data reduction is to determine the mean subjective scale value for each smear over all views and all observers. The first step in data analysis is to perform statistical tests of reliability. For each individual study, evidence of reliability is indirectly assessed by computing a matrix of Spearman Rank Order correlations (see Siegel, 1956, pp. 203-213) for all possible pairings of dimensions. A significant correlation is considered evidence of reliability in the sense that, if observers were unreliable in their individual assessments, it would preclude the inter-observer consistency required for such a correlation. Direct estimates of reliability are made in two situations, where the mean scale values derived from separate studies could be correlated.

The second step in data analysis is to perform tests of validity. In each of the studies we first look for differences between positive and negative smears in distribution of the mean scale reading for each dimension. We employ Mann-Whitney U tests to determine the statistical significance of those differences.

We next consider the possibility that differences between positive and negative smears might be evident in interactions between dimensions; their distribution in 2-space is now examined. The data are first plotted in each of the 2-spaces formed by all possible pairings of the dimensions and then the plots are inspected for evidence of separation between positive and negative smears. The tendency to separate is defined by the following objective procedure: (1) A straight line is drawn through the space in such a way that the smears are maximally separated, i.e., divided into the most unlikely partition, in the sense of Fisher's exact test (see Bradley, 1968, pp. 195-196); and (2) Those spaces are accepted as indicating evidence of separation if the probability of the partition is less than $p < .05$, two-tailed. Note that this probability measure is not presented as an index of the true probability of the partition, but merely as an objective criterion of separation. Statistical significance of the separation has to be sought in determining the likelihood of its repeated independent occurrence.

Beyond these two basic tests, there are a number of comparisons between performance on positive and negative smears where differences can be treated as evidence of validity. For example, a systematic difference between positive and negative smears in consistency or reliability would indicate that the observer in some sense saw the positive smears differently than the negative smears. Such comparisons are made where appropriate.

2. STUDY III. A PSYCHOMETRIC EVALUATION INVOLVING SIX DIMENSIONS OF TEXTURE ASSESSMENT MADE BY NAIVE OBSERVERS.

In this study the observers assessed background qualities along six dimensions: DIRTINESS and DULLNESS of the scene as a whole; EXPLOSIVENESS and LOOSENESS of clusters of cells in general; and DOUGHINESS and BRITTLENESS of cells in general. Each of these dimensions was defined by a pair of words suggested in Study I, representing extreme positions along the dimension. No anchor points, such as the position of common objects along the scale were provided, nor was any unit of measurement provided. Aside from general directions on how to proceed and guidelines regarding the three levels of analysis, no perceptual operations of any kind were suggested. The observers were left to their own devices and had to develop their perceptual operations independently. The primary aim of this study was to establish a base line of task definition, a level beyond which, presumably, one could improve performance by providing explicit perceptual operations.

a. Observers. The observers were 24 undergraduates at Northeastern University, untrained in cytology, who volunteered to participate in the experiment as part of a class exercise in a psychology course on perception.

b. Method. Views 1, 3, 4 and 8 were used as the stimuli. The first 20 presentations, View 1 from each of the 20 smears, was a practice run. The next 60 presentations (Views 3, 4 and 8) were test stimuli. Within each sequence, views of the positive and negative smears were randomly ordered and the sequence of 80 views was presented three times. For half of the observers, the first time through the 80 presentations they made Scene analyses, the second time through, Cluster analyses, and the third time through, Cell analyses. For the rest of the observers the order was reversed (Cell, Cluster, Scene). Discarding the practice sequence, each observer made a total of 60 judgments (three for each of the 10 positive and 10 negative smears) on each dimension.

c. Instructions. The observers were told: (1) That the experiment was aimed at harnessing "natural" perceptions for scientific and technical purposes; (2) That they would be looking at some tissue photographed through a microscope; (3) That some of the slides would be from patients who had cancer and some from healthy controls; (4) That the test would be tedious and they did not have to participate (a few of the students did choose to take that option and left before the experiment started); (5) That the experimenter would be back to explain further about the experiment and show them the results.

The observers were then supplied with answer sheets and the scaling format shown in Table III. The levels of analysis were illustrated by pointing out features on several sample views of the smears. They were asked to make the two assessments at one level of analysis of each view each time it was presented and to indicate their assessments of each view by marking on the answer sheet the positions that they felt it occupied on the appropriate scales. No definitions or criteria regarding the dimension or the assessment procedure were provided beyond what was evident in the scaling format. Each observer had to determine his own criteria and perceptual operations and apply them independently.

d. Results. The mean scale value for each smear, averaged over all views and observers, is shown in Table IV.

Evidence of Reliability. If the observers were assigning scale values to the smears randomly and independently, we would expect homogeneity among the mean scale readings in Table IV with the scores tending to be near a scale value of 4.5. Inspection reveals, to the contrary, considerable variability both within and between dimensions, providing our first subjective indication that the assessments probably are discriminating and reliable. The inhomogeneities between dimensions suggest that the observers are doing different things in analyzing the different dimensions, but doing those different things with sufficient consistency from one observer to another for the inhomoge-

TABLE III

FORMAT FOR SCALING TEXTURES (STUDY III)

						SCENE							
1	Clean	0	1	2	3	4	5	6	7	8	9	Dirty	1
2	Bright	0	1	2	3	4	5	6	7	8	9	Dull	2
						CLUSTER							
3	Calm	0	1	2	3	4	5	6	7	8	9	Explosive	3
4	Sticky	0	1	2	3	4	5	6	7	8	9	Loose	4
						CELL							
5	Filmy	0	1	2	3	4	5	6	7	8	9	Doughy	5
6	Pliable	0	1	2	3	4	5	6	7	8	9	Brittle	6

TABLE IV

MEAN SUBJECTIVE SCALE VALUES (STUDY III)

Slide #	DIRTINESS	DULLNESS	EXPLOSIVE-NESS	LOOSENESS	DOUGHINESS	BRITTLENESS
			Positive Smears			
2	5.74	4.38	5.55	4.17	5.38	5.67
9	5.57	6.31	3.81	5.39	4.03	4.66
12	5.18	3.97	4.99	3.93	4.04	4.26
15	4.77	4.42	4.21	5.06	4.43	4.86
18	5.44	4.38	6.46	2.56	4.54	3.38
19	5.99	4.55	5.10	4.45	4.91	4.50
24	6.36	4.78	5.37	3.64	4.48	4.68
26	6.72	4.92	6.36	3.16	4.82	4.32
38	6.00	4.30	5.80	3.93	4.91	4.85
45	5.67	4.74	5.08	4.35	4.55	4.12
			Negative Smears			
3	5.86	5.23	4.59	4.63	4.74	4.54
4	4.07	4.28	3.99	4.56	3.73	5.59
5	5.76	6.01	3.88	4.92	3.47	3.91
7	6.65	5.07	5.96	3.07	4.07	4.81
10	3.50	3.72	3.67	4.11	4.21	5.25
11	4.62	4.16	4.80	3.65	4.78	5.34
13	4.89	4.44	4.10	4.11	4.48	4.33
14	4.60	4.46	4.31	3.78	3.96	4.24
16	6.63	5.61	5.90	2.26	5.63	3.59
20	5.81	3.63	6.33	2.07	4.46	3.77

neities to become apparent. The same can be said for the inhomogeneities within dimensions. They suggest that the observers see differences among the smears but see those differences with sufficient consistency from one observer to another for the inhomogeneities within dimensions to become apparent.

Our first step in providing objective evidence of these effects is to compute correlations between dimensions, pointing out that significant correlations would not be expected to occur unless the observers were seeing differences among the smears and seeing those differences in consistent fashion from smear to smear and dimension to dimension. The matrix of correlations between dimensions in Table V shows that there is a statistically significant correlation between LOOSENESS and EXPLOSIVENESS in both negative and positive smears; a significant correlation between EXPLOSIVENESS and DIRTINESS in the negative smears and between EXPLOSIVENESS and DOUGHINESS in the positive smears. Beyond those particular effects, there is general evidence of consistency in the fact that 14 out of 15 cells above the diagonal have matching sign counterparts below the diagonal. This similarity in patterns of correlation between the two sets of data is further indirect evidence of reliability.

Evidence of Validity. We sought evidence of validity first by conducting Mann-Whitney U tests of difference in distribution between the mean scale value for positive and negative smears. There were no statistically significant effects.

The next step in testing validity was to plot the data in all possible 2-spaces. We then inspected those plots for evidence of separation of positive and negative smears, in the sense described in the General Method section (III-1b). Only three of the 15 possible 2-spaces provided such evidence, and they are shown in Figure 5.

TABLE V
SPEARMAN RANK ORDER CORRELATIONS BETWEEN DIMENSIONS (STUDY III)
(Correlations for positive smears lie above the diagonal;
those for negative smears lie below)

	DIRTINESS	DULLNESS	EXPLOSIVENESS	LOOSENESS	DOUGHINESS	BRITTLENESS
DIRTINESS	--	.38	.54	-.38	.57	.14
DULLNESS	.54	--	-.20	.25	-.21	-.09
EXPLOSIVENESS	.72*	-.05	--	-.83**	.64*	-.18
LOOSENESS	-.35	.36	-.80**	--	-.20	.39
DOUGHINESS	.35	-.08	.49	-.46	--	.25
BRITTLENESS	.52	-.39	-.34	.33	-.16	--

*Significant at $p < .05$, two-tailed

**Significant at $p < .01$, two-tailed

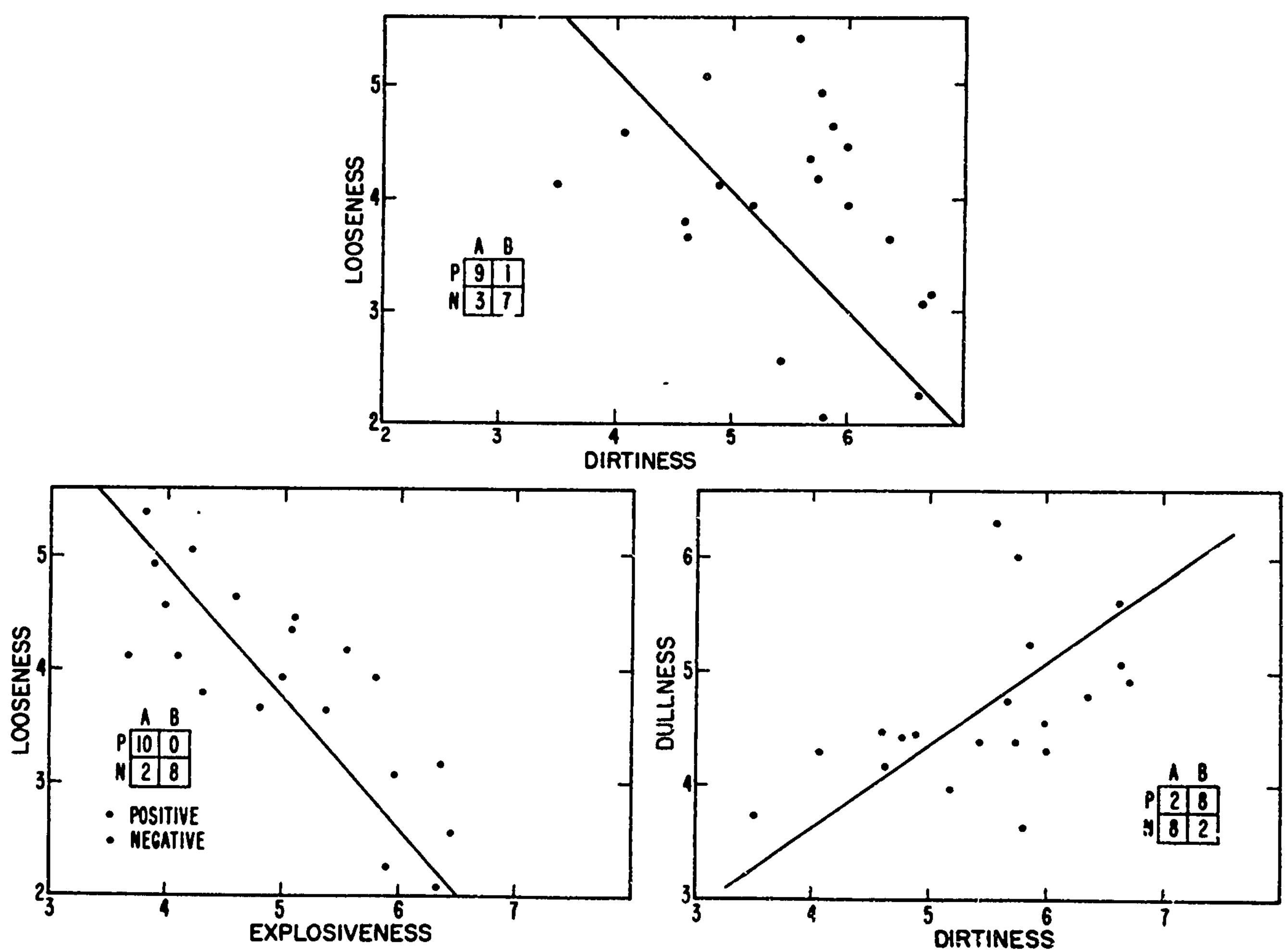

Figure 5. Potentially Useful Decision Boundaries for Identifying Suspicious Smears in Prescreening. The straight line drawn through each space partitions most of the positive from most of the negative smears. The number of positive and negative smears falling above or below the decision boundary are shown in a 2x2 table. (Study III)

In each case, inspection of the plot revealed the possibility of drawing a straight line through the space, which would partition most of the negative from most of the positive smears. For example, in the 2-space defined by EXPLOSIVENESS and LOOSENESS, 10 out of 10 positive smears lie above the line and eight out of 10 negatives lie below the line. If repeated tests with other smears showed that a boundary drawn through the space in this same way repeatedly described the same form and degree of separation, then such a boundary could prove useful in prescreening. Any smears falling above the line could be considered more suspicious than those falling below the line and, hence, to be treated to a more thorough evaluation in subsequent screening.

3. STUDY IV. A PSYCHOMETRIC EVALUATION INVOLVING FOUR DIMENSIONS OF TEXTURE ASSESSMENT MADE BY NAIVE OBSERVERS EQUIPPED WITH RUDIMENTARY PERCEPTUAL OPERATIONS AND SCALING ANCHORS.

In this study another group of naive observers assessed four texture qualities in the Pap smears: OPACITY, EXTRUDABILITY, EXPLOSIVENESS and LOOSENESS. The procedure was similar in all respects to that followed in Study III, except that in this study the observers were provided with a more definite task and some rudimentary perceptual operations.

a. Observers. The observers were 70 young women, all untrained in cytology, and students at Northeastern University in programs for nursing or dental technology. They participated voluntarily as part of a class exercise in an Introductory Psychology course.

b. Method. The observers assessed the texture qualities in six views (1, 2, 4, 5, 6, 8) for each smear. Views 1 and 2 were for practice. A counterbalanced design was employed to control effects of fatigue. The observers practiced scaling OPACITY and EXTRUDABILITY on views 1 and 2, and then were tested with views 4 and 5. They then practiced scaling EXPLOSIVENESS and LOOSENESS on views 1 and 2 and were tested with views 4, 5, 6 and 8. They then were retested on OPACITY and EXTRUDABILITY, scaling views 6 and 8. Discarding the practice sequences, each observer made a total of four assessments on each smear for each dimension.

c. Instructions. In addition to the same general instruction provided in Study III, the observers were given the following brief definitions of the dimensions while the experimenter pointed to relevant features in sample views of the imagery:

(1) OPACITY is a quality of see-throughness. Water is transparent. If a material is opaque you can't see any light through it.

(2) EXTRUDABILITY is a quality that makes a material deform and flow when it is squeezed. Think of the cells as about as big as your hand. How would they feel if you picked them up and squeezed them. Would they extrude like a pancake, or would they crumple up like Saran® wrap?

(3) To assess EXPLOSIVENESS, think of the way the material was laid down. Were the cells shot explosively into their locations, or were they

gently wafted into place?

(4) STICKINESS is a quality that makes a material cling to itself. Think of Saran® wrap. It clings to itself. Cellophane stays loose. Think of the cells as about as big as your hand. Think of picking up some that are lying together. Would they cling to each other? How would it feel to pull them apart?

The scaling format, shown in Table VI, was also different from that used in Study III with anchor points of familiar materials added to two of the dimensions.

TABLE VI

FORMAT FOR SCALING TEXTURES (STUDY IV)

1	Transparent	0	1	2	3	4	5	6	7	8	9	Opaque	1
2	Pliable	0	1	2	3	4	5	6	7	8	9	Extrudable	2
		Saran® Wrap							Molding Clay				
3	Calm	0	1	2	3	4	5	6	7	8	9	Explosive	3
4	Sticky	0	1	2	3	4	5	6	7	8	9	Loose	4
		Saran® Wrap							Cellophane				

d. Results. The mean scale value for each smear, averaged over all views and all observers, is shown in Table VII.

Evidence of Reliability. Inspection of the data in Table VII reveals a degree of inhomogeneity, both within and between dimensions, which suggests that the observers are assigning scale values nonrandomly and with some degree of consistency from observer to observer. We refer to the discussion in the results of Study III for an outline of the logic behind that inference. We again seek indirect but objective evidence of consistency in correlations between dimensions. A matrix of Spearman Rank Order Correlations is presented in Table VIII, which shows significant correlations in all cases.

Beyond that general interpretation, we can also point out that there is a greater proportion of pairs of dimensions in this study than in Study III that are significantly correlated. This could be because the variations along the two new dimensions tested here are more discriminable. It could also be due to the fact that the assessments are more precise here, due to two factors: (1) The observers based their judgments on four views of each smear here, whereas in Study III they based their judgments on only three views, and (2) There were nearly three times as many observers participating. These factors both add up to each assessment being based on nearly four times as

TABLE VII

MEAN SUBJECTIVE SCALE VALUES (STUDY IV)

Slide #	OPACITY	EXTRUDABILITY	EXPLOSIVENESS	LOOSENESS
		Positive Smears		
2	5.22	4.93	5.04	5.40
9	4.31	4.73	4.60	5.06
12	4.32	4.97	4.76	5.25
15	3.88	4.56	3.78	5.59
18	5.93	5.28	5.01	3.37
19	4.87	4.96	4.38	5.05
24	5.64	5.10	5.50	4.17
26	5.12	5.23	5.36	4.38
38	5.18	5.22	5.53	4.47
45	5.84	5.22	6.32	3.19
		Negative Smears		
3	5.20	5.09	5.14	4.18
4	4.62	4.96	4.81	4.27
5	4.63	4.95	4.97	4.94
7	5.64	5.25	6.18	3.25
10	4.63	4.91	4.97	4.80
11	5.44	4.97	5.45	4.06
13	5.29	5.11	5.61	4.37
14	4.99	4.90	4.88	4.62
16	5.28	5.12	5.63	3.92
20	5.61	5.33	5.87	3.63

TABLE VIII

SPEARMAN RANK ORDER CORRELATIONS BETWEEN DIMENSIONS (STUDY IV)
(Correlations for positive smears lie above the diagonal;
those for negative smears lie below)

	OPACITY	EXTRUDABILITY	EXPLOSIVENESS	LOOSENESS
OPACITY	--	.74*	.74*	-.78**
EXTRUDABILITY	.79**	--	.66*	-.83**
EXPLOSIVENESS	.92***	.90***	--	-.69*
LOOSENESS	-.78**	-.85**	-.82**	--

*Significant at $p < .05$ two-tailed

**Significant at $p < .01$ two-tailed

***Significant at $p < .001$ two-tailed

many individual assessments (280 to 72). We also have to consider that the observers here were provided with rudimentary perceptual operations, and anchor points on two of the scales. Each of these factors could also have contributed toward increasing precision of the subjective estimates. But to determine whether the overall record of reliability is better here than in Study III because of greater discriminability along the dimensions or more precise assessments would require further study.

Evidence of Validity. We again sought evidence of validity, first through Mann-Whitney U Tests which revealed no statistically significant difference between positive and negative smears on any of the four dimensions.

The next step in testing validity was to plot the data in all possible 2-spaces. We then inspected these plots for evidence of separation in the manner described previously in the general method section. Three of the six possible pairings gave evidence of separation and are shown in Figure 6. In each case inspection reveals that a straight line, drawn through the space, can partition most of the negative from most of the positive smears. The implications for these separation schemes, if they were to prove reliable, have already been discussed for similar results in Study III.

Evidence of Effects of Instructions and Anchor Points. We look first at the effects of a variation in instructions. In Study III, the observers were

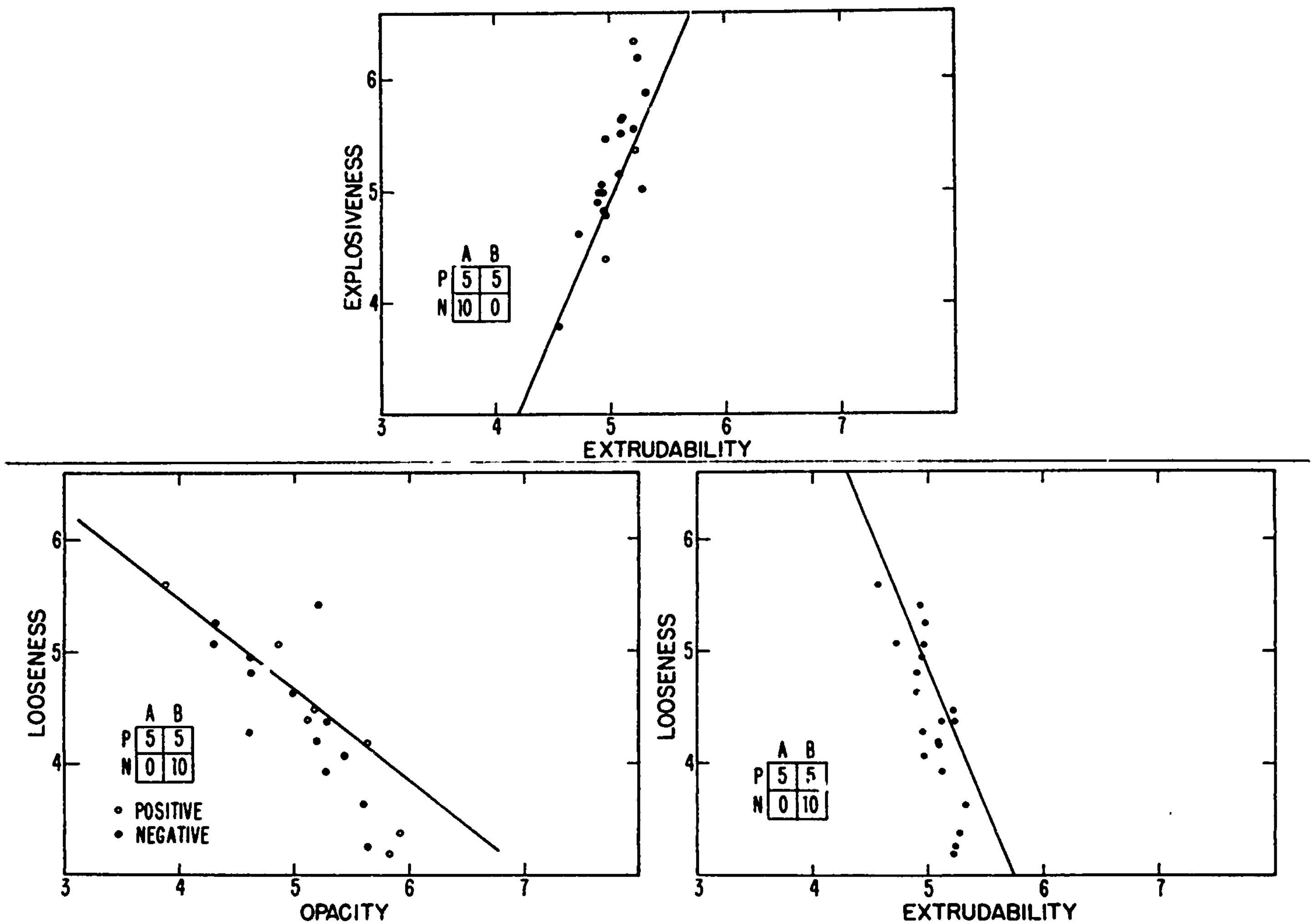

Figure 6. Potentially Useful Decision Boundaries for Identifying Suspicious Smears in Prescreening. The straight line drawn through each space partitions most of the positive from most of the negative smears. The number of positive and negative smears falling above or below the decision boundary are shown in a 2x2 table. (Study IV)

left to define and evaluate EXPLOSIVENESS in their own individual ways. In this study they were given a definition which provided them with a standard way of visualizing EXPLOSIVENESS. The effect of this variation in instructions is tested by a Wilcoxon matched pairs signed ranks test (Siegel, 1956, pp. 75-83). In that test, the mean scale values of EXPLOSIVENESS for each of the negative smears obtained in Study III were paired with those obtained in this study. The same test was made on the positive smears. There was no statistically significant difference between assessments of the positive smears, but assessments of the negative smears were significantly effected ($T = 5$, $p < .02$, two-tailed). The same smears tended to get higher assessments of EXPLOSIVENESS in this study than they did in Study III. The most likely cause of this effect is the change in instructions. However, different observer populations were involved, which might also account in whole or in part for the effect. Whatever the case, this result demonstrates how sensitive these assessments can be to task or observer variables. This could either indicate unreliability or suggest the positive quality that these assessments can be shaped by means of observer selection, instruction and training.

In an examination of the combined effects of a difference in instructions and a difference in anchor points, the observers were given: (1) a definition of LOOSENESS, (2) a rudimentary perceptual operation for assessing it, and (3) anchor points on the 10 point scale. We looked for statistically significant effects, again using a Wilcoxon matched pairs signed ranks test. No statistically significant difference was found for the positive smears, but assessments of the negative smears were significantly affected ($T = 7$ $p < .05$, two-tailed). The same smears tended to get higher ratings of LOOSENESS in this study than they did in Study III with the most likely causes of this effect the changes in instructions and scaling format. But, again, this interpretation has to be tempered by consideration of differences in the observer populations.

4. STUDY V. A PSYCHOMETRIC EVALUATION OF FOUR DIMENSIONS OF TEXTURE ASSESSMENT MADE BY CYTOTECHNICIANS BEFORE AND AFTER TRAINING.

The observers in this study were student cytotechnicians. We had an opportunity to study their performance both before and after training. In each test they performed the same task as in Study IV, except that they saw two more views of each smear. This study examines the performance of a small group of highly motivated observers and the effects of training on their performance.

a. Observers. There were 10 observers, students in the Boston School of Cytotechnology who participated in the study voluntarily as part of their training.

b. Method. Views 1, 2, 3, 4, 5, 6, 7 and 8 were used as the stimuli. Views 1 and 2 from each of the 20 smears were used for practice. Other than the addition of Views 3 and 7 to the test series, the procedure was the same as in Study IV. Test 1 was administered on the first day that the students attended classes at the Boston School of Cytotechnology with Test 2 administered approximately six months later, after the students had largely completed their classroom studies and were training on-the-job in cytology laboratories at several hospitals in the Boston area.

c. Results of Test 1. The mean scale value for each smear, averaged over all views and all observers, is shown in Table IX.

(1) Evidence of Reliability. The data in Table IX reveal, as they did in the previous studies, a degree of inhomogeneity that indicates the observers were not responding randomly, and which provides evidence of a certain degree of inter-observer consistency. Objective, but still indirect evidence of reliability is presented in Table X, which shows Spearman Rank Order Correlations between dimensions.

Statistically significant correlations occur in eight cases. A comparison of the correlation matrix obtained here in Study V, Test 1 with that in Study IV reveals a greater proportion of statistically significant correlations in Study IV, probably because each assessment here is based on only 60 observations in contrast to 280 in Study IV. Therefore it appears that there are detectable effects on the reliability of performance due to changing the number of observations, at least four-fold. It is important to note also that this effect was probably attenuated by two factors: (1) the observers in Study V, Test 1 saw two more views of each smear than the observers in Study IV and (2) the observers in Study V, Test 1 had some vested interest in what they were doing and were probably highly motivated.

Direct evidence of reliability is available in correlations between the mean scale values obtained in this study and those obtained in Study IV. Spearman Rank Order Correlations were computed for positive and negative smears separately and are shown in Table XI.

(2) Evidence of Validity. Mann-Whitney U Tests revealed no statistically significant differences between distributions of the mean scale values for positive and negative smears. The data were next plotted in all possible 2-spaces, and evidence was sought, in the plots, of separation of positive and negative smears. Following the procedure outlined in the General Method section herein, five spaces were found in which separation occurred as shown in Figure 7.

d. Results of Test 2 (After Six Months Training). The mean scale values for each smear, averaged over all views and all observers, are presented in Table XII.

Evidence of Reliability. The same observations can be made regarding inhomogeneities between and within dimensions that were made in previous discussions. They imply a certain degree of consistency over observers. We turn again to correlations between dimensions for objective evidence of consistency with Spearman Rank Order Correlations between all possible pairs of dimensions shown in Table XIII. In all but one case, the correlations are statistically significant.

It is also possible to obtain direct evidence of reliability by correlating the mean scale values obtained here, with those obtained in Test 1. The indices of reliability are shown in Table XIV. In a pure sense the assessments made in the two studies are not independent and the legitimacy of the measure of reliability could be questioned. For all practical purposes, however, they probably are independent, since it is very unlikely that observers, in taking

TABLE IX

MEAN SUBJECTIVE SCALE VALUES (STUDY V, Test 1)

Slide #	OPACITY	EXTRUDABILITY	EXPLOSIVENESS	LOOSENESS
		Positive Smears		
2	5.93	5.58	5.85	3.27
9	3.70	4.75	4.93	5.27
12	3.83	4.83	5.83	4.35
15	3.25	4.40	4.52	6.23
18	4.82	5.37	5.87	2.67
19	4.23	5.05	5.32	5.03
24	4.05	5.02	5.98	3.42
26	4.33	5.60	6.55	3.08
38	4.70	5.17	5.78	3.68
45	5.45	5.57	5.43	3.73
		Negative Smears		
3	5.13	5.33	5.15	4.13
4	4.57	4.17	4.87	4.35
5	3.10	4.08	3.90	6.25
7	3.53	4.85	5.88	4.08
10	4.48	4.53	4.00	5.38
11	5.65	5.50	5.82	2.52
13	5.05	5.28	4.75	4.55
14	3.85	4.52	4.67	5.07
16	6.40	6.18	5.30	2.07
20	4.30	4.66	6.00	3.12

TABLE X

SPEARMAN RANK ORDER CORRELATIONS BETWEEN DIMENSIONS (STUDY V, Test 1)
(Correlations for positive smears lie above the diagonal;
those for negative smears lie below.)

	OPACITY	EXTRUDABILITY	EXPLOSIVENESS	LOOSENESS
OPACITY	--	.88***	.44	-.71*
EXTRUDABILITY	.79**	--	.64*	-.79**
EXPLOSIVENESS	.29	.58	--	-.90***
LOOSENESS	-.53	-.78**	-.89***	--

*Significant at $p < .05$, two-tailed

**Significant at $p < .01$, two-tailed

***Significant at $p < .001$, two-tailed

TABLE XI

RELIABILITY OF MEAN SCALE READINGS BETWEEN STUDY IV AND STUDY V, Test 1.
(Spearman Rank Order Correlations)

	Positive Smears	Negative Smears
OPACITY	.81***	.10
EXTRUDABILITY	.65*	.56*
EXPLOSIVENESS	.53	.75**
LOOSENESS	.54	.90***

*Significant at $p < .05$, one-tailed

**Significant at $p < .01$, one-tailed

***Significant at $p < .001$, one-tailed

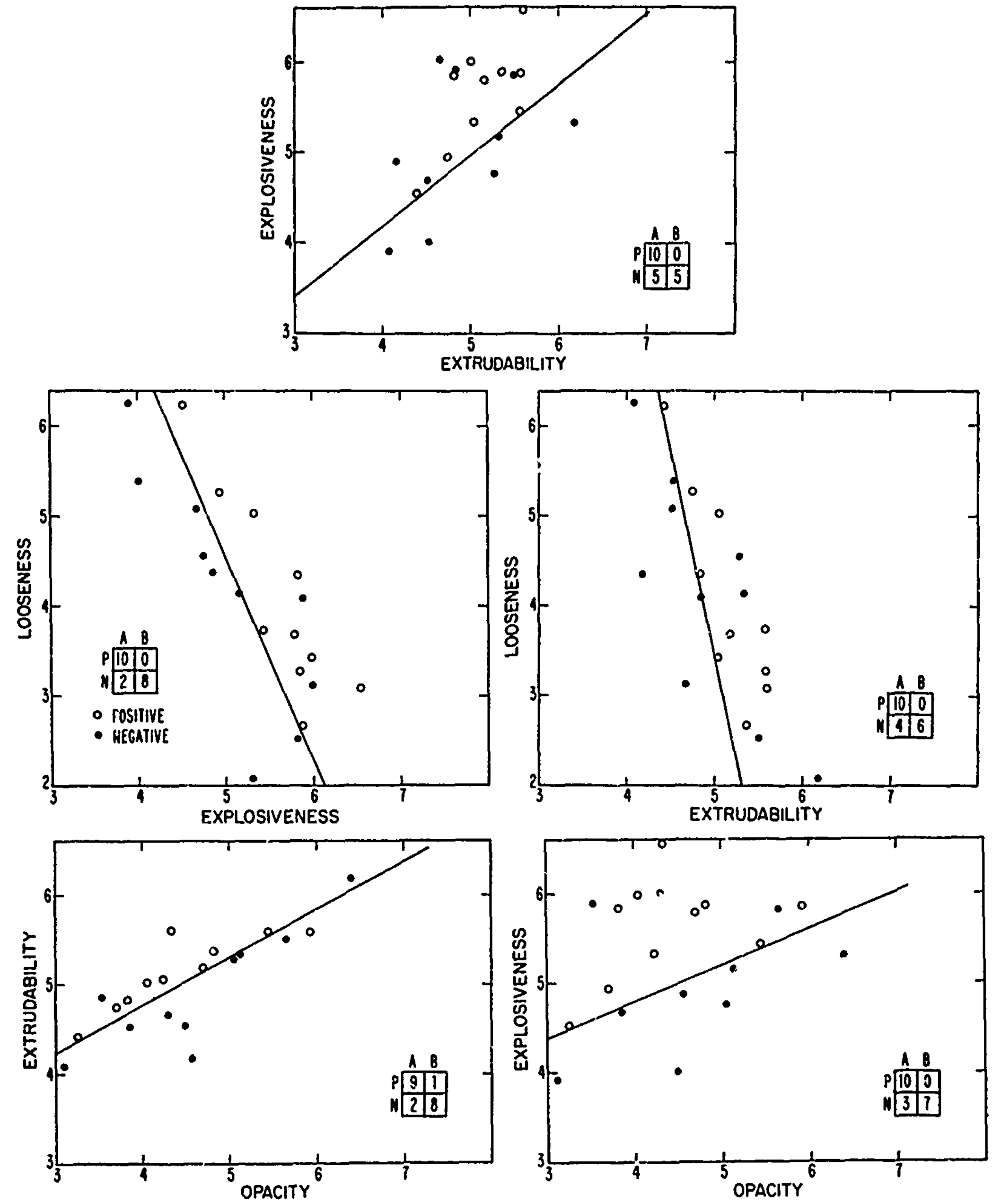

Figure 7. P tentially Useful Decision Boundaries for Identifying Suspicious Smears in Prescreening. The straight line drawn through each space partitions most of the positive from most of the negative smears. The number of positive and negative smears falling above or below the decision boundary are shown in a 2x2 table. (Study V, Test 1)

TABLE XII

MEAN SUBJECTIVE SCALE VALUES (STUDY V, Test 2)

Slide #	OPACITY	EXTRUDABILITY	EXPLOSIVENESS	LOOSENESS
		Positive Smears		
2	7.33	7.52	6.72	2.73
9	5.67	6.28	5.02	4.23
12	4.63	5.47	5.17	4.67
15	3.47	4.55	3.75	5.92
18	5.63	6.65	6.17	2.57
19	4.28	5.53	4.80	4.77
24	4.57	5.67	5.98	3.72
26	5.68	6.58	6.30	3.28
38	6.72	7.02	6.28	3.05
45	6.78	6.88	6.06	3.61
		Negative Smears		
3	6.27	6.55	5.30	4.12
4	4.32	4.40	4.74	5.27
5	4.38	5.02	3.80	5.22
7	3.46	4.62	5.35	5.07
10	3.90	3.85	3.45	6.07
11	5.60	5.90	5.80	3.47
13	4.93	5.48	4.78	5.17
14	3.50	3.72	4.08	5.83
16	7.00	7.00	5.70	2.70
20	4.17	4.93	5.47	4.65

TABLE XIII

SPEARMAN RANK ORDER CORRELATIONS BETWEEN DIMENSIONS (STUDY V, Test 2)
(Correlations for positive smears lie above the diagonal;
those for negative smears lie below.)

	OPACITY	EXTRUDABILITY	EXPLOSIVENESS	LOOSENESS
OPACITY		.92***	.82**	-.73*
EXTRUDABILITY	.91***		.86**	-.88***
EXPLOSIVENESS	.45	.65*		-.90***
LOOSENESS	-.68*	-.88***	-.92***	

*Significant at $p < .05$, two-tailed

**Significant at $p < .01$, two-tailed

***Significant at $p < .001$, two-tailed

TABLE XIV

RELIABILITY OF MEAN SCALE READINGS BETWEEN STUDY V, TEST 1 AND
STUDY V, TEST 2
(Spearman Rank Order Correlations)

	Positive Smears	Negative Smears
OPACITY	.78**	.80**
EXTRUDABILITY	.76**	.76**
EXPLOSIVENESS	.73*	.88***
LOOSENESS	.88***	.89***

*Significant at $p < .05$, one-tailed

**Significant at $p < .01$, one-tailed

***Significant at $p < .001$, one-tailed

Test 2, could remember what the smears looked like and how they assessed them in Test 1. Note, in comparing these indices with those in Table XI, that we are correlating assessments made by the same observers in Table XIV and different observers in Table XI.

Evidence of Validity. Mann-Whitney U tests were performed to determine whether there were any statistically significant differences in mean scale values between positive and negative smears. They revealed a difference in only one case where assessments of EXTRUDABILITY on positive smears are higher than on negative smears ($p < .05$, two-tailed). This variable suggests itself, therefore, as a valid discriminator of positive and negative smears.

We next sought evidence of separation in plots of the data in all possible 2-spaces. Evidence of separation was found in four cases shown in Figure 8.

Evidence of the Effects of Training. Two effects of training are evident from Wilcoxon tests of difference in distribution between the mean scale values in Test 1 and Test 2, which reveal differences in positive smears on two dimensions. After training, the same smears receive lower assessments of OPACITY and EXTRUDABILITY ($p < .001$, two-tailed, in both cases). Another effect of training is suggested in a comparison of the correlation matrix in Table XIII with that in Table X. There is a greater number of statistically significant correlations between dimensions in Study V, Test 2 than in Study V, Test 1 and in every case but one (in which there is a tie) the correlation indices are higher in Study V, Test 2 than in Study V, Test 1, suggesting that training tends to increase reliability of the assessments.

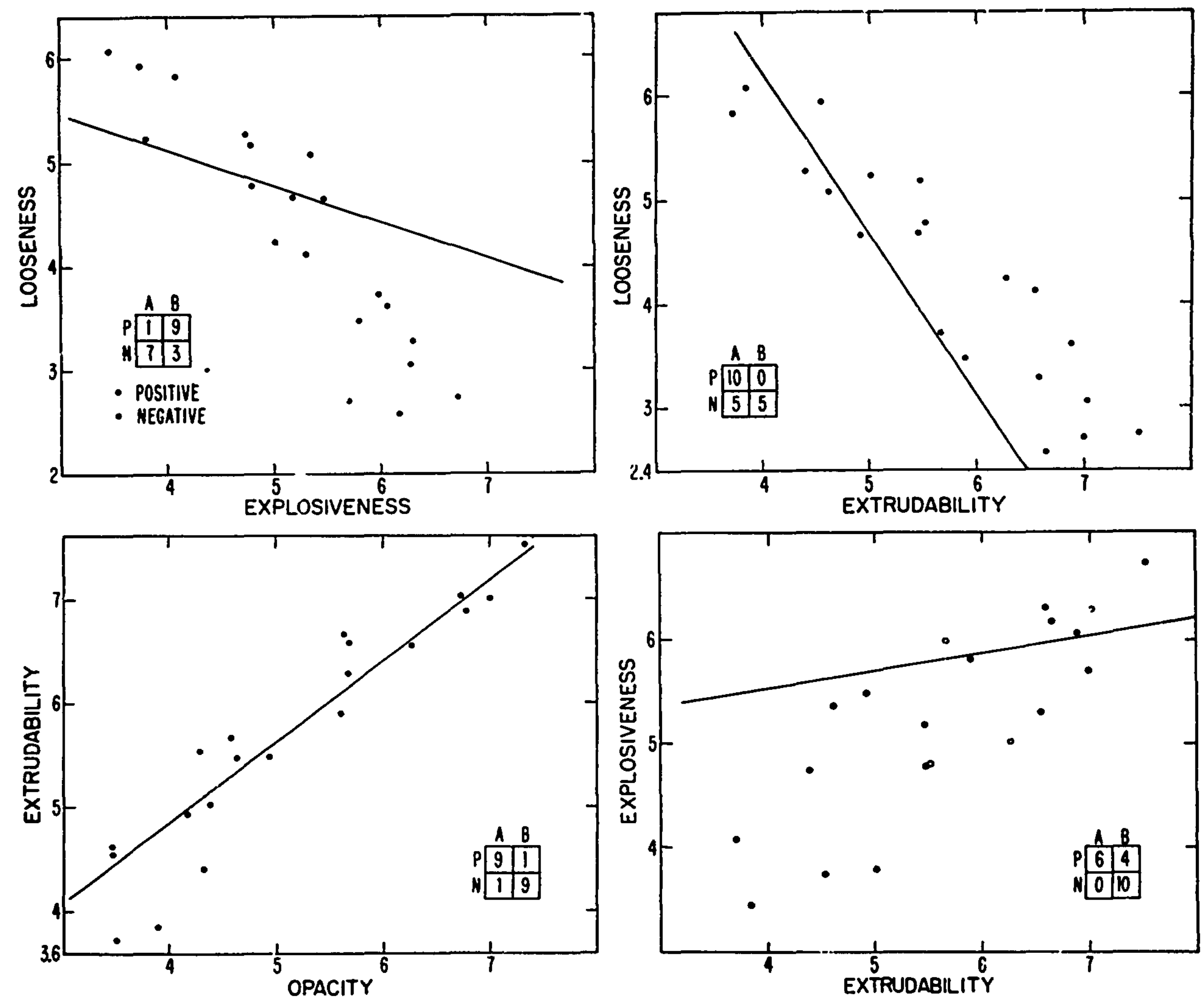

Figure 8. Potentially Useful Decision Boundaries for Identifying Suspicious Smears in Prescreening. The straight line drawn through each space partitions most of the positive from most of the negative smears. The number of positive and negative smears falling above or below the decision boundary are shown in a 2x2 table. (Study V, Test 2)

SECTION IV
SUMMARY OF RESULTS AND DISCUSSION

The most firmly established and general finding is that observers can reliably discriminate and scale variations in several qualities of the total appearance of smears seen at low microscopic power. Evidence of reliability has been presented in each study in the form of a matrix of correlations between dimensions and we give, in Table XV, a summary of the significant correlations that were found in each of those matrices. It shows that there were eight pairs of dimensions that correlated significantly in one or another study,

TABLE XV

SUMMARY OF SIGNIFICANT CORRELATIONS BETWEEN DIMENSIONS FOUND IN EACH STUDY

		Positive Smears				Negative Smears			
		III	IV	V(1)	V(2)	III	IV	V(1)	V(2)
EXPLOSIVENESS	X DIRTINESS	o	.	.	.	+	.	.	.
	X DOUGHINESS	+	.	.	.	o	.	.	.
	X LOOSENESS	-	-	-	-	-	-	-	-
	X OPACITY	.	+	o	+	.	+	o	o
	X EXTRUDABILITY	.	+	+	+	.	+	+	+
EXTRUDABILITY	X LOOSENESS	.	-	-	-	.	-	-	-
	X OPACITY	.	+	+	+	.	+	+	+
LOOSENESS	X OPACITY	.	-	-	-	.	-	o	-

+ = positive correlation   o = no significant correlation
- = negative correlation   . = no test

in either the positive or the negative smears. Two of those cases (EXPLOSIVENESS X DIRTINESS and EXPLOSIVENESS X DOUGHINESS) were only tested once, in Study III, and in each case the correlations did not occur in both the positive and the negative smears. The evidence of reliability of judging DIRTINESS and DOUGHINESS is, therefore, marginal. In the other six cases there were multiple tests, and the same direction of correlation was repeatedly found in both the positive and the negative smears. These six cases were made up of combinations of four dimensions: EXPLOSIVENESS, LOOSENESS, EXTRUDABILITY and OPACITY. We conclude that variations along those four dimensions definitely are correlated, and that observers can reliably see and scale variations along each of those dimensions. The evidence of correlations within dimensions presented in Tables XI and XIV provide additional and consistent evidence of reliability. We can see an obvious similarity of assessment across the three groups of observers, and that permits the generalization that similar assessments would be made by other similarly constituted groups of observers. We can also see similar patterns of correlations in two independent groups of smears, the 10 positive and the 10 negative, which provide a slim but clear basis for generalizing this result to all smears.

Evidence of validity was sought in each study; first with Mann-Whitney U tests of difference between positive and negative smears on individual dimensions, and second with tests of separation in 2-space. In only one of the Mann-Whitney U tests performed over the three studies was a statistically significant difference found between positive and negative smears. That difference, positive higher than negative on the EXTRUDABILITY dimension was found in Study V, part 2. In view of its probability ($p < .05$) and the total number of tests performed (18), that difference could reasonably be attributed to chance.

A summary of the tests of separation in 2-space is presented in Table XVI, with each separation coded for the form it assumed. In general, the decision boundary is drawn through the long axis of the scatter plot, and within each 2-space, then, it has roughly the same orientation from one experiment to the next, but the proportion of positives and negatives which fall above and below the line can vary. Each separation can be characterized as having the majority of positive smears above or negative smears below the decision boundary (coded 1), or vice versa (coded 2) (see Table XVI).

There were eight spaces in which separation occurred, and six of those spaces were subjected to repeated tests. To establish whether these separations might reasonably have occurred by chance, we considered first that if positive and negative smears were randomly mixed in the scatter plots, then separations of the kind we have defined would be expected to occur less often than not. We have, therefore, selected .5 as a conservative upper bound on the chance probability of separation. We also considered that if separations were a matter of chance, when they did occur they would assume one or the other form with equal probability. Our statistical analyses are based, therefore, on the following chance probabilities for the outcome of each experiment:

no separation, (0),	$p(0) = .5$
separation of form 1, (1)	$p(1) = .25$
separation of form 2, (2),	$p(2) = .25$

Based on these probabilities, separation in any individual experiment would not be significant ($p < .5$, two-tailed), but evidence of repeated separation could be significant. We proceeded therefore to determine the probability of each set of results obtained in the repeated tests. Table XVI shows, for example, that separation was found in the LOOSENESS X EXPLOSIVENESS space in three out of four experiments. There were two separations of form 1 and one of form 2. We calculated the chance probability of obtaining a sequence with at least that number of separations and with at least that proportion of more or less frequent form (consistency of separation). This was achieved by determining the combined probability of the following sets of possible results, in any order: 1111, 1112, 1110, 1120

$$p\ (1111) = .25^4 \times 1 = .0039$$

$$p\ (1112) = .25^4 \times 4 = .0156$$

$$p\ (1110) = .25^3 \times .50 \times 4 = .0312$$

$$p\ (1120) = .25^3 \times .50 \times 12 = \underline{.0937}$$

$$.1444$$

The two-tailed probability is then determined by doubling that combined probability. Thus, for a set of results with at least the number and consistency of separations found for the LOOSENESS X EXPLOSIVENESS space, the probability of chance occurrence is $p < .29$. This same method of calculation was applied to each set shown in Table XVI, and the associated probabilities are shown at the right.

We can conclude from the analysis that there is at least one space, LOOSENESS X EXTRUDABILITY, in which positive smears probably do separate from negative smears. The evidence in sum, though based on a very crude test of separation, warrants the conclusion that subjective assessments of the overall appearance can separate positive from negative smears in our small test sample. We have to be cautious, however, in generalizing that conclusion to all smears. A confident generalization would have to depend on evidence from studies employing a much larger sample of smears. The important point, however, is that observers can reliably sense and scale variations in the overall appearance of smears, and if some of those variations do relate to the presence or absence of cancer, it is simply a matter of more extensive studies of the kind reported here to identify them.

With regard to other findings from these studies, comparisons between experiments were also made to check on various effects of instructions, scaling format and training. Several findings are presented in the results sections of Experiments IV, V, Test 1 and V, Test 2. Statistically significant differences in performance between Experiments III and IV were found that were probably due to differences in instructions and scaling format. A drop in reliability between Study IV and Study V, Test 1 was interpreted as caused by a four-fold decrease in the number of assessments per smear. Greater reliability in Study V, Test 2 over Study V, Test 1, also other differences in scaling, were attributed to the effects of training.

We consider now implications of these findings for the specific problem of interpreting and screening Pap smears. Psychometric assessments of the kind we report here may help in providing more sensitive and quantitative assessments of background variations which have to be taken into account in interpreting cellular changes, perhaps also in contributing directly to the diagnosis of cancer. These techniques might also be used to generate sets of quantified visual standards of background variation systematically related to such

TABLE XVI

SUMMARY OF SEPARATIONS IN 2-SPACE FOUND IN EACH STUDY

2-Space	III	IV	V 1	V 2	
	STUDY				
DULLNESS X DIRTINESS	2	_	_	_	$p < .50$ two-tailed*
DIRTINESS X LOOSENESS	1	_	_	_	$p < .50$ " "
LOOSENESS X EXPLOSIVENESS	1	0	1	2	$p < .29$ " "
LOOSENESS X OPACITY	_	1	0	0	$p < .63$ " "
LOOSENESS X EXTRUDABILITY	_	1	1	1	$p < .04$ " "
EXTRUDABILITY X EXPLOSIVENESS	_	2	1	1	$p < .13$ " "
EXTRUDABILITY X OPACITY	_	0	1	1	$p < .25$ " "
EXPLOSIVENESS X OPACITY	_	0	1	0	$p < .63$ " "

_ = no test

0 = no separation (see text p. 17 for criteria)

1 = separation with majority of positives above or negatives below the decision boundary.

2 = separation with majority of negatives above or positives below the decision boundary.

* The two-tailed probability of obtaining a sequence with at least that number of separations and at least that proportion of more to less frequent form of separation (see text for further explanation).

variables as age, menstrual cycle, and acute infection as well as to the course of chronic diseases, which might prove helpful particularly in training cytotechnicians.

We can also consider the possible value of psychometric assessments in cytological research. Identifying variations in background qualities and in determining correlations among those variations may contribute to cytological or histological theory. Finally, we can suggest the potential role of psychometric assessments in discovering disease related optical properties in the background, subject to automated analysis. Automated analysis of background qualities might prove to be more easily achieved than automated analysis of cellular characteristics.

Our findings are also significant from a general standpoint. They show that human assessments of complex optical imagery can be discriminating, quantitative and reliable. They suggest that there may be much more information available in subjective assessments of imagery than is usually assumed. Those investigators concerned with imagery analysis are quick to acknowledge that the human observer is a most elegant pattern recognizer, but, at the same time, many would be quick to consider abandoning him for the most primitive automatic optical analyzer. There is an understandable scientific prejudice that human assessments are unreliable and insensitive, which may be true to a degree for observers who operate individually according to their own idiosyncratic procedures and internal standards. These studies illustrate, however, that observers can be programmed to follow standard perceptual operations and gauge their judgments against common standards. By pooling and averaging repeated independent assessments, we can generate sensitive and reliable data. The central question may not be whether human assessments can be sufficiently sensitive and reliable for scientific purposes, but whether we can tolerate the potentially cumbersome and costly procedures that may be required to achieve sensitivity and reliability: namely, the coordinating and pooling of assessments from a number of observers. These studies, however, show that the approach may be practical. In Study V, for example, remarkably reliable and sensitive discrimination was achieved by pooling the assessments of only 10 observers. Furthermore, each assessment on each smear took less than seven man minutes, and considering the potential for increasing the rate of display presentation and response recording by automated techniques, that time could probably be halved. These techniques, therefore, could be of value, not only in research, but in routine screening situations as well.

The studies reported in Section III lead to the conclusion that subjective assessments of texture may be of practical use in the analysis and screening of Pap smears. With similar studies of texture assessments in solar observing reported elsewhere (Pickett, 1971), they support the general conclusion that psychometric techniques may be of practical use in a wide range of imagery screening contexts. Of particular significance to the Air Force is the possibility of using subjective texture assessments in intelligence screening of aerial photographs.

APPENDIX I
CHECKLIST USED TO SURVEY DESCRIPTORS OF TEXTURE IN 100X VIEWS OF PAP SMEARS

Name:______________________________

Laboratory:________________________

Instructions:
(1) write name and laboratory on pp. 1 & 2;
(2) Place a check mark in only one of the columns for each word;
(3) Be sure to check every word;
(4) Add and classify at bottom of p. 2 any other descriptive adjectives that come to mind;
(5) Please work independently.

	Describes a visible quality which:			Does not describe a visible quality
	suggests negative	makes you suspicious	suggests positive	
Bright				
Brittle				
Calm				
Clean				
Clumped				
Cohesive				
Compact				
Consistent				
Creamy				
Crumbly				
Dirty				
Doughy				
Droopy				
Dull				
Elastic				
Enmeshed				
Explosive				
Extrudable				
Fatty				
Fibrous				
Filmy				
Firm				
Floating				
Fragile				
Gluey				
Granular				
Gummy				
Hard				
Leathery				
Loose				
Lumpy				
Lustrous				

Preceding page blank

Name:______________________________ Laboratory______________________

	Describes a visible quality which:			Does not describe a visible quality
	suggests negative	makes you suspicious	suggests positive	
Matted				
Milky				
Oily				
Opaque				
Pasty				
Pearly				
Pliable				
Puffy				
Pulpy				
Raw				
Regular				
Ropy				
Rubbery				
Shrunken				
Shiny				
Silky				
Slimy				
Slippery				
Soapy				
Soft				
Spongy				
Starchy				
Sticky				
Stiff				
Thick				
Tight				
Transparent				
Variable				
Velvety				
Waxy				

APPENDIX II

A THESAURUS OF DESCRIPTORS OF COMPLEX OPTICAL IMAGERY

1. GENERAL DESCRIPTION AND SUGGESTED APPLICATIONS.

Presented below is a word list of potential use in surveying and enhancing the descriptive vocabulary of workers who screen complex optical imagery. The list consists of 1707 entries (1058 different words) organized under 177 subheadings and 130 major headings keyed to Roget's Thesaurus (The Original Roget's Thesaurus of English Words and Phrases, St. Martins Press, New York, 1965). It provides a comprehensive list that should be helpful in assembling checklists for surveys of specialized visual description such as those reported in Section II. The researcher can feel confident that in scanning this list he has been reminded of a very broad range of potential visual description without having to carry out a systematic survey of a standard dictionary or thesaurus.

The list is presented in two forms: one with the 1058 base words presented in alphabetical order; the other with the 177 subheadings presented in alphabetical order. With the first form, one or two descriptors which may come to mind in scanning samples of complex imagery can be looked up to determine the subheadings under which they occur in the second form. By examining the word families listed under those subheadings, the viewer may then discover descriptors which more sharply capture the sensed visual qualities than the words that first came to mind. Scrutiny of the word families may also reveal gradations of meaning that suggest a basis for scaling the imagery along qualitative dimensions; and inter-family comparisons may suggest frameworks for multidimensional scaling.

2. SPECIFIC DESCRIPTION AND METHOD OF PREPARATION.

This specialized thesaurus was prepared because it became obvious at the start of the work reported in Section I that a systematic approach to selection of words for the checklist was required. The problem was to assure that the checklist was efficient in the sense of including mostly relevant descriptors, and comprehensive in not leaving many out. Our first effort was an attempt to assemble a master list of all adjectives of visual description from which one could abstract most of the potentially relevant descriptors for any particular problem of visual description that came along. The criteria for including a word in that master list were that it describe any directly visible quality of an object or batch of material, e.g., mottled or marbled; or any quality of a substantive or structural nature which might be inferred from its appearance, e.g., flexible from its wrinkled or droopy appearance, or brittle from its fragmented appearance. Beginning with a list of all adjectives we could recall that fit the criteria, we continued with a systematic scan of relevant sections of Roget's Thesaurus for all words we could recognize that fit the criteria. At this stage it became apparent that the task was unmanageable, first, for the sheer number of words that had to be examined in the obviously relevant broad categories in Roget's Thesaurus, and second, because there was no logical basis for identifying all of the less obviously relevant narrow categories which we kept discovering. At this point we stopped the process to devise a more manageable approach.

In our revised approach, we searched in two stages, using two thesauruses. In the first stage, we scanned March's Thesaurus (March's Thesaurus and Dictionary of the English Language, Doubleday, New York, 1968), to make a fine-grained identification of all relevant categories. In the second stage, we returned to Roget's Thesaurus, this time equipped with a manageable but comprehensive scheme. March's Thesaurus is suited to a systematic screening for all relevant categories because it is not hierarchically organized. It is basically a dictionary, but at frequent intervals in the alphabetic listing it treats a word as a reference word, organizing under it, as in Roget's Thesaurus, a family of related words. Because of this non-hierarchical arrangement, March's Thesaurus permits making a systematic scan. One can go through it from A to Z, looking not at every word, but at least at every reference word. Under every reference word is a small clearly segregated list of related adjectives, so that, at a glance, one can tell whether words in that narrow category fit the criteria for visual descriptors.

Our systematic scan of March's Thesaurus yielded 146 narrow categories of visual description (See Table XVII). At this point we listed all the adjectives in March's Thesaurus found under those categories that fitted our criteria. We then combined that list with the partial list we had already assembled by the first procedure. That combined interim list was then subjected to some editing. We decided to focus primarily on descriptors of masses of visible material as opposed to descriptors of particular objects or specific visual patterns; to exclude, e.g., specific descriptors like square, circular and octagonal, and to retain general descriptors, e.g., angular, curly, and bumpy. Some specific descriptors may still appear in the list, but generally we sought adjectives for mass nouns. We also decided to exclude most of the words for colors, and words for describing dynamic qualities, e.g., churning, scintillating. When edited, the combined interim list totaled 514 words.

In the next stage, we looked up in Roget's Thesaurus each of the 514 words in the interim list, and scanned the paragraphs of adjectives in which they occurred, looking for other adjectives that fit our criteria. The original look-up word from the interim list (identified by an asterisk) plus any other words we found in that paragraph were then entered in column 1 of the master list. The initial italicized word in the paragraph in which each entry was found serves as that entry's subheading, and is listed across from it in column 2. The number of the heading under which the paragraph appears serves as the major heading for each entry and is listed across from it in column 3.

TABLE XVII
LIST OF VISUALLY RELEVANT REFERENCE WORDS
FROM MARCH'S THESAURUS

ACTION-PASSIVENESS
ACTIVITY-INDOLENCE
ADDITION-SUBTRACTION
ADMISSION-EXCLUSION
ADMISSION-EXPULSION
ADVANCE-RETROGRESSION
AGITATION
ANGULARITY
AIM-ABERRATION
ANTERIORITY-POSTERITY
APERTURE-CLOSURE
ARCHITECTURE
ATTRACTION-REPULSION
BEAUTY-UGLINESS
BETTERMENT-DETERIORATION
BLUENESS-ORANGE
BORDER
BOUNDARY
BREADTH-NARROWNESS
CACOPHONY
CIRCLE-WINDING
CIRCUITION
CLEANLINESS-FILTHINESS
CLEARNESS-OBSCURITY
COHESION-LOOSENESS
COLOR-ACHROMATISM
COMPOSITION-RESOLUTION
CONCENTRATION-RADIATION
CONFINEMENT
CONNECTION-INDEPENDENCE
CONTENTS-RECEIVER
CONTINUITY-INTERRUPTION
CONVEXITY-CONCAVITY
COVER-LINING
CRASH-DRUMMING
CROSSING
CURVATION-RECTILINEARITY
DAMPNESS-DRYNESS
DIAPHANEITY-OPALESCENCE
DIAPHANEITY-OPAQUENESS
DIMNESS
DRESS-UNDRESS
ELASTICITY-INELASTICITY
ELEVATION-DEPRESSION
EMBELLISHMENT-DISFIGUREMENT
ENLARGEMENT-DIMINUTION
ENTIRETY-DEFICIENCY
ERECTNESS-FLATNESS
EXCESS-LACK
EXCITABILITY-INEXCITABILITY
EXCITATION
FAULTLESSNESS-FAULTINESS
FEELING-INSENSIBILITY
FORM-FORMLESSNESS
FRIABILITY
FRICTION-LUBRICATION
GATHERING-SCATTERING
GRAY-BROWN
GREATNESS-LITTLENESS
GROOVE
HARDNESS-SOFTNESS
HARSHNESS-MILDNESS
HEAVINESS-LIGHTNESS
HURRY-LEISURE
IMPETUS-REACTION
INCLUSION-OMISSION
INCREASE-DECREASE
INCREMENT-REMNANT
INDENTATION
INFANCY-AGE
INJECTION-EJECTION
INSTRUMENT
INSTRUMENTALITY
INTERSPACE-CONTACT
KEEPING-RELINQUISHMENT
LAMINA-FIBER
LASTING-TRANSIENTNESS
LATERALITY-CONTRAPOSITION
LEADING-FOLLOWING
LENGTH-SHORTNESS
LEVELNESS
LIGHT-DARKNESS
LIQUEFACTION-VOLATILIZATION
LIQUID-GAS
LUMINARY-SHADE
MAGNITUDE-SMALLNESS
MANIFESTATION-LATENCY
MIDDLE
MINERALOGY
MIXTURE-HOMOGENEITY
MOVEMENT-REST
MULTIPLICITY-PAUCITY
MUTABILITY-STABILITY
MUTATION-PERMANENCE
NEED
NUMBER

NUMBERING
OBSTRUCTION-HELP
ORGANIZATION-DISORGANIZATION
OUTLINE
OUTSIDE-INSIDE
PARALLELISM-INCLINATION
PERIODICITY-IRREGULARITY
PLICATURE
PRECEDENCE-SUCCESSION
PREPARATION-NONPREPARATION
PROPORTION-DEFORMITY
PROVISION-WASTE
PULPINESS-OILINESS
PULPINESS-ROSIN
PURITY-CRUDENESS
PUSH-PULL
RECURRENCE
REDNESS-GREENNESS
REFUGE-PITFALL
REGULARITY-IRREGULARITY
REMOTENESS-NEARNESS
REVERSAL
RIVER-WIND
ROUNDNESS
SAMENESS-CONTRAST
SCULPTURE
SHARPNESS-BLUNTNESS
SMOOTHNESS-ROUGHNESS
SOLIDITY-RARITY
STRENGTH-WEAKNESS
SUPREMACY-SUBORDINACY
SUSPENSION-SUPPORT
SWIFTNESS-SLOWNESS
TEXTURE
TOUGHNESS-BRITTLENESS
TURBULENCE-CALM
UNIFORMITY-DIVERSITY
UNIFORMITY-MULTIFORMITY
UNION-DISUNION
USEFULNESS-USELESSNESS
VARIATION
VIBRATION
VARIEGATION
VIGOR-INERTIA
VISCIDITY-FOAM
VISIBILITY-INVISIBILITY
WATER-AIR
WHITENESS-BLACKNESS
WHOLE-PART
YELLOWNESS-PURPLE

3. THESAURUS WITH BASE WORDS ARRANGED ALPHABETICALLY

ABLAZE		LUMINOUS	417	BALLED		ROTUND	252
ACUTE		SHARP	256	BALLED-UP		CROSSED	222
ADAPTABLE		FLEXIBLE	327	BALLOONING		CONVEX	253
ADHESIVE	*	COHESIVE	48	BANDED		MOTTLED	437
ADHESIVE	*	RETENTIVE	778	BARBED		SHARP	256
ADHESIVE	*	TOUGH	329	BARE	*	DRY	342
ADHESIVE	*	VISCID	354	BARE	*	PLAIN	573
ADJUSTABLE		CONFORMABLE	83	BARE	*	SIMPLE	44
ADULTERATED		MIXED	43	BARE	*	UNCOVERED	229
AERATED		BUBBLY	355	BARE		WEAKENED	163
AERIFIED		RARE	325	BARRED		CROSSED	222
AFLAME		LUMINOUS	417	BARRED		MOTTLED	437
AGLOW		LUMINOUS	417	BASTED		UNCTUOUS	357
AIR-PROOF		SEALED-OFF	264	BATED		UNSHARPENED	257
AIR-TIGHT		SEALED-OFF	264	BEADLIKE		ROTUND	252
AIRLESS		TRANQUIL	266	BEADY		ROTUND	252
AIRY		GASEOUS	336	BEAMING		LUMINOUS	417
AIRY		INSUBSTANTIA	4	BECLOUDED		UNLIT	418
AIRY		LIGHT	323	BEDDED		LAYERED	207
AIRY		WINDY	352	BEDRAGGLED		DIRTY	649
ALBINO		COLORLESS	426	BEECHY		ARBOREAL	366
ALIGNED		UNIFORM	16	BEEFY	*	FLESHY	195
ALLOYED		MIXED	43	BEFOGGED		UNLIT	418
ALLUVIAL		TERRITORIAL	344	BEGRIMED		DIRTY	649
ALTERABLE		UNSTABLE	152	BELLIED		CELLULAR	194
AMORPHOUS		DISTORTED	246	BELLYING		CONVEX	253
AMORPHOUS		FLUIDAL	335	BENDABLE		SOFT	327
AMORPHOUS		NON-UNIFORM	17	BICOLOR	*	VARIEGATED	437
ANHYDROUS		DRY	342	BILLOWING		CONVEX	253
ARCHED		ARCUATE	253	BILLOWY		CONVEX	253
ARCHED		CONCAVE	255	BITUMINOUS		RESINOUS	357
ARERATED		RARE	325	BLACK	*	DIRTY	649
ARID		DRY	342	BLACK		SOFT-HUED	425
ARMORED		HARD	326	BLADDER-LIKE		EXPANDED	197
ARMORED		INVULNERABLE	660	BLANK		CLEAN	648
ARROWY		SHARP	256	BLANK		COLORLESS	426
ASHEN	*	COLORLESS	426	BLANK		INSUBSTANTIA	4
ASHEN	*	GRAY	429	BLANK		OPAQUE	423
ASHEN-HUED		COLORLESS	426	BLEACHED		COLORLESS	426
ASHY	*	COLORLESS	426	BLEACHED		DRY	342
ASHY	*	GRAY	429	BLEARY		DIM	419
ASKEW		DISTORTED	246	BLEMISHED		DEFORMED	246
ASPHALTIC		RESINOUS	357	BLEMISHED		INCOMPLETE	55
ASSORTED		UNIFORM	16	BLEMISHED		MOTTLED	437
AWRY		ORDERLESS	61	BLENDED		MIXED	43
BAGGY		RECEPIENT	194	BLINDING		LUMINOUS	417
BAGGY		SPACIOUS	183	BLISTERED		ROUGH	259
BAKED		DRY	342	BLISTERY		CONVEX	253
BAKED		HEATED	381	BLOATED		CONVEX	253
BALD		HAIRLESS	229	BLOATED		DEFORMED	246

BLOATED		EXPANDED	197	BULBOUS		EXPANDED	197
BLUFF		UNSHARPENED	257	BUMPY	*	DISCONTINUOU	72
BLUNT		UNSHARPENED	257	BUMPY	*	NON-UNIFORM	17
BLUNT-NOSED		UNSHARPENED	257	BUMPY	*	ROUGH	259
BLUNTED		UNSHARPENED	257	BUOYANT		LIGHT	323
BLURRED	*	AMORPHOUS	244	BURNED		DRY	342
BLURRED	*	DIM	419	BURNED		HEATED	381
BLURRY		SHADOWY	419	BURNISHED		UNDIMMED	417
BLUSHING		LUMINOUS	417	BUSHY		ARBOREAL	366
BOB-TAILED		INCOMPLETE	55	BUSHY		DENSE	324
BOGGY		MARSHY	347	BUSHY		VEGETAL	366
BOMB-PROOF		INVULNERABLE	660	BUTTERY		FATTY	357
BOMB-PROOF		UNYIELDING	162	CAKED		DIRTY	649
BONY		HARD	326	CALLOUS		HARD	326
BORED		PERFORATED	263	CALLOUSED		HARD	326
BOWED		ARCUATE	253	CAMBERED		ARCUATE	253
BRAMBLY		SHARP	256	CAMERATED		CELLULAR	194
BRANCHING		SPACIOUS	183	CANALLED		FURROWED	262
BRANCHING		UNASSEMBLED	75	CANESCENT		GRAY	429
BRANDED		HEATED	381	CARIOUS		UNCLEAN	649
BRANNY		POWDERY	332	CARTILAGINOU		HARD	326
BREAKABLE		BRITTLE	330	CAST-IRON		HARD	326
BRIERY	*	SHARP	256	CAVERNOUS		CONCAVE	255
BRIGHT	*	CLEAN	648	CELLULAR	*	CELLULAR	194
BRIGHT		COLORED	425	CELLULAR	*	CONCAVE	255
BRIGHT	*	FLORID	425	CEMENTED		FIRM-SET	45
BRIGHT	*	LUMINESCENT	420	CHALKY		TERRITORIAL	344
BRIGHT	*	LUMINOUS	417	CHAMELEON		IRIDESCENT	437
BRIGHT	*	UNDIMMED	417	CHANGEABLE		TRANSIENT	114
BRILLIANT		COLORED	425	CHANGEFUL		TRANSIENT	114
BRILLIANT		FLORID	425	CHANNELED		FURROWED	262
BRILLIANT		LUMINOUS	417	CHARRED		HEATED	381
BRINDED		MOTTLED	437	CHECKERED		PIED	437
BRINDLED	*	MOTTLED	437	CHILLY		COLD	380
BRISTLING		SHARP	256	CHUNKY		FLESHY	195
BRISTLY	*	HAIRY	259	CLAMMY		COHESIVE	48
BRISTLY	*	SHARP	256	CLAMMY	*	VISCID	354
BRITTLE	*	BRITTLE	330	CLARIFIED		UNMIXED	44
BRITTLE		FLIMSY	163	CLAYEY		TERRITORIAL	344
BRITTLE		INSUBSTANTIA	4	CLEAN		PLAIN	573
BRITTLE		POWDERY	332	CLEAN	*	UNMIXED	44
BROKEN		DISCONTINUOU	72	CLEANED		CLEAN	648
BROKEN	*	ROUGH	259	CLEAR	*	ORDERLY	60
BROKEN		WEAKENED	163	CLEAR	*	PERSPICUOUS	567
BROWN	*	DRY	342	CLEAR	*	TRANSPARENT	422
BROWNED		UNCOOKED	670	CLEAR	*	UNDIMMED	417
BUBBLING		BUBBLY	355	CLEAR	*	UNMIXED	44
BUBBLY		AIRY	340	CLEAR	*	WELL-SEEN	443
BUCKLED	*	CONVOLUTED	251	CLEFT		SPACED	201
BUCKLED		DISTORTED	246	CLINGING	*	COHESIVE	48

CLINGING		RETENTIVE	778	COLORLESS	*	COLORLESS	426
CLINGING	*	TOUGH	329	COLORLESS	*	DIM	419
CLOSE		COHESIVE	48	COLORLESS	*	DULL	840
CLOSE		DENSE	324	COLORLESS		INSUBSTANTIA	4
CLOSE		FIRM-SET	45	COLORLESS	*	WEAK	163
CLOSE-FITTIN		ADJUSTED	24	COLUMNAR		ROTUND	252
CLOSE-PACKED		DENSE	324	COMBLIKE		SHARP	256
CLOSE-SET		FIRM-SET	45	COMPACT		COHESIVE	48
CLOSE-TEXTUR		DENSE	324	COMPACT		DENSE	324
CLOSE-WOVEN		TEXTURAL	331	COMPARTMENTA		CELLULAR	194
CLOSE-WOVEN		TOUGH	329	COMPLICATED		COMPLEX	61
CLOSED		CONTRACTED	198	COMPOSITE		MIXED	43
CLOTTED	*	DENSE	324	COMPRESSED		CONTRACTED	198
CLOTTED	*	DIRTY	649	COMPRESSIBLE		CONTRACTED	198
CLOTTED	*	SEMILIQUID	354	COMPRESSIBLE		RARE	325
CLOUDED		OPAQUE	423	COMPRESSIBLE		SOFT	327
CLOUDLESS		UNDIMMED	417	COMPRESSIVE		CONTRACTED	198
CLOUDY	*	CLOUDY	355	CONCRETE		COHESIVE	48
CLOUDY	*	DIM	419	CONCRETE		DENSE	324
CLOUDY	*	HUMID	341	CONCRETE		HARD	326
CLOUDY	*	IMPERSPICUOU	568	CONCRETE		MATERIAL	319
CLOUDY	*	MOTTLED	437	CONDENSED		CONTRACTED	198
CLOUDY	*	OPAQUE	423	CONDENSED		DENSE	324
CLOUDY	*	SEMITRANSPAR	424	CONFORMABLE		REGULAR	81
CLOUDY	*	UNLIT	418	CONFORMING		CONFORMABLE	83
CLOVEN		SPACED	201	CONSISTENT		UNIFORM	16
COAGULATE		COHESIVE	48	CONSPICUOUS		WELL-SEEN	443
COARSE	*	ROUGH	259	CONTORTED		CONVOLUTED	251
COARSE	*	TEXTURAL	331	CONTRACTIBLE		CONTRACTED	198
COARSE	*	UNCLEAN	649	CONTRACTILE		CONTRACTED	198
COARSE-GRAIN		ROUGH	259	CONVEX		CELLULAR	194
COARSE-GRAIN		TEXTURAL	331	CONVEX		EXPANDED	197
COATED		OPAQUE	423	CONVOLUTED		FIBROUS	208
COBWEBBY		DIRTY	649	COOL		COLD	380
COGGED		TOOTHED	256	COOL		GRAY	429
COHESIVE	*	COHESIVE	48	COPSY		ARBOREAL	366
COHESIVE	*	FIRM-SET	45	CORIACEOUS		TOUGH	329
COHESIVE		RETENTIVE	778	CORNEOUS		HARD	326
COHESIVE		TOUGH	329	CORRUGATED	*	ROUGH	259
COHESIVE		VISCID	354	CORRUGATED	*	UNDULATORY	251
COILED		COMPLEX	61	COTTONY		FIBROUS	208
COLLIED		DIRTY	649	CRACKED	*	BLEMISHED	845
COLLOIDAL		SEMILIQUID	354	CRACKED	*	DILAPIDATED	655
COLORED	*	COLORED	425	CRACKED		IMPERFECT	647
COLORED		LUMINOUS	417	CRACKED	*	SPACED	201
COLORFUL	*	COLORED	425	CRAGGY		DIFFICULT	700
COLORFUL	*	FLORID	425	CRAGGY	*	ROUGH	259
COLORFUL	*	LUMINESCENT	420	CRAGGY	*	SHARP	256
COLORFUL	*	LUMINOUS	417	CREAMY	*	FATTY	357
COLORFUL	*	VARIEGATED	437	CREAMY	*	SEMILIQUID	354

CREAMY	*	SOFT-HUED	425
CREASED		FOLDED	261
CREASY		FOLDED	261
CRENATE		NOTCHED	260
CRIMPED		UNDULATORY	251
CRINKLED		ANGULAR	247
CRINKLY		UNDULATORY	251
CRISP		BRITTLE	330
CRISS-CROSS		CROSSED	222
CROSS-GRAINE		ROUGH	259
CROSSED		TEXTURAL	331
CRUMBLED		POWDERY	332
CRUMBLING		POWDERY	332
CRUMBLING		WEAKENED	163
CRUMBLY		BRITTLE	330
CRUMBLY		POWDERY	332
CRUMPLED		CONVOLUTED	251
CRUMPLED		FOLDED	261
CRUSHED		FOLDED	261
CRYSTAL		TRANSPARENT	422
CRYSTALLINE	*	DENSE	324
CRYSTALLINE	*	HARD	326
CRYSTALLINE	*	SYMMETRICAL	245
CRYSTALLINE	*	TRANSPARENT	422
CRYSTALLIZED		DENSE	324
CURDLED		SEMILIQUID	354
CURLY	*	HAIRY	259
CURLY	*	UNDULATORY	251
CUSHIONY		SOFT	327
CUSPED		SHARP	256
DAINTY		LITTLE	196
DAINTY		SMALL	33
DAMAGED		BLEMISHED	845
DAMP		HUMID	341
DAMP-PROOF		DRY	342
DAMP-PROOF		UNYIELDING	162
DANGLING		NON-ADHESIVE	49
DANGLING		PENDENT	217
DANK		HUMID	341
DAPPLED		MIXED	43
DAPPLED		PIED	437
DARK	*	DARK	418
DARK	*	IMPERSPICUOU	568
DARK	*	INVISIBLE	444
DARK		SOFT-HUED	425
DARKISH		DIM	419
DAZZLING		LUMINOUS	417
DECAYED		ANTIQUATED	127
DECAYING		WEAKENED	163
DECKED		LAYERED	207
DECOLORED		COLORLESS	426
DECOMPOSED		NON-ADHESIVE	49
DEEP		FLORID	425
DEEP-COLORED		COLORED	425
DEEP-COLORED		FLORID	425
DEFECTIVE		DEFORMED	246
DEFICIENT		INCOMPLETE	55
DEFICIENT		INSUFFICIENT	636
DEFICIENT		UNEQUIPPED	670
DEFINITE	*	PERSPICUOUS	567
DEFINITE	*	WELL-SEEN	443
DEFLATED		CONTRACTED	198
DEFLATED		WEAKENED	163
DEHYDRATED		DRY	342
DELICATE		BRITTLE	330
DELICATE		FLIMSY	163
DELICATE		SOFT-HUED	425
DELICATE		TEXTURAL	331
DENSE	*	DENSE	324
DENSE	*	FIRM-SET	45
DENSE	*	UNYIELDING	162
DENTATE	*	NOTCHED	260
DEPRESSED		CONCAVE	255
DESICCATED		DRY	342
DETECTABLE		VISIBLE	443
DETERIORATED		BLEMISHED	845
DETERIORATED		CONTRACTED	198
DETERIORATED		INCOMPLETE	55
DEWY	*	CLEAN	648
DEWY	*	HUMID	341
DIAPHANOUS		UNDIMMED	417
DILAPIDATED		BRITTLE	330
DIM		COLORLESS	426
DIM		OPAQUE	423
DIMMED		UNLIT	418
DINGY	*	COLORLESS	426
DINGY	*	DARK	418
DINGY	*	DIM	419
DINGY	*	DIRTY	649
DINGY	*	SOFT-HUED	425
DIRT-FREE		CLEAN	648
DIRTY		BLEMISHED	845
DIRTY		BUBBLY	355
DIRTY		DIM	419
DIRTY	*	DIRTY	649
DIRTY		MARSHY	347
DIRTY	*	OPAQUE	423
DIRTY		POWDERY	332
DISCOLORED		COLORLESS	426
DISINFECTED		CLEAN	648

DISSOLUBLE		LIQUIFIED	337	DUN	*	DIM	419
DISTENDED		EXPANDED	197	DUNGY		UNCLEAN	649
DISTINCT		WELL-SEEN	443	DUSKY		DIM	419
DISTORTED		UNEQUAL	29	DUST-COVERED		POWDERY	332
DISTORTED		UNSIGHTLY	842	DUSTY	*	DIRTY	649
DISTORTED		WEAKENED	163	DUSTY	*	DRY	342
DOG-EARED		DILAPIDATED	655	DUSTY	*	MOTTLED	437
DOG-EARED		FOLDED	261	DUSTY	*	POWDERY	332
DOG-EARED		USED	673	DUSTY	*	SOFT-HUED	425
DOUGHY		LIGHT	323	DYED		COLORED	425
DOUGHY		SOFT	327	EDDYING		FLOWING	350
DOWNY	*	DOWNY	259	EDGED		SHARP	256
DOWNY	*	FIBROUS	208	EDGELESS		UNSHARPENED	257
DOWNY		HAIRY	259	EEL-LIKE		SNAKY	251
DOWNY	*	SMOOTH	258	EFFERVESCENT		BUBBLY	355
DOWNY	*	SOFT	327	EFFERVESCENT		WATERY	339
DRAB	*	DILAPIDATED	655	EFFULGENT		LUMINOUS	417
DRAB	*	DULL	840	EGGSHELL		BRITTLE	330
DRAB	*	SOFT-HUED	425	ELASTIC		RARE	325
DRAB	*	UNIFORM	16	ELASTIC		SOFT	327
DRAINED		DRY	342	ELEMENTAL		SIMPLE	44
DRAWN		CONTRACTED	198	ELONGATED		LONG	203
DREGGY		DIRTY	649	EMBOSSED		SALIENT	254
DREGGY		MARSHY	347	EMBRYONIC		EXIGUOUS	196
DRENCHED		FULL	54	EMPTY		INSUBSTANTIA	4
DRIBBLING		HUMID	341	EMULSIVE	*	SEMILIQUID	354
DRIBBLING		SMALL	33	ENAMELED		ORNAMENTED	844
DRILLED		PERFORATED	263	ENAMELED		SMOOTH	258
DRILLED		UNIFORM	16	ENTANGLED	*	COMPLEX	61
DRIPPING		FLOWING	350	EQUILATERAL		EQUAL	28
DRIPPING		HUMID	341	EQUILATERAL		UNIFORM	16
DRIZZLING		HUMID	341	ESTENSILE		FLEXIBLE	327
DRIZZLY		HUMID	341	ETHEREAL		GASEOUS	336
DROOPING		PENDENT	217	EVAPORABLE		VAPORIFIC	338
DROOPING		WEAK	163	EVAPORATED		DRY	342
DROPPING		FLOWING	350	EVEN		FLAT	216
DROUGHTY		DRY	342	EVEN	*	SMOOTH	258
DROWNED		DRENCHED	341	EVEN	*	STRAIGHT	249
DRUMLY		OPAQUE	423	EVERGREEN		UNYIELDING	162
DRY	*	DRY	342	EVERGREEN		VEGETAL	366
DRY	*	HOT	379	EXPANDED		CONVEX	253
DRY	*	NON-ADHESIVE	49	EXPANDING		EXPANDED	197
DRY	*	UNPRODUCTIVE	172	EXTENDED		LONG	203
DRY		WEAK	163	EXTENSIVE		LONG	203
DUCTILE		FLEXIBLE	327	EYE-CATCHING		WELL-SEEN	443
DULL	*	COLORLESS	426	FADED	*	COLORLESS	426
DULL	*	DIM	419	FADED		DIM	419
DULL	*	GRAY	429	FADED		DRY	342
DULL	*	SOFT-HUED	425	FADED	*	SOFT-HUED	425
DULL		UNSHARPENED	257	FADING		COLORLESS	426

FADING		TRANSIENT	114		FLABBY		WEAK	163
FAINT		DIM	419		FLACCID		SOFT	327
FAINT	*	INCONSIDERAB	33		FLACCID		WEAK	163
FAIR	*	UNDIMMED	417		FLAGELLIFORM		FIBROUS	208
FANGED		TOOTHED	256		FLAKY		BRITTLE	330
FAST		FIRM-SET	45		FLAKY		LAYERED	207
FAST		TIED	45		FLAMING		LUMINOUS	417
FAT		FATTY	357		FLAPPING		NON-ADHESIVE	49
FAT		FLESHY	195		FLARING		FLORID	425
FEATHERY	*	DOWNY	259		FLARING		LUMINOUS	417
FEATHERY		HAIRY	259		FLASHING		LUMINOUS	417
FEATHERY	*	LIGHT	323		FLASHY		FLORID	425
FEATURELESS		INSUBSTANTIA	4		FLAT		SMOOTH	258
FECAL		UNCLEAN	649		FLAT		SOFT-HUED	425
FENNY		HUMID	341		FLAT		UNIFORM	16
FENNY		MARSHY	347		FLAT		UNSHARPENED	257
FERRO-CONCRE		HARD	326		FLATTENED		UNSHARPENED	257
FESTERING		UNCLEAN	649		FLAUNTING		FLORID	425
FETID		UNCLEAN	649		FLAWED		BLEMISHED	845
FIBROUS		TOUGH	329		FLAWLESS		PERFECT	646
FIERY		LUMINOUS	417		FLEECY		FIBROUS	208
FILAMENTOUS		FIBROUS	208		FLEECY		HAIRY	259
FILMY	*	DIM	419		FLEECY		SMOOTH	258
FILMY	*	LAYERED	207		FLEECY		SOFT	327
FILMY	*	OPAQUE	423		FLESHY		CONVEX	253
FILMY	*	TEXTURAL	331		FLESHY		EXPANDED	197
FILTHY		DIRTY	649		FLESHY	*	FATTY	357
FINE	*	DRY	342		FLESHY	*	FLESHY	195
FINE	*	RARE	325		FLESHY	*	PULPY	356
FINE	*	TEXTURAL	331		FLEXIBLE		CONFORMABLE	83
FINE	*	TRANSPARENT	422		FLEXIBLE	*	FLEXIBLE	327
FINE-GRAINED		TEXTURAL	331		FLIMSY	*	BRITTLE	330
FINE-SPUN		FIBROUS	208		FLIMSY	*	RARE	325
FINE-SPUN		TEXTURAL	331		FLINTY		HARD	326
FINE-WOVEN		TEXTURAL	331		FLOCCULENT	*	POWDERY	332
FIRE-PROOF		INVULNERABLE	660		FLOCCULENT	*	SOFT	327
FIRE-PROOF		UNYIELDING	162		FLOOD-LIT		LUMINOUS	417
FIRM	*	DENSE	324		FLOPPING		NON-ADHESIVE	49
FIRM	*	FIRM-SET	45		FLOPPY		NON-ADHESIVE	49
FIRM	*	FIXED	153		FLOPPY		SOFT	327
FIRM	*	HARD	326		FLOPPY		WEAK	163
FIRM		RETENTIVE	778		FLORAL		VEGETAL	366
FIRM		RIGID	326		FLORID	*	FLORID	425
FIRM-PACKED		DENSE	324		FLORID		VARIEGATED	437
FIRM-PACKED		RIGID	326		FLOURY	*	POWDERY	332
FIRM-SET		RIGID	326		FLOWERY		VEGETAL	366
FIXED		FIRM-SET	45		FLOWING		FLUIDAL	335
FIZZY		BUBBLY	355		FLOWING		UNSTABLE	152
FLABBY	*	PULPY	356		FLUENT		FLUIDAL	335
FLABBY	*	SOFT	327		FLUFFY		HAIRY	259

FLUID	*	AMORPHOUS	244
FLUID	*	FLOWING	350
FLUID		NON-ADHESIVE	49
FLUID	*	UNSTABLE	152
FLUIDAL		SOFT	327
FLUORESCENT	*	LUMINESCENT	420
FLUSH		FLAT	216
FLUSH		SMOOTH	258
FLUSH		UNIFORM	16
FLUTED		FURROWED	262
FOAMY	*	BUBBLY	355
FOAMY	*	LIGHT	323
FOGGY		DIM	419
FOGGY		OPAQUE	423
FOLDED		CONVOLUTED	251
FOLDED		FURROWED	262
FOLIATE		LAYERED	207
FOLIATED		LAYERED	207
FORESTAL		ARBOREAL	366
FORESTED		ARBOREAL	366
FORKED		ANGULAR	247
FORKED		CROSSED	222
FORMLESS	*	AMORPHOUS	244
FOSSILIZED		HARD	326
FOUL		UNCLEAN	649
FRAGILE		BRITTLE	330
FRAGILE		FLIMSY	163
FRAGILE		INSUBSTANTIA	4
FRAIL		BRITTLE	330
FRAIL		EPHERMERAL	114
FRAIL		FLIMSY	163
FRAIL		UNSAFE	661
FRANGIBLE		BRITTLE	330
FRANGIBLE		FLIMSY	163
FRAYED		DILAPIDATED	655
FRECKLED		BLEMISHED	845
FRECKLED		MOTTLED	437
FRESH		CLEAN	648
FRESH		COLD	380
FRIABLE		BRITTLE	330
FRIABLE		POWDERY	332
FRIZZY	*	HAIRY	259
FRIZZY	*	UNDULATORY	251
FROST-BOUND		COLD	380
FROSTED		GRAY	429
FROSTED		OPAQUE	423
FROSTY		COLD	380
FROTHY	*	BUBBLY	355
FROTHY	*	LIGHT	323
FROZEN		COHESIVE	48
FROZEN		DENSE	324
FULL-COLORED		FLORID	425
FURCATE	*	ANGULAR	247
FURCATE	*	CROSSED	222
FURRY	*	HAIRY	259
FUSED		HEATED	381
FUSED		MIXED	43
FUSTY		DIRTY	649
FUZZY		AMORPHOUS	244
FUZZY		SHADOWY	419
GASEOUS	*	GASEOUS	336
GASEOUS		INSUBSTANTIA	4
GASEOUS	*	LIGHT	323
GASEOUS		RARE	325
GASSY		GASEOUS	336
GASSY		VAPORIFIC	338
GATHERED		TIED	45
GAUDY		FLORID	425
GAUZY		INSUBSTANTIA	4
GELATINOUS		SEMILIQUID	354
GIMCRACK		BRITTLE	330
GIMCRACK		FLIMSY	163
GIVING		SOFT	327
GIVING		WEAK	163
GLARING		WELL-SEEN	443
GLASSY	*	BRITTLE	330
GLASSY	*	COLORLESS	426
GLASSY	*	DIM	419
GLASSY	*	HARD	326
GLASSY	*	SMOOTH	258
GLASSY	*	TRANSPARENT	422
GLASSY	*	UNDIMMED	417
GLAZED		SMOOTH	258
GLEAMING		UNDIMMED	417
GLINTING		LUMINOUS	417
GLITTERING	*	ORNAMENTED	844
GLITTERY		LUMINOUS	417
GLOBULAR		ROTUND	252
GLOSSLESS		COLORLESS	426
GLOSSY	*	LUMINOUS	417
GLOWING		COLORED	425
GLOWING		FLORID	425
GLOWING		LUMINOUS	417
GLUED	*	FIRM-SET	45
GLUEY		COHESIVE	48
GLUEY		RETENTIVE	778
GLUEY		VISCID	354
GNARLED		AMORPHOUS	244
GNARLED	*	DENSE	324
GNARLED	*	DISTORTED	246

GNARLED	*	ROUGH	259	HAZY	*	CLOUDY	355
GORY		FLUIDAL	335	HAZY	*	DIM	419
GOSSAMER		INSUBSTANTIA	4	HAZY	*	ILL-SEEN	444
GOSSAMERY		TEXTURAL	331	HAZY	*	OPAQUE	423
GRAINED		TEXTURAL	331	HEAVY		DENSE	324
GRANITIC		HARD	326	HOARY		GRAY	429
GRANULAR	*	POWDERY	332	HODDEN		TEXTURAL	331
GRANULAR	*	TEXTURAL	331	HOLEY		DILAPIDATED	655
GRANULATED		POWDERY	332	HOLEY		PERFORATED	263
GRASSY	*	SOFT	327	HOLLOW		INSUBSTANTIA	4
GRASSY	*	VEGETAL	366	HOLLOW		RARE	325
GRATED		POWDERY	332	HOMESPUN		SIMPLE	44
GRAVELLY		HARD	326	HOMESPUN		TEXTURAL	331
GRAVELLY		POWDERY	332	HOMOGENEOUS		SIMPLE	44
GRAY	*	COLORLESS	426	HONEYCOMBED		CONCAVE	255
GRAY	*	DIM	419	HONEYCOMBED		PERFORATED	263
GRAY	*	UNIFORM	16	HORIZONTAL		FLAT	216
GREASED		SMOOTH	258	HORNED		TOOTHED	256
GREASED		UNCTUOUS	357	HORNY		HARD	326
GREASY	*	DIRTY	649	HUELESS		COLORLESS	426
GREASY	*	SMOOTH	258	HULKY		UNWIELDY	195
GREASY	*	UNCTUOUS	357	HYALINE		TRANSPARENT	422
GREEN	*	VEGETAL	366	HYDROUS		WATERY	339
GRIMY		DIM	419	ICE-CAPPED		COLD	380
GRIMY		DIRTY	649	ICY		COLD	380
GRISTLY		HARD	326	IMMACULATE		CLEAN	648
GRISTLY		TOUGH	329	IMMISCIBLE		NON-ADHESIVE	49
GRITTY		HARD	326	IMMOBILE		STILL	266
GRITTY		POWDERY	332	IMMOVABLE		FIRM-SET	45
GRITTY		TEXTURAL	331	IMMOVABLE		STILL	266
GRIZZLED	*	GRAY	429	IMPENETRABLE		CLOSED	264
GRIZZLED	*	PIED	437	IMPERMEABLE		CLOSED	264
GRIZZLY	*	GRAY	429	IMPERMEABLE		DENSE	324
GROUND	*	POWDERY	332	IMPERMEABLE		SCREENED	421
GROVY		ARBOREAL	366	IMPERMEABLE		UNYIELDING	162
GUMMOUS		RESINOUS	357	IMPERVIOUS	*	CLOSED	264
GUMMY	*	COHESIVE	48	IMPERVIOUS	*	DENSE	324
GUMMY		RETENTIVE	778	IMPERVIOUS	*	OPAQUE	423
GUMMY	*	TOUGH	329	IMPERVIOUS	*	SCREENED	421
GUMMY	*	VISCID	354	IMPOROUS		CLOSED	264
HAIRY	*	FIBROUS	208	IMPOROUS		DENSE	324
HAIRY	*	HAIRY	259	IMPRESSIBLE		SOFT	327
HAIRY		SHARP	256	INCANDESCENT	*	LUMINESCENT	420
HAND-WOVEN		CROSSED	222	INCANDESCENT		LUMINOUS	417
HANGING		PENDENT	217	INCOMPRESSIB		DENSE	324
HARD	*	HARD	326	INCOMPRESSIB		RIGID	326
HARD	*	IMPERSPICUOU	568	INDENTED		CONVOLUTED	251
HARD-GRAINED		ARBOREAL	366	INDENTED		UNDULATORY	251
HARD-GRAINED		VEGETAL	366	INDISSOLUBLE		RETENTIVE	778
HARDENED		HARD	326	INDISTINCT	*	DIM	419

INDISTINCT	*	ILL-SEEN	444
INDISTINCT		SHADOWY	419
INELASTIC		DENSE	324
INELASTIC	*	RIGID	326
INELASTIC	*	TOUGH	329
INELASTIC		UNYIELDING	162
INEXTENSIBLE		RIGID	326
INEXTRICABLE		FIRM-SET	45
INEXTRICABLE		TIED	45
INFLEXIBLE		RIGID	326
INFLEXIBLE		STRAIGHT	249
INFRANGIBLE		UNYIELDING	162
INSOLUBLE	*	INDISSOLUBLE	324
INSUBSTANTIA		BRITTLE	330
INSUBSTANTIA		RARE	325
INSUBSTANTIA		WEAK	163
INTERCONNECT		CORRELATIVE	12
INTERLACED		CROSSED	222
INTERLOCKING		CORRELATIVE	12
INTERVOLVED		TIED	45
INTERWOVEN		CROSSED	222
INTRACTABLE		RIGID	326
INTRICATE		COMPLEX	61
INVARIABLE		UNIFORM	16
IRIDESCENT	*	IRIDESCENT	437
IRIDESCENT		MIXED	43
IRON		HARD	326
JAGGED	*	ANGULAR	247
JAGGED	*	NOTCHED	260
JAGGED	*	ROUGH	259
JAGGY		NOTCHED	260
JAGGY		SHARP	256
JAMMED		FIRM-SET	45
JAMMY		VISCID	354
JASPERED		MOTTLED	437
JELLIED		SEMILIQUID	354
JUICELESS		DRY	342
JUICY		HUMID	341
JUICY		SEMILIQUID	354
JUICY		SOFT	327
JUMBLED		MIXED	43
JUNGLY		ARBOREAL	366
KALEIDOSCOPI		MIXED	43
KEEN		SHARP	256
KINKY		UNDULATORY	251
KNOBBY		ROUGH	259
KNOTTED		COMPLEX	61
KNOTTED	*	CROSSED	222
KNOTTED	*	DENSE	324
KNOTTED	*	ROUGH	259
KNOTTED		TIED	45
KNOTTY	*	DENSE	324
LACK-LUSTER	*	COLORLESS	426
LACK-LUSTER	*	DIM	419
LACQUERED		SMOOTH	258
LACTEAL		SEMILIQUID	354
LACTESCENT		SEMILIQUID	354
LAMBENT		LUMINOUS	417
LAMELLAR		LAYERED	207
LAMINATED		LAYERED	207
LANATE		SMOOTH	258
LANCE-SHAPED		TAPERING	256
LARDY		FATTY	357
LASHED		TIED	45
LASHLIKE		FIBROUS	208
LATHERY		BUBBLY	355
LATTICED		CROSSED	222
LATTICED		SPACED	201
LAX		NON-ADHESIVE	49
LEADEN	*	COLORLESS	426
LEADEN	*	DIM	419
LEADEN	*	GRAY	429
LEADEN	*	WEIGHTY	322
LEAKY		POROUS	263
LEATHERY	*	TOUGH	329
LEVEL		FLAT	216
LEVEL		SMOOTH	258
LEVEL		UNIFORM	16
LIGHT		BUBBLY	35[illegible]
LIGHT	*	LIGHT	3[illegible]
LIGHT		LUMINOUS	4[illegible]7
LIGHT	*	RARE	325
LIGHT		SHALLOW	212
LIGHT	*	SOFT	327
LIGHT	*	SOFT-HUED	425
LIGHT		WEAK	163
LIGHT-COLORE		COLORLESS	426
LIGHT-WEIGHT		LIGHT	323
LIGHTWEIGHT		INSUBSTANTIA	4
LIGHTWEIGHT		WEAK	163
LIMP	*	SOFT	327
LIMP		WEAK	163
LIMPID		PERSPICUOUS	567
LIMPID	*	TRANSPARENT	422
LINED		FURROWED	262
LINED		MOTTLED	437
LINSEY-WOOLS	*	MIXED	43
LINSEY-WOOLS	*	TEXTURAL	331
LIQUEFIABLE		LIQUIFIED	337
LIQUEFIED		FLUIDAL	335

LIQUID	*	AMORPHOUS	244
LIQUID		FLUIDAL	335
LIQUID		NON-ADHESIVE	49
LIQUID	*	TRANSPARENT	422
LITHE		FLEXIBLE	327
LOAMY		TERRITORIAL	344
LOOMED		CROSSED	222
LOOSE	*	NON-ADHESIVE	49
LOOSE	*	PENDENT	217
LOOSE	*	UNSTABLE	152
LOOSE		WEAK	163
LOOSE-KNIT		NON-ADHESIVE	49
LUBRICATED		SMOOTH	258
LUBRICATED		UNCTUOUS	357
LUCID		PERSPICUOUS	567
LUCID		UNDIMMED	417
LUMINESCENT	*	LUMINESCENT	420
LUMINOUS	*	LUMINESCENT	420
LUMINOUS		WELL-SEEN	443
LUMPISH		FLESHY	195
LUMPY	*	DENSE	324
LUMPY		FLESHY	195
LUMPY	*	ROUGH	259
LUMPY	*	SEMILIQUID	354
LUSH		VEGETAL	366
LUSTERLESS		COLORLESS	426
LUSTROUS	*	LUMINOUS	417
LUXURIENT		DENSE	324
MAGGOTY		UNCLEAN	649
MALLEABLE	*	CONFORMABLE	83
MALLEABLE	*	FLEXIBLE	327
MALLEABLE	*	UNSTABLE	152
MANGY		HAIRLESS	229
MANIFOLD	*	MULTIFORM	82
MANIFOLD	*	VARIEGATED	437
MARBLED		MOTTLED	437
MARKED		BLEMISHED	845
MARSHY	*	DIRTY	649
MARSHY	*	HUMID	341
MARSHY	*	MARSHY	347
MARSHY	*	PULPY	356
MARSHY		SEMILIQUID	354
MARSHY		SOFT	327
MASSED		DENSE	324
MASSIVE		DENSE	324
MASSIVE	*	DENSE	324
MASSIVE	*	WEIGHTY	322
MASSY	*	DENSE	324
MASSY	*	MATERIAL	319
MASSY	*	WEIGHTY	322
MAT		SOFT-HUED	425
MATTED		CROSSED	222
MATTED		DENSE	324
MATTED		DIRTY	649
MATTED		HAIRY	259
MATTERY		FLUIDAL	335
MAZY		COMPLEX	61
MAZY		LABYRINTHINE	251
MEANDERING		FLOWING	350
MEANDERING		LABYRINTHINE	251
MEATY		FLESHY	195
MELLOW		SOFT	327
MELTING		FLUIDAL	335
MELTING		SOFT	327
MELTING		UNSTABLE	152
MEMBRANOUS		LAYERED	207
MERCURIAL		UNSTABLE	152
MESHED		CROSSED	222
MESHED		SPACED	201
MILDEWED	*	ANTIQUATED	127
MILDEWED		DILAPIDATED	655
MILDEWED		DIM	419
MILKY	*	FATTY	357
MILKY	*	SEMILIQUID	354
MILKY	*	SEMITRANSPAR	424
MILLED		POWDERY	332
MIRY		MARSHY	347
MISTED		OPAQUE	423
MISTED		UNLIT	418
MISTY	*	CLOUDY	355
MISTY	*	DIM	419
MISTY	*	HUMID	341
MISTY	*	ILL-SEEN	444
MISTY	*	INSUBSTANTIA	4
MISTY	*	OPAQUE	423
MISTY	*	SEMITRANSPAR	424
MOIRE	*	IRIDESCENT	437
MOIST	*	HUMID	341
MOIST	*	WATERY	339
MOLDABLE		FLEXIBLE	327
MOLDING		COHESIVE	48
MOLE		GRAY	429
MOLTEN		LIQUIFIED	337
MONOLITHIC		COHESIVE	48
MONOLITHIC		SIMPLE	44
MOORISH		MARSHY	347
MOORY		MARSHY	347
MOSAIC		MULTIFORM	82
MOSAIC		VARIEGATED	437
MOSS-GROWN	*	DILAPIDATED	655

MOSSY		MARSHY	347	OILED	*	SMOOTH	258
MOSSY	*	SOFT	327	OILED	*	UNCTUOUS	357
MOSSY		VEGETAL	366	OILY	*	DIRTY	649
MOTH-EATEN		DILAPIDATED	655	OILY	*	SMOOTH	258
MOTH-EATEN		DIRTY	649	OILY	*	UNCTUOUS	357
MOTLEY		MIXED	43	OOZY	*	FLOWING	350
MOTLEY		MULTIFORM	82	OOZY	*	HUMID	341
MOTLEY		VARIEGATED	437	OOZY	*	MARSHY	347
MOUSY	*	COLORLESS	426	OPACIOUS		OPAQUE	423
MOUSY	*	GRAY	429	OPALESCENT	*	IRIDESCENT	437
MUCILAGINOUS	*	VISCID	354	OPALESCENT	*	SEMITRANSPAR	424
MUCKY		DIRTY	649	OPALINE	*	IRIDESCENT	437
MUCKY		MARSHY	347	OPALINE	*	SEMITRANSPAR	424
MUCOUS	*	VISCID	354	OPAQUE		IMPERSPICUOU	568
MUDDY	*	DIM	419	OPAQUE		UNLIT	418
MUDDY	*	DIRTY	649	PADDED		SOFT	327
MUDDY	*	HUMID	341	PALE	*	COLORLESS	426
MUDDY	*	MARSHY	347	PALE		DIM	419
MUDDY	*	OPAQUE	423	PALE		INSUBSTANTIA	4
MUDDY	*	SEMILIQUID	354	PALE	*	SOFT-HUED	425
MULTICOLORED		VARIEGATED	437	PALE	*	WEAK	163
MULTIFOLD		MULTIFORM	82	PALLID		COLORLESS	426
MULTIFORM		MIXED	43	PALPABLE		VISIBLE	443
MULTIFORM		VARIEGATED	437	PANED		VARIEGATED	437
MUMMIFIED		DRY	342	PANELED		VARIEGATED	437
MURKY	*	DARK	418	PAPER		INSUBSTANTIA	4
MURKY	*	DENSE	324	PARCHED		DRY	342
MURKY	*	OPAQUE	423	PARTICOLORED		VARIEGATED	437
MUSHY		MARSHY	347	PASTEL		SOFT-HUED	425
MUSHY		SEMILIQUID	354	PASTY	*	COLORLESS	426
MUSHY		SOFT	327	PASTY	*	PULPY	356
MUSTY	*	DIRTY	649	PATCHED		DIRTY	649
MYRRHY		RESINOUS	357	PATCHED		MIXED	43
NAPLESS	*	HAIRLESS	229	PATCHED		VARIEGATED	437
NAPPY	*	DOWNY	259	PATCHY	*	MIXED	43
NAPPY		HAIRY	259	PATCHY		PIED	437
NEEDLELIKE		SHARP	256	PATINATED		SOFT-HUED	425
NEON		LUMINESCENT	420	PATTERNED		UNIFORM	16
NETTED		CROSSED	222	PATTERNLESS		NON-UNIFORM	17
NEUTRAL		GRAY	429	PEACHY	*	DOWNY	259
NODULAR		ROUGH	259	PEACHY		HAIRY	259
NON-DURABLE		EPHERMERAL	114	PEARLY	*	GRAY	429
NOTCHED		ANGULAR	247	PEARLY	*	IRIDESCENT	437
NOTCHED		CONVOLUTED	251	PEARLY	*	SEMITRANSPAR	424
NOTCHED		SHARP	256	PEARLY	*	SOFT-HUED	425
NOTCHED	*	TOOTHED	256	PEBBLY		HARD	326
NOTCHY		NOTCHED	260	PECTINATED		SHARP	256
NUBBLY		ROUGH	259	PELLUCID		UNDIMMED	417
OBDURATE		RIGID	326	PENDENT		NON-ADHESIVE	49
OBSCURED		UNLIT	418	PENDULOUS		NON-ADHESIVE	49

PENDULOUS		PENDENT	217
PENSILE		PENDENT	217
PEPPERED		PERFORATED	263
PERCEPTIBLE		VISIBLE	443
PERCOLATING		POROUS	263
PERISTALTIC		SNAKY	251
PETRIFIED		HARD	326
PETRIFIED		STILL	266
PHLEGMATIC		VISCID	354
PHOSPHORESCE		LUMINESCENT	420
PIEBALD	*	PIED	437
PIED	*	PIED	437
PILLOWY		SOFT	327
PIMPLED	*	CONVEX	253
PIMPLY		CONVEX	253
PINCHED		CONTRACTED	198
PINTO		PIED	437
PITCHY	*	DARK	418
PITCHY	*	RESINOUS	357
PITHY		SOFT	327
PITTED	*	BLEMISHED	845
PITTED	*	ROUGH	259
PITUITOUS		VISCID	354
PLAID		VARIEGATED	437
PLAIN	*	WELL-SEEN	443
PLAITED		CROSSED	222
PLANE		FLAT	216
PLASMATIC		FLUIDAL	335
PLASTIC	*	FLEXIBLE	327
PLASTIC	*	UNSTABLE	152
PLIABLE	*	FLEXIBLE	327
PLIANT		CONFORMABLE	83
PLIANT		FLEXIBLE	327
PLUMP	*	FLESHY	195
PLUMPISH		FLESHY	195
PLUSHY		SOFT	327
PLUVIAL		HUMID	341
POACHY		MARSHY	347
POCK-MARKED		BLEMISHED	845
POCKMARKED		MOTTLED	437
POLISHED		CLEAN	648
POLISHED		ORNAMENTED	844
POLISHED		SMOOTH	258
POLISHED		UNDIMMED	417
POROUS		CONCAVE	255
POT-HOLED		ROUGH	259
POUCHY		EXPANDED	197
POWDERY	*	BRITTLE	330
POWDERY	*	DRY	342
POWDERY	*	POWDERY	332

PRICKLY		SHARP	256
PUCKERY		FOLDED	261
PUDDLED		OPAQUE	423
PUFFY	*	EXPANDED	197
PUFFY	*	FLESHY	195
PUFFY	*	UNSTABLE	152
PULPY	*	PULPY	356
PULPY	*	SEMILIQUID	354
PULPY	*	SOFT	327
PURE		CLEAN	648
PURE		UNMIXED	44
PUSSY		FLUIDAL	335
QUAGGY		MARSHY	347
RADIANT	*	LUMINESCENT	420
RADIANT	*	LUMINOUS	417
RADIANT	*	RADIATING	417
RAGGED		CONVOLUTED	251
RAGGED		UNDULATORY	251
RAINBOW		VARIEGATED	437
RANK		VEGETAL	366
RAVELED		CROSSED	222
RAW		AMORPHOUS	244
REFLECTING		LUMINOUS	417
REFLECTING	*	RADIATING	417
REFRACTIVE		LUMINOUS	417
REFULGENT		LUMINOUS	417
REGULAR		UNIFORM	16
RELAXED		NON-ADHESIVE	49
RELAXED		WEAK	163
RESINY		RESINOUS	357
RIBBED	*	TEXTURAL	331
RICKETY		WEAK	163
RIDDLED		PERFORATED	263
RIFLED		FURROWED	262
RIGID		DENSE	324
RIGID		STRAIGHT	249
RIGID		TOUGH	329
RIPPLED		FURROWED	262
RIPPLING		FLOWING	350
RIPPLING		ROUGH	259
ROAN	*	PIED	437
ROCKY		HARD	326
ROCKY		UNSTABLE	152
ROPY	*	DENSE	324
ROPY	*	FIBROUS	208
ROPY	*	SEMILIQUID	354
ROPY	*	THICK	205
ROTTED		UNCLEAN	649
ROTTEN		DILAPIDATED	655
ROTTEN		WEAKENED	163

ROUGH	*	AMORPHOUS	244	SERRATED		ANGULAR	247
ROUGH	*	NON-UNIFORM	17	SERRATED		NOTCHED	260
ROUGH	*	ROUGH	259	SERRATED		TOOTHED	256
ROUGH		TEXTURAL	331	SET		FIRM-SET	45
ROUGH-HEWN	*	ROUGH	259	SEVERABLE		BRITTLE	330
ROUND		FLESHY	195	SEWN		TIED	45
RUBBERY		TOUGH	329	SHABBY		DILAPIDATED	655
RUDDY	*	FLORID	425	SHADED		SHADOWY	419
RUGGED	*	AMORPHOUS	244	SHADOWLESS		UNDIMMED	417
RUNNING		FLUIDAL	335	SHADOWY		AMORPHOUS	244
RUNNING		UNSTABLE	152	SHADOWY		INSUBSTANTIA	4
RUNNY		FLUIDAL	335	SHADOWY		SCREENED	421
RUNNY		LIQUIFIED	337	SHADY		SCREENED	421
RUNNY		NON-ADHESIVE	49	SHADY		SHADOWY	419
RUSTED		DIM	419	SHAGGED		HAIRY	259
RUSTING		WEAKENED	163	SHAGGY		HAIRY	259
RUSTY		DILAPIDATED	655	SHAKY		FLIMSY	163
RUSTY	*	DIM	419	SHALY		LAYERED	207
RUSTY	*	UNSHARPENED	257	SHARP		NOTCHED	260
RUTTY		FURROWED	262	SHATTERY	*	BRITTLE	330
SANDY	*	DRY	342	SHATTERY	*	FLIMSY	163
SANDY	*	POWDERY	332	SHEENY		LUMINOUS	417
SAPLESS		DRY	342	SHEER	*	TRANSPARENT	422
SAPPY		FLUIDAL	335	SHINING		CLEAN	648
SAPPY		SEMILIQUID	354	SHINING		LUMINESCENT	420
SATINY		SMOOTH	258	SHINING		LUMINOUS	417
SATINY		TEXTURAL	331	SHINING		WELL-SEEN	443
SATURATED		DRENCHED	341	SHINY	*	CLEAN	648
SCABBY		ROUGH	259	SHINY	*	LUMINOUS	417
SCABBY		UNCLEAN	649	SHINY	*	SMOOTH	258
SCALLOPED		UNDULATORY	251	SHIVERY		BRITTLE	330
SCALY	*	LAYERED	207	SHODDY		FLIMSY	163
SCARRED		BLEMISHED	845	SHRIVELED		DRY	342
SCINTILLATIN		LUMINOUS	417	SHRUBBY		ARBOREAL	366
SCLEROTIC		HARD	326	SHRUNK	*	CONTRACTED	198
SCREENED		UNLIT	418	SHUFFLED		ORDERLESS	61
SCRUBBY	*	ARBOREAL	366	SIFTED		POWDERY	332
SCUMMY		BUBBLY	355	SILKEN		SMOOTH	258
SEAMED		LAYERED	207	SILKY		FIBROUS	208
SEBACEOUS		FATTY	357	SILKY	*	SMOOTH	258
SEC[illegible]RE		FIRM-SET	45	SILKY	*	SOFT	327
SE[illegible]		TIED	45	SILKY	*	TEXTURAL	331
S[illegible]ACHED		NON-ADHESIVE	49	SILTY		MARSHY	347
SE[illegible]		SEMILIQUID	354	SILTY		SEMILIQUID	354
SE[illegible]		TOUGH	329	SILVERY		GRAY	429
SEPA[illegible]		NON-ADHESIVE	49	SIMILAR		UNIFORM	16
SERE		DRY	342	SINUOUS	*	CONVOLUTED	251
SERE		LEAN	206	SLABBY	*	MARSHY	347
SERPENTINE		LABYRINTHINE	251	SLABBY	*	SEMILIQUID	354
SERPENTINE		SNAKY	251	SLACK	*	NON-ADHESIVE	49

SLACK	*	ORDERLESS	61
SLACK	*	WEAK	263
SLATY	*	LAYERED	207
SLEAZY		FLIMSY	163
SLEEK	*	SMOOTH	258
SLICK		SMOOTH	258
SLIGHT		WEAK	163
SLIMY	*	DIRTY	649
SLIMY		HUMID	341
SLIMY		MARSHY	347
SLIMY		SEMILIQUID	354
SLIPPERY	*	NON-ADHESIVE	49
SLIPPERY	*	SMOOTH	258
SLIPPERY	*	UNCTUOUS	357
SLITHERY		SMOOTH	258
SLOPPING		DRENCHED	341
SLUMMY		UNCLEAN	649
SLUSHY		HUMID	341
SLUSHY		MARSHY	347
SLUSHY		SEMILIQUID	354
SMALL		CONTRACTED	198
SMALL		WEAK	163
SMOKY	*	DIM	419
SMOKY	*	DIRTY	649
SMOKY		GRAY	429
SMOKY	*	OPAQUE	423
SMOKY	*	POWDERY	332
SMOKY	*	VAPORIFIC	338
SMOOTH		FLAT	216
SMOOTH		HAIRLESS	229
SMOOTH	*	NON-ADHESIVE	49
SMOOTH	*	ORDERLY	60
SMOOTH	*	REGULAR	81
SMOOTH	*	SMOOTH	258
SMOOTH	*	SOFT	327
SMOOTH		TEXTURAL	331
SMOOTH	*	UNIFORM	16
SMOOTH-TEXTU		SMOOTH	258
SNAGGY	*	SHARP	256
SNAKY	*	SNAKY	251
SNARLED	*	COMPLEX	61
SNUB		UNSHARPENED	257
SOAKED		DRENCHED	341
SOAPY		BUBBLY	355
SOAPY	*	FATTY	357
SOAPY	*	SMOOTH	258
SODDEN		DRENCHED	341
SOFT	*	FLUIDAL	335
SOFT		LUMINOUS	417
SOFT	*	SMOOTH	258
SOFT	*	SOFT	327
SOFT		SOFT-HUED	425
SOFT	*	UNSTABLE	152
SOFT	*	WEAK	263
SOFT-GRAINED		ARBOREAL	366
SOFT-GRAINED		VEGETAL	366
SOGGY		MARSHY	347
SOGGY	*	PULPY	356
SOGGY		SOFT	327
SOILED		BLEMISHED	845
SOILED		DIRTY	649
SOLID		COHESIVE	48
SOLID		DENSE	324
SOLID		FIRM-SET	45
SOLID		THICK	205
SOLIDIFIED		DENSE	324
SOLIDIFIED		FIRM-SET	45
SOLUBLE		FLUIDAL	335
SOLUBLE		LIQUIFIED	337
SOLVENT		LIQUIFIED	337
SOOTY	*	DIM	419
SOOTY	*	DIRTY	649
SOOTY	*	OPAQUE	423
SOOTY		POWDERY	332
SOUPY		SEMILIQUID	354
SPARKLING	*	BUBBLY	355
SPARKLING		LUMINOUS	417
SPECKLED		MOTTLED	437
SPIDERY		LEAN	206
SPIKED		SHARP	256
SPIKY	*	SHARP	256
SPINDLY		LEAN	206
SPINOUS		SHARP	256
SPINY	*	SHARP	256
SPIRAL		COILED	251
SPIRALING		COILED	251
SPLINTERY	*	BRITTLE	330
SPLIT		SPACED	201
SPOILED		BLEMISHED	845
SPONGY	*	MARSHY	347
SPONGY		POROUS	263
SPONGY	*	PULPY	356
SPONGY		RARE	325
SPONGY	*	SOFT	327
SPOTLESS		CLEAN	648
SPOTTED		BLEMISHED	845
SPOTTED		MOTTLED	437
SPOTTY	*	BLEMISHED	845
SPOTTY	*	MOTTLED	437
SPRINGLESS		RIGID	326

SPRINGLESS		TOUGH	329	STREAKY		MOTTLED	437
SPRINGY	*	SOFT	327	STREAMING	*	NON-ADHESIVE	49
SPRINKLED		HUMID	341	STRETCHABLE		FLEXIBLE	327
SPUMY		BUBBLY	355	STRETCHED		EXPANDED	197
SPURRED		SHARP	256	STRIATED		FURROWED	262
SQELCHY		HUMID	341	STRIATED		MOTTLED	437
SQUALID		UNCLEAN	649	STRIKING		WELL-SEEN	443
SQUAMOUS	*	LAYERED	207	STRINGY	*	FIBROUS	208
SQUASHY	*	FLUIDAL	335	STRINGY	*	TOUGH	329
SQUASHY	*	HUMID	341	STRIPED		MOTTLED	437
SQUASHY	*	MARSHY	347	STRIPPED		WEAKENED	163
SQUASHY	*	SEMILIQUID	354	STRONG		THICK	205
SQUASHY	*	SOFT	327	STRONG-FIBER		TOUGH	329
SQUELCHY		MARSHY	347	STUBBY	*	THICK	205
SQUELCHY		SEMILIQUID	354	STUBBY	*	UNSHARPENED	257
SQUELCHY		SOFT	327	STUDDED		ROUGH	259
STAGNATING		QUIESCENT	266	STUDDED		SHARP	256
STAINED		BLEMISHED	845	SUBTILE		RARE	325
STAINED		DIRTY	649	SUBTILE		TEXTURAL	331
STAINLESS	*	CLEAN	648	SUNDRIED		DRY	342
STANDARDIZED		REGULAR	81	SUPPLE		FLEXIBLE	327
STANDARDIZED		UNIFORM	16	SUSPENDED		PENDENT	217
STARCHED		CLEAN	648	SWAMPY		MARSHY	347
STARCHED		RIGID	326	SWOLLEN		EXPANDED	197
STARCHY	*	HARD	326	SYLVAN		ARBOREAL	366
STARCHY		RIGID	326	SYMMETRICAL		UNIFORM	16
STARCHY	*	SEMILIQUID	354	SYRUPY		VISCID	354
STEAMING		BUBBLY	355	TABBY		MOTTLED	437
STEAMY		BUBBLY	355	TABULAR		LAYERED	207
STEAMY		GASEOUS	336	TACKY		VISCID	354
STEAMY		VAPORIFIC	338	TANGLED	*	DENSE	324
STEELY		GRAY	429	TANGLED		MIXED	43
STEELY	*	HARD	326	TANGLED	*	TIED	45
STEELY	*	STRONG	162	TARNISHED		DIRTY	649
STICKY	*	COHESIVE	48	TARRY		RESINOUS	357
STICKY		RETENTIVE	778	TATTY		DILAPIDATED	655
STICKY		TOUGH	329	TAUT	*	RIGID	326
STICKY	*	VISCID	354	TAUT	*	TIED	45
STIFF	*	RIGID	326	TEARABLE		BRITTLE	330
STIRRED		MIXED	43	TEARABLE		FLIMSY	163
STITCHED		TIED	45	TEMPERED		HARD	326
STODGY		SEMILIQUID	354	TENDER		SOFT	327
STONY	*	HARD	326	TENDER	*	SOFT-HUED	425
STONY	*	ROUGH	259	TENSE		RIGID	326
STORIED		LAYERED	207	TENSE		TIED	45
STRANGLED		CONTRACTED	198	TENUOUS		FLIMSY	163
STRANGULATED		CONTRACTED	198	TENUOUS		INSUBSTANTIA	4
STRATIFIED		LAYERED	207	TENUOUS		RARE	325
STRATIFORM	*	LAYERED	207	TEXTILE		CROSSED	222
STREAKED		MOTTLED	437	TEXTILE		TEXTURAL	331

TEXTURAL	*	TEXTURAL	331	TRANSPARENT	*	UNDIMMED	417
THAWING		SEMILIQUID	354	TRANSPICUOUS		TRANSPARENT	422
THICK		BUBBLY	355	TREACLY		VISCID	354
THICK	*	DENSE	324	TRICOLOR	*	VARIEGATED	437
THICK	*	DIM	419	TUFTY		HAIRY	259
THICK		DIRTY	649	TUMBLEDOWN		BRITTLE	330
THICK		FIBROUS	208	TUMESCENT		EXPANDED	197
THICK	*	OPAQUE	423	TUMID		EXPANDED	197
THICK	*	SEMILIQUID	354	TURBID		OPAQUE	423
THICK-GROWIN		DENSE	324	TURFEN		VEGETAL	366
THICK-RIBBED		THICK	205	TURFY		VEGETAL	366
THICKSET	*	DENSE	324	TURFY		SOFT	327
THICKSET	*	THICK	205	TURGESCENT		EXPANDED	197
THIN		HAIRLESS	229	TURGID	*	EXPANDED	197
THIN		INSUBSTANTIA	4	TURNING		LABYRINTHINE	251
THIN		RARE	325	TUSKED		TOOTHED	256
THIN	*	TRANSPARENT	422	TUSKY		TOOTHED	256
THIN		WEAK	163	TWEEDY		CROSSED	222
THISTLY		SHARP	256	TWILIGHT		DIM	419
THORNY	*	SHARP	256	TWILLED		TEXTURAL	331
THREADBARE	*	DIRTY	649	TWINING		CONVOLUTED	251
THREADBARE	*	HAIRLESS	229	TWISTED		CONVOLUTED	251
TIED		COMPLEX	61	TWISTING		LABYRINTHINE	251
TIGHT	*	COHESIVE	48	UMBRAGEOUS		SCREENED	421
TIGHT		CONTRACTED	198	UNATTACHED		UNSTABLE	152
TIGHT	*	DRY	342	UNBENT		STRAIGHT	249
TIGHT		EXPANDED	197	UNDILUTED		UNMIXED	44
TIGHT	*	FIRM-SET	45	UNHEWN		AMORPHOUS	244
TIGHT	*	RIGID	326	UNIFIED		SIMPLE	44
TIGHT		TIED	45	UNIFORM		COHESIVE	48
TIGHT-STRUNG		RIGID	326	UNIFORM		SIMPLE	44
TIMBERED		ARBOREAL	366	UNIQUE		NON-UNIFORM	17
TINGED		COLORED	425	UNRAVELED		SIMPLE	44
TINTED		COLORED	425	UNSTABLE		WEAK	163
TOOTHED		NOTCHED	260	VACUOUS		INSUBSTANTIA	4
TOOTHLESS		UNSHARPENED	257	VAGUE		SHADOWY	419
TOOTHY		TOOTHED	256	VAPORABLE		VAPORIFIC	338
TOTTERY		WEAK	163	VAPORISH		VAPORIFIC	338
TOUGH		COHESIVE	48	VAPORIZABLE		VAPORIFIC	338
TOUGH	*	HARD	326	VAPOROUS	*	GASEOUS	336
TOUGH	*	STRONG	162	VAPOROUS	*	INSUBSTANTIA	4
TOUGH	*	TOUGH	329	VAPOROUS	*	OPAQUE	423
TOUGHENED		STRONG	162	VAPOROUS	*	VAPORIFIC	338
TOUGHENED		TOUGH	329	VAPORY		VAPORIFIC	338
TRACTILE		FLEXIBLE	327	VARIFORM		MULTIFORM	82
TRANSLUCENT	*	TRANSPARENT	422	VARNISHED		RESINOUS	357
TRANSLUCENT	*	UNDIMMED	417	VARNISHED		SMOOTH	258
TRANSPARENT	*	INSUBSTANTIA	4	VEINED		MOTTLED	437
TRANSPARENT		PERSPICUOUS	567	VELVETY	*	DOWNY	259
TRANSPARENT	*	TRANSPARENT	422	VELVETY		HAIRY	259

VELVETY	*	SMOOTH	258
VELVETY	*	SOFT	327
VERDANT		VEGETAL	366
VERSICOLOR		IRIDESCENT	437
VISCID		COHESIVE	48
VISCID	*	THICK	205
VISCID		TOUGH	329
VISCOUS	*	COHESIVE	48
VITREOUS		HARD	326
VITREOUS		TRANSPARENT	422
VIVID		COLORED	425
VIVID		FLORID	425
VIVID		LUMINOUS	417
VOLATILE		TRANSIENT	114
VOLATILE		VAPORIFIC	338
VULCANIZED		TOUGH	329
WAN		DIM	419
WANING		DIM	419
WARTY		CONVEX	253
WATER LOGGED		MARSHY	347
WATERED		MIXED	43
WATERLESS		DRY	342
WATERLOGGED		DRENCHED	341
WATERY		FLUIDAL	335
WATERY	*	HUMID	341
WATERY		MARSHY	347
WATERY	*	NON-ADHESIVE	49
WATERY	*	WATERY	339
WATERY	*	WEAK	163
WAVY		UNDULATORY	251
WAXED		SMOOTH	258
WAXEN	*	FATTY	357
WAXY	*	FATTY	357
WAXY	*	SOFT	327
WEAK		BRITTLE	330
WEATHER-BEAT	*	DILAPIDATED	655
WEATHER-BEAT	*	WEAKENED	163
WEATHERED		SOFT-HUED	425
WEBBED		CROSSED	222
WEBBY		CROSSED	222
WEDGED		FIRM-SET	45
WEEDY		VEGETAL	366
WEIGHTED		WEIGHTY	322
WEIGHTLESS		LIGHT	323
WEIGHTY		DENSE	324
WEIGHTY		MATERIAL	31[illegible]
WELL-BRUSHED		SMOOTH	258
WELL-DEFINED		WELL-SEEN	443
WELL-KNIT		COHESIVE	48
WELL-LIT		LUMINESCENT	420
WELL-LIT		LUMINOUS	417
WELL-MARKED		WELL-SEEN	443
WELL-THUMBED		USED	673
WELL-TIED		TIED	45
WELL-WORN		DILAPIDATED	655
WELL-WORN		USED	673
WET		HUMID	341
WET		WATERY	339
WETTED		HUMID	341
WHETTED		SHARP	256
WHIFFLING		UNSTABLE	152
WHIPPED		LIGHT	323
WHIPPY		FLEXIBLE	327
WHISKERY		FIBROUS	208
WHORLED		COILED	251
WIDESPREAD		EXPANDED	197
WILD		ARBOREAL	366
WIND-DRIED		DRY	342
WINDING		COMPLEX	61
WINDING	*	CONVOLUTED	251
WINDY	*	AIRY	340
WINDY	*	GASEOUS	336
WIRE-DRAWN		FIBROUS	208
WIRY	*	FIBROUS	208
WISPY		FLIMSY	163
WISPY		RARE	325
WITHERED		DRY	342
WITHERED		WEAKENED	163
WOBBLING		UNSTABLE	152
WOBBLY		WEAK	163
WOOD		ARBOREAL	366
WOODED		ARBOREAL	366
WOODEN		ARBOREAL	366
WOODLAND		ARBOREAL	366
WOODY		ARBOREAL	366
WOODY		VEGETAL	366
WOOLLY	*	HAIRY	259
WOOLLY	*	SMOOTH	258
WOOLLY		UNDULATORY	251
WOOLY		FIBROUS	208
WORN	*	DILAPIDATED	655
WORN	*	USED	673
WORN	*	WEAKENED	163
WOVEN	*	CROSSED	222
WOVEN	*	TEXTURAL	331
WRIGGLING		SNAKY	251
WRINKLED		FURROWED	262
WRINKLED		ROUGH	259
WRINKLED		UNDULATORY	251
WRINKLY		FOLDED	261

YEASTY	*	BUBBLY	355
YEASTY	*	LIGHT	323
YIELDING		SOFT	327
YIELDING		UNSTABLE	152
YIELDING		WEAK	163
ZIGZAG	*	ANGULAR	247
ZONED		LAYERED	207

4. THESAURUS WITH SUBHEADINGS ARRANGED ALPHABETICALLY

CLOSE-FITTIN		ADJUSTED	24
BUBBLY		AIRY	340
WINDY	*	AIRY	340
BLURRED	*	AMORPHOUS	244
FLUID	*	AMORPHOUS	244
FORMLESS	*	AMORPHOUS	244
FUZZY		AMORPHOUS	244
GNARLED		AMORPHOUS	244
LIQUID	*	AMORPHOUS	244
RAW		AMORPHOUS	244
ROUGH	*	AMORPHOUS	244
RUGGED	*	AMORPHOUS	244
SHADOWY		AMORPHOUS	244
UNHEWN		AMORPHOUS	244
CRINKLED		ANGULAR	247
FORKED		ANGULAR	247
FURCATE	*	ANGULAR	247
JAGGED	*	ANGULAR	247
NOTCHED		ANGULAR	247
SERRATED		ANGULAR	247
ZIGZAG	*	ANGULAR	247
DECAYED		ANTIQUATED	127
MILDEWED	*	ANTIQUATED	127
BEECHY		ARBOREAL	366
BUSHY		ARBOREAL	366
COPSY		ARBOREAL	366
FORESTAL		ARBOREAL	366
FORESTED		ARBOREAL	366
GROVY		ARBOREAL	366
HARD-GRAINED		ARBOREAL	366
JUNGLY		ARBOREAL	366
SCRUBBY	*	ARBOREAL	366
SHRUBBY		ARBOREAL	366
SOFT-GRAINED		ARBOREAL	366
SYLVAN		ARBOREAL	366
TIMBERED		ARBOREAL	366
WILD		ARBOREAL	366
WOOD		ARBOREAL	366
WOODED		ARBOREAL	366
WOODEN		ARBOREAL	366
WOODLAND		ARBOREAL	366
WOODY		ARBOREAL	366
ARCHED		ARCUATE	253
BOWED		ARCUATE	253
CAMBERED		ARCUATE	253
CRACKED	*	BLEMISHED	845
DAMAGED		BLEMISHED	845
DETERIORATED		BLEMISHED	845
DIRTY		BLEMISHED	845
FLAWED		BLEMISHED	845
FRECKLED		BLEMISHED	845
MARKED		BLEMISHED	845
PITTED	*	BLEMISHED	845
POCK-MARKED		BLEMISHED	845
SCARRED		BLEMISHED	845
SOILED		BLEMISHED	845
SPOILED		BLEMISHED	845
SPOTTED		BLEMISHED	845
SPOTTY	*	BLEMISHED	845
STAINED		BLEMISHED	845
BREAKABLE		BRITTLE	330
BRITTLE	*	BRITTLE	330
CRISP		BRITTLE	330
CRUMBLY		BRITTLE	330
DELICATE		BRITTLE	330
DILAPIDATED		BRITTLE	330
EGGSHELL		BRITTLE	330
FLAKY		BRITTLE	330
FLIMSY	*	BRITTLE	330
FRAGILE		BRITTLE	330
FRAIL		BRITTLE	330
FRANGIBLE		BRITTLE	330
FRIABLE		BRITTLE	330
GIMCRACK		BRITTLE	330
GLASSY	*	BRITTLE	330
INSUBSTANTIA		BRITTLE	330
POWDERY	*	BRITTLE	330
[illegible]ERABLE		BRITTLE	330
SHATTERY	*	BRITTLE	330
SHIVERY		BRITTLE	330
SPLINTERY	*	BRITTLE	330
TEARABLE		BRITTLE	330
TUMBLEDOWN		BRITTLE	330
WEAK		BRITTLE	330
AERATED		BUBBLY	355
BUBBLING		BUBBLY	355
DIRTY		BUBBLY	355
EFFERVESCENT		BUBBLY	355
FIZZY		BUBBLY	355
FOAMY	*	BUBBLY	355
FROTHY	*	BUBBLY	355
LATHERY		BUBBLY	355
LIGHT		BUBBLY	355
SCUMMY		BUBBLY	355
SOAPY		BUBBLY	355
SPARKLING	*	BUBBLY	355
SPUMY		BUBBLY	355
STEAMING		BUBBLY	355
STEAMY		BUBBLY	355
THICK		BUBBLY	355

YEASTY	* BUBBLY	355	SPIRALING	COILED	251
BELLIED	CELLULAR	194	WHORLED	COILED	251
CAMERATED	CELLULAR	194	CHILLY	COLD	380
CELLULAR	* CELLULAR	194	COOL	COLD	380
COMPARTMENTA	CELLULAR	194	FRESH	COLD	380
CONVEX	CELLULAR	194	FROST-BOUND	COLD	380
BLANK	CLEAN	648	FROSTY	COLD	380
BRIGHT	* CLEAN	648	ICE-CAPPED	COLD	380
CLEANED	CLEAN	648	ICY	COLD	380
DEWY	* CLEAN	648	BRIGHT	COLORED	425
DIRT-FREE	CLEAN	648	BRILLIANT	COLORED	425
DISINFECTED	CLEAN	648	COLORED	* COLORED	425
FRESH	CLEAN	648	COLORFUL	* COLORED	425
IMMACULATE	CLEAN	648	DEEP-COLORED	COLORED	425
POLISHED	CLEAN	648	DYED	COLORED	425
PURE	CLEAN	648	GLOWING	COLORED	425
SHINING	CLEAN	648	TINGED	COLORED	425
SHINY	* CLEAN	648	TINTED	COLORED	425
SPOTLESS	CLEAN	648	VIVID	COLORED	425
STAINLESS	* CLEAN	648	ALBINO	COLORLESS	426
STARCHED	CLEAN	648	ASHEN	* COLORLESS	426
IMPENETRABLE	CLOSED	264	ASHEN-HUED	COLORLESS	426
IMPERMEABLE	CLOSED	264	ASHY	* COLORLESS	426
IMPERVIOUS	* CLOSED	264	BLANK	COLORLESS	426
IMPOROUS	CLOSED	264	BLEACHED	COLORLESS	426
CLOUDY	* CLOUDY	355	COLORLESS	* COLORLESS	426
HAZY	* CLOUDY	355	DECOLORED	COLORLESS	426
MISTY	* CLOUDY	355	DIM	COLORLESS	426
ADHESIVE	* COHESIVE	48	DINGY	* COLORLESS	426
CLAMMY	COHESIVE	48	DISCOLORED	COLORLESS	426
CLINGING	* COHESIVE	48	DULL	* COLORLESS	426
CLOSE	COHESIVE	48	FADED	* COLORLESS	426
COAGULATE	COHESIVE	48	FADING	COLORLESS	426
COHESIVE	* COHESIVE	48	GLASSY	* COLORLESS	426
COMPACT	COHESIVE	48	GLOSSLESS	COLORLESS	426
CONCRETE	COHESIVE	48	GRAY	* COLORLESS	426
FROZEN	COHESIVE	48	HUELESS	COLORLESS	426
GLUEY	COHESIVE	48	LACK-LUSTER	* COLORLESS	426
GUMMY	* COHESIVE	48	LEADEN	* COLORLESS	426
MOLDING	COHESIVE	48	LIGHT-COLORE	COLORLESS	426
MONOLITHIC	COHESIVE	48	LUSTERLESS	COLORLESS	426
SOLID	COHESIVE	48	MOUSY	* COLORLESS	426
STICKY	* COHESIVE	48	PALE	* COLORLESS	426
TIGHT	* COHESIVE	48	PALLID	COLORLESS	426
TOUGH	COHESIVE	48	PASTY	* COLORLESS	426
UNIFORM	COHESIVE	48	COILED	COMPLEX	61
VISCID	COHESIVE	48	COMPLICATED	COMPLEX	61
VISCOUS	* COHESIVE	48	ENTANGLED	* COMPLEX	61
WELL-KNIT	COHESIVE	48	INTRICATE	COMPLEX	61
SPIRAL	COILED	251	KNOTTED	COMPLEX	61

MAZY		COMPLEX	61	TWINING		CONVOLUTED	251
SNARLED	*	COMPLEX	61	TWISTED		CONVOLUTED	251
TIED		COMPLEX	61	WINDING	*	CONVOLUTED	251
WINDING		COMPLEX	61	INTERCONNECT		CORRELATIVE	12
ARCHED		CONCAVE	255	INTERLOCKING		CORRELATIVE	12
CAVERNOUS		CONCAVE	255	BALLED-UP		CROSSED	222
CELLULAR	*	CONCAVE	255	BARRED		CROSSED	222
DEPRESSED		CONCAVE	255	CRISS-CROSS		CROSSED	222
HONEYCOMBED		CONCAVE	255	FORKED		CROSSED	222
POROUS		CONCAVE	255	FURCATE	*	CROSSED	222
ADJUSTABLE		CONFORMABLE	83	HAND-WOVEN		CROSSED	222
CONFORMING		CONFORMABLE	83	INTERLACED		CROSSED	222
FLEXIBLE		CONFORMABLE	83	INTERWOVEN		CROSSED	222
MALLEABLE	*	CONFORMABLE	83	KNOTTED	*	CROSSED	222
PLIANT		CONFORMABLE	83	LATTICED		CROSSED	222
CLOSED		CONTRACTED	198	LOOMED		CROSSED	222
COMPRESSED		CONTRACTED	198	MATTED		CROSSED	222
COMPRESSIBLE		CONTRACTED	198	MESHED		CROSSED	222
COMPRESSIVE		CONTRACTED	198	NETTED		CROSSED	222
CONDENSED		CONTRACTED	198	PLAITED		CROSSED	222
CONTRACTIBLE		CONTRACTED	198	RAVELED		CROSSED	222
CONTRACTILE		CONTRACTED	198	TEXTILE		CROSSED	222
DEFLATED		CONTRACTED	198	TWEEDY		CROSSED	222
DETERIORATED		CONTRACTED	198	WEBBED		CROSSED	222
DRAWN		CONTRACTED	198	WEBBY		CROSSED	222
PINCHED		CONTRACTED	198	WOVEN	*	CROSSED	222
SHRUNK	*	CONTRACTED	198	DARK	*	DARK	418
SMALL		CONTRACTED	198	DINGY	*	DARK	418
STRANGLED		CONTRACTED	198	MURKY	*	DARK	418
STRANGULATED		CONTRACTED	198	PITCHY	*	DARK	418
TIGHT		CONTRACTED	198	BLEMISHED		DEFORMED	246
BALLOONING		CONVEX	253	BLOATED		DEFORMED	246
BELLYING		CONVEX	253	DEFECTIVE		DEFORMED	246
BILLOWY		CONVEX	253	BUSHY		DENSE	324
BILLOWING		CONVEX	253	CLOSE		DENSE	324
BLISTERY		CONVEX	253	CLOSE-PACKED		DENSE	324
EXPANDED		CONVEX	253	CLOSE-TEXTUR		DENSE	324
FLESHY		CONVEX	253	CLOTTED	*	DENSE	324
PIMPLED	*	CONVEX	253	COMPACT		DENSE	324
PIMPLY		CONVEX	253	CONCRETE		DENSE	324
WARTY		CONVEX	253	CONDENSED		DENSE	324
BLOATED		CONVEX	253	CRYSTALLINE	*	DENSE	324
BUCKLED	*	CONVOLUTED	251	CRYSTALLIZED		DENSE	324
CONTORTED		CONVOLUTED	251	DENSE	*	DENSE	324
CRUMPLED		CONVOLUTED	251	FIRM	*	DENSE	324
FOLDED		CONVOLUTED	251	FIRM-PACKED		DENSE	324
INDENTED		CONVOLUTED	251	FROZEN		DENSE	324
NOTCHED		CONVOLUTED	251	GNARLED	*	DENSE	324
RAGGED		CONVOLUTED	251	HEAVY		DENSE	324
SINUOUS	*	CONVOLUTED	251	IMPERMEABLE		DENSE	324

IMPERVIOUS	*	DENSE	324
IMPOROUS		DENSE	324
INCOMPRESSIB		DENSE	324
INELASTIC		DENSE	324
KNOTTED	*	DENSE	324
KNOTTY	*	DENSE	324
LUMPY	*	DENSE	324
LUXURIENT		DENSE	324
MASSED		DENSE	324
MASSIVE	*	DENSE	324
MASSY	*	DENSE	324
MATTED		DENSE	324
MURKY	*	DENSE	324
RIGID		DENSE	324
ROPY	*	DENSE	324
SOLID		DENSE	324
SOLIDIFIED		DENSE	324
TANGLED	*	DENSE	324
THICK	*	DENSE	324
THICK-GROWIN		DENSE	324
THICKSET	*	DENSE	324
WEIGHTY		DENSE	324
CRAGGY		DIFFICULT	700
CRACKED	*	DILAPIDATED	655
DOG-EARED		DILAPIDATED	655
DRAB	*	DILAPIDATED	655
FRAYED		DILAPIDATED	655
HOLEY		DILAPIDATED	655
MILDEWED		DILAPIDATED	655
MOSS-GROWN	*	DILAPIDATED	655
MOTH-EATEN		DILAPIDATED	655
ROTTEN		DILAPIDATED	655
RUSTY		DILAPIDATED	655
SHABBY		DILAPIDATED	655
TATTY		DILAPIDATED	655
WEATHER-BEAT	*	DILAPIDATED	655
WELL-WORN		DILAPIDATED	655
WORN	*	DILAPIDATED	655
BLEARY		DIM	419
BLURRED	*	DIM	419
CLOUDY	*	DIM	419
COLORLESS	*	DIM	419
DARKISH		DIM	419
DINGY	*	DIM	419
DIRTY		DIM	419
DULL	*	DIM	419
DUN	*	DIM	419
DUSKY		DIM	419
FADED		DIM	419
FAINT		DIM	419
FILMY	*	DIM	419
FOGGY		DIM	419
GLASSY	*	DIM	419
GRAY	*	DIM	419
GRIMY		DIM	419
HAZY	*	DIM	419
INDISTINCT	*	DIM	419
LACK-LUSTER	*	DIM	419
LEADEN	*	DIM	419
MILDEWED		DIM	419
MISTY	*	DIM	419
MUDDY	*	DIM	419
PALE		DIM	419
RUSTED		DIM	419
RUSTY	*	DIM	419
SMOKY	*	DIM	419
SOOTY	*	DIM	419
THICK	*	DIM	419
TWILIGHT		DIM	419
WAN		DIM	419
WANING		DIM	419
BEDRAGGLED		DIRTY	649
BEGRIMED		DIRTY	649
BLACK	*	DIRTY	649
CAKED		DIRTY	649
CLOTTED	*	DIRTY	649
COBWEBBY		DIRTY	649
COLLIED		DIRTY	649
DINGY	*	DIRTY	649
DIRTY	*	DIRTY	649
DREGGY		DIRTY	649
DUSTY	*	DIRTY	649
FILTHY		DIRTY	649
FUSTY		DIRTY	649
GREASY	*	DIRTY	649
GRIMY		DIRTY	649
MARSHY	*	DIRTY	649
MATTED		DIRTY	649
MOTH-EATEN		DIRTY	649
MUCKY		DIRTY	649
MUDDY	*	DIRTY	649
MUSTY	*	DIRTY	649
OILY	*	DIRTY	649
PATCHED		DIRTY	649
SLIMY	*	DIRTY	649
SMOKY	*	DIRTY	649
SOILED		DIRTY	649
SOOTY	*	DIRTY	649
STAINED		DIRTY	649
TARNISHED		DIRTY	649

THICK		DIRTY	649
THREADBARE	*	DIRTY	649
BROKEN		DISCONTINUOU	72
BUMPY	*	DISCONTINUOU	72
AMORPHOUS		DISTORTED	246
ASKEW		DISTORTED	246
BUCKLED		DISTORTED	246
GNARLED	*	DISTORTED	246
DOWNY	*	DOWNY	259
FEATHERY	*	DOWNY	259
NAPPY	*	DOWNY	259
PEACHY	*	DOWNY	259
VELVETY	*	DOWNY	259
DROWNED		DRENCHED	341
SATURATED		DRENCHED	341
SLOPPING		DRENCHED	341
SOAKED		DRENCHED	341
SODDEN		DRENCHED	341
WATERLOGGED		DRENCHED	341
ANHYDROUS		DRY	342
ARID		DRY	342
BAKED		DRY	342
BARE	*	DRY	342
BLEACHED		DRY	342
BROWN	*	DRY	342
BURNED		DRY	342
DAMP-PROOF		DRY	342
DEHYDRATED		DRY	342
DESICCATED		DRY	342
DRAINED		DRY	342
DROUGHTY		DRY	342
DRY	*	DRY	342
DUSTY	*	DRY	342
EVAPORATED		DRY	342
FADED		DRY	342
FINE	*	DRY	342
JUICELESS		DRY	342
MUMMIFIED		DRY	342
PARCHED		DRY	342
POWDERY	*	DRY	342
SANDY	*	DRY	342
SAPLESS		DRY	342
SERE		DRY	342
SHRIVELED		DRY	342
SUNDRIED		DRY	342
TIGHT	*	DRY	342
WATERLESS		DRY	342
WIND-DRIED		DRY	342
WITHERED		DRY	342
COLORLESS	*	DULL	840
DRAB	*	DULL	840
FRAIL		EPHERMERAL	114
NON-DURABLE		EPHERMERAL	114
EQUILATERAL		EQUAL	28
EMBRYONIC		EXIGUOUS	196
BLADDER-LIKE		EXPANDED	197
BLOATED		EXPANDED	197
BULBOUS		EXPANDED	197
CONVEX		EXPANDED	197
DISTENDED		EXPANDED	197
EXPANDING		EXPANDED	197
FLESHY		EXPANDED	197
POUCHY		EXPANDED	197
PUFFY	*	EXPANDED	197
STRETCHED		EXPANDED	197
SWOLLEN		EXPANDED	197
TIGHT		EXPANDED	197
TUMESCENT		EXPANDED	197
TUMID		EXPANDED	197
TURGESCENT		EXPANDED	197
TURGID	*	EXPANDED	197
WIDESPREAD		EXPANDED	197
BUTTERY		FATTY	357
CREAMY	*	FATTY	357
FAT		FATTY	357
FLESHY	*	FATTY	357
LARDY		FATTY	357
MILKY	*	FATTY	357
SEBACEOUS		FATTY	357
SOAPY	*	FATTY	357
WAXEN	*	FATTY	357
WAXY	*	FATTY	357
CONVOLUTED		FIBROUS	208
COTTONY		FIBROUS	208
DOWNY	*	FIBROUS	208
FILAMENTOUS		FIBROUS	208
FINE-SPUN		FIBROUS	208
FLAGELLIFORM		FIBROUS	208
FLEECY		FIBROUS	208
HAIRY	*	FIBROUS	208
LASHLIKE		FIBROUS	208
ROPY	*	FIBROUS	208
SILKY		FIBROUS	208
STRINGY	*	FIBROUS	208
THICK		FIBROUS	208
WHISKERY		FIBROUS	208
WIRE-DRAWN		FIBROUS	208
WIRY	*	FIBROUS	208
WOOLY		FIBROUS	208
CEMENTED		FIRM-SET	45

CLOSE		FIRM-SET	45	CELICATE		FLIMSY	163
CLOSE-SET		FIRM-SET	45	FRAGILE		FLIMSY	163
COHESIVE	*	FIRM-SET	45	FRAIL		FLIMSY	163
CENSE	*	FIRM-SET	45	FRANGIBLE		FLIMSY	163
FAST		FIRM-SET	45	GIMCRACK		FLIMSY	163
FIRM	*	FIRM-SET	45	SHAKY		FLIMSY	163
FIXED		FIRM-SET	45	SHATTERY	*	FLIMSY	163
GLUEC	*	FIRM-SET	45	SHOCDY		FLIMSY	163
IMMOVABLE		FIRM-SET	45	SLEAZY		FLIMSY	163
INEXTRICABLE		FIRM-SET	45	TEARABLE		FLIMSY	163
JAMMEC		FIRM-SET	45	TENUOUS		FLIMSY	163
SECURE		FIRM-SET	45	WISPY		FLIMSY	163
SET		FIRM-SET	45	BRIGHT	*	FLORID	425
SOLID		FIRM-SET	45	BRILLIANT		FLCRID	425
SOLICIFIEC		FIRM-SET	45	COLORFUL	*	FLCRID	425
TIGHT	*	FIRM-SET	45	CEEP		FLORID	425
WEDGED		FIRM-SET	45	CEEP-COLORED		FLORID	425
FIRM	*	FIXED	153	FLARING		FLORID	425
EVEN		FLAT	216	FLASHY		FLORID	425
FLUSH		FLAT	216	FLAUNTING		FLORID	425
HORIZONTAL		FLAT	216	FLORIC	*	FLCRID	425
LEVEL		FLAT	216	FULL-COLORED		FLCRID	425
PLANE		FLAT	216	GAUCY		FLCRID	425
SMOOTH		FLAT	216	GLOWING		FLCRID	425
BEEFY	*	FLESHY	195	RUCCY	*	FLORID	425
CHUNKY		FLESHY	195	VIVID		FLCRID	425
FAT		FLESHY	195	CRIPPING		FLOWING	350
FLESHY	*	FLESHY	195	CROPPING		FLOWING	350
LUMPISH		FLESHY	195	EDCYING		FLOWING	350
LUMPY		FLESHY	195	FLUIC	*	FLOWING	350
MEATY		FLESHY	195	MEANDERING		FLOWING	350
PLUMP	*	FLESHY	195	OCZY	*	FLOWING	350
PLUMPISH		FLESHY	195	RIPPLING		FLOWING	350
PUFFY	*	FLESHY	195	AMORPHOUS		FLUIDAL	335
ROUND		FLESHY	195	FLOWING		FLUIDAL	335
ACAPTABLE		FLEXIBLE	327	FLUENT		FLUIDAL	335
CUCTILE		FLEXIBLE	327	GORY		FLUICAL	335
ESTENSILE		FLEXIBLE	327	LICLEFIEC		FLUICAL	335
FLEXIBLE	*	FLEXIBLE	327	LICLIC		FLUIDAL	335
LITHE		FLEXIBLE	327	MATTERY		FLUICAL	335
MOLDABLE		FLEXIBLE	327	MELTING		FLUIDAL	335
MALLEABLE	*	FLEXIBLE	327	PLASMATIC		FLUICAL	335
PLASTIC	*	FLEXIBLE	327	PUSSY		FLUIDAL	335
PLIABLE	*	FLEXIBLE	327	RUNNING		FLUIDAL	335
PLIANT		FLEXIBLE	327	RUNNY		FLUIDAL	335
STRETCHABLE		FLEXIBLE	327	SAPPY		FLUIDAL	335
SUPPLE		FLEXIBLE	327	SOFT	*	FLUICAL	335
TRACTILE		FLEXIBLE	327	SOLUBLE		FLUIDAL	335
WHIPPY		FLEXIBLE	327	SQUASHY	*	FLUICAL	335
BRITTLE		FLIMSY	163	WATERY		FLUIDAL	335

CREASED	FCLCED	261	CCWNY	HAIRY	259
CREASY	FCLCED	261	FEATHERY	HAIRY	259
CRUMPLEC	FOLCED	261	FLEECY	HAIRY	259
CRUSHEC	FCLCED	261	FLUFFY	HAIRY	259
COG-EARED	FCLCED	261	FRIZZY	* HAIRY	259
PUCKERY	FCLCEC	261	FURRY	* HAIRY	259
WRINKLY	FOLCED	261	HAIRY	* HAIRY	259
DRENCHED	FULL	54	MATTEC	HAIRY	259
CANALLED	FURROWEC	262	NAPPY	HAIRY	259
CHANNELED	FURROWEC	262	PEACHY	HAIRY	259
FLUTED	FURROWEC	262	SHAGGEC	HAIRY	259
FOLDEC	FURROWEC	262	SHAGGY	HAIRY	259
LINED	FURROWEC	262	TUFTY	HAIRY	259
RIFLEC	FURROWEC	262	VELVETY	HAIRY	259
RIPPLEC	FURROWEC	262	WCOLLY	* HAIRY	259
RUTTY	FURROWED	262	ARMCREC	HARD	326
STRIATED	FURROWEC	262	BONY	HARD	326
WRINKLED	FURROWEC	262	CALLCUS	HARC	326
AIRY	GASEOUS	336	CALLCUSED	HARC	326
ETHEREAL	GASEOUS	336	CARTILAGINOU	HARD	326
GASEOUS	* GASEOUS	336	CAST-IRON	HARC	326
GASSY	GASEOUS	336	CCNCRETE	HARD	326
STEAMY	GASECUS	336	CORNECUS	HARC	326
VAPOROUS	* GASEOUS	336	CRYSTALLINE	* HARD	326
WINDY	* GASEOUS	336	FERRC-CONCRE	HARC	326
ASHEN	* GRAY	429	FIRM	* HARC	326
ASHY	* GRAY	429	FLINTY	HARD	326
CANESCENT	GRAY	429	FCSSILIZEC	HARD	326
CCOL	GRAY	429	GLASSY	* HARD	326
DULL	* GRAY	429	GRANITIC	HARD	326
FROSTED	GRAY	429	GRAVELLY	HARD	326
GRIZZLEC	* GRAY	429	GRISTLY	HARD	326
GRIZZLY	* GRAY	429	GRITTY	HARC	326
HCARY	GRAY	429	HARC	* HARD	326
LEADEN	* GRAY	429	HARCENED	HARD	326
MCLE	GRAY	429	HCRNY	HARD	326
MCUSY	* GRAY	429	IRCN	HARC	326
NEUTRAL	GRAY	429	PEBBLY	HARD	326
PEARLY	* GRAY	429	PETRIFIEC	HARD	326
SILVERY	GRAY	429	RCCKY	HARD	326
SMCKY	GRAY	429	SCLEROTIC	HARD	326
STEELY	GRAY	429	STARCHY	* HARC	326
BALD	HAIRLESS	229	STEELY	* HARD	326
MANGY	HAIRLESS	229	STCNY	* HARD	326
NAPLESS	* HAIRLESS	229	TEMPERED	HARC	326
SMOOTH	HAIRLESS	229	TOUGH	* HARD	326
THIN	HAIRLESS	229	VITRECUS	HARC	326
THREACBARE	* HAIRLESS	229	BAKED	HEATED	381
BRISTLY	* HAIRY	259	BRANCEC	HEATED	381
CURLY	* HAIRY	259	BURNEC	HEATED	381

CHARRED		HEATED	381
FUSED		HEATED	381
DRY	*	HOT	379
CLOUDY	*	HUMID	341
DAMP		HUMID	341
DANK		HUMID	341
DEWY	*	HUMID	341
DRIBBLING		HUMID	341
DRIPPING		HUMID	341
DRIZZLING		HUMID	341
DRIZZLY		HUMID	341
FENNY		HUMID	341
JUICY		HUMID	341
MARSHY	*	HUMID	341
MISTY	*	HUMID	341
MOIST	*	HUMID	341
MUDDY	*	HUMID	341
OOZY	*	HUMID	341
PLUVIAL		HUMID	341
SLIMY		HUMID	341
SLUSHY		HUMID	341
SPRINKLED		HUMID	341
SQELCHY		HUMID	341
SQUASHY	*	HUMID	341
WATERY	*	HUMID	341
WET		HUMID	341
WETTED		HUMID	341
HAZY	*	ILL-SEEN	444
INDISTINCT	*	ILL-SEEN	444
MISTY	*	ILL-SEEN	444
CRACKED		IMPERFECT	647
CLOUDY	*	IMPERSPICUOU	568
DARK		IMPERSPICUOU	568
DARK	*	IMPERSPICUOU	568
HARD	*	IMPERSPICUOU	568
OPAQUE		IMPERSPICUOU	568
BLEMISHED		INCOMPLETE	55
BOB-TAILED		INCOMPLETE	55
DEFICIENT		INCOMPLETE	55
DETERIORATED		INCOMPLETE	55
FAINT	*	INCONSIDERAB	33
INSOLUBLE	*	INDISSOLUBLE	324
AIRY		INSUBSTANTIA	4
BLANK		INSUBSTANTIA	4
BRITTLE		INSUBSTANTIA	4
COLORLESS		INSUBSTANTIA	4
EMPTY		INSUBSTANTIA	4
FEATURELESS		INSUBSTANTIA	4
FRAGILE		INSUBSTANTIA	4
GASEOUS		INSUBSTANTIA	4
GAUZY		INSUBSTANTIA	4
GOSSAMER		INSUBSTANTIA	4
HOLLOW		INSUBSTANTIA	4
LIGHTWEIGHT		INSUBSTANTIA	4
MISTY	*	INSUBSTANTIA	4
PALE		INSUBSTANTIA	4
PAPER		INSUBSTANTIA	4
SHADOWY		INSUBSTANTIA	4
TENUOUS		INSUBSTANTIA	4
THIN		INSUBSTANTIA	4
TRANSPARENT	*	INSUBSTANTIA	4
VACUOUS		INSUBSTANTIA	4
VAPOROUS	*	INSUBSTANTIA	4
DEFICIENT		INSUFFICIENT	636
DARK	*	INVISIBLE	444
ARMORED		INVULNERABLE	660
BOMB-PROOF		INVULNERABLE	660
FIRE-PROOF		INVULNERABLE	660
CHAMELEON		IRIDESCENT	437
IRIDESCENT	*	IRIDESCENT	437
MOIRE	*	IRIDESCENT	437
OPALESCENT	*	IRIDESCENT	437
OPALINE	*	IRIDESCENT	437
PEARLY	*	IRIDESCENT	437
VERSICOLOR		IRIDESCENT	437
MAZY		LABYRINTHINE	251
MEANDERING		LABYRINTHINE	251
SERPENTINE		LABYRINTHINE	251
TURNING		LABYRINTHINE	251
TWISTING		LABYRINTHINE	251
BEDDED		LAYERED	207
DECKED		LAYERED	207
FILMY	*	LAYERED	207
FLAKY		LAYERED	207
FOLIATE		LAYERED	207
FOLIATED		LAYERED	207
LAMELLAR		LAYERED	207
LAMINATED		LAYERED	207
MEMBRANOUS		LAYERED	207
SCALY	*	LAYERED	207
SEAMED		LAYERED	207
SHALY		LAYERED	207
SLATY	*	LAYERED	207
SQUAMOUS	*	LAYERED	207
STORIED		LAYERED	207
STRATIFIED		LAYERED	207
STRATIFORM	*	LAYERED	207
TABULAR		LAYERED	207
ZONED		LAYERED	207
SERE		LEAN	206

SPICERY		LEAN	206	FLASHING		LUMINOUS	417
SPINDLY		LEAN	206	FLOOD-LIT		LUMINOUS	417
AIRY		LIGHT	323	GLINTING		LUMINOUS	417
BUOYANT		LIGHT	323	GLITTERY		LUMINOUS	417
DOUGHY		LIGHT	323	GLOSSY	*	LUMINOUS	417
FEATHERY	*	LIGHT	323	GLOWING		LUMINOUS	417
FOAMY	*	LIGHT	323	INCANDESCENT		LUMINOUS	417
FROTHY	*	LIGHT	323	LAMBENT		LUMINOUS	417
GASEOUS	*	LIGHT	323	LIGHT		LUMINOUS	417
LIGHT	*	LIGHT	323	LUSTROUS	*	LUMINOUS	417
LIGHT-WEIGHT		LIGHT	323	RADIANT	*	LUMINOUS	417
WEIGHTLESS		LIGHT	323	REFLECTING		LUMINOUS	417
WHIPPED		LIGHT	323	REFRACTIVE		LUMINOUS	417
YEASTY	*	LIGHT	323	REFULGENT		LUMINOUS	417
DISSOLUBLE		LIQUIFIED	337	SCINTILLATIN		LUMINOUS	417
LIQUEFIABLE		LIQUIFIED	337	SHEENY		LUMINOUS	417
MOLTEN		LIQUIFIED	337	SHINING		LUMINOUS	417
RUNNY		LIQUIFIED	337	SHINY	*	LUMINOUS	417
SOLUBLE		LIQUIFIED	337	SOFT		LUMINOUS	417
SOLVENT		LIQUIFIED	337	SPARKLING		LUMINOUS	417
DAINTY		LITTLE	196	VIVID		LUMINOUS	417
ELONGATED		LONG	203	WELL-LIT		LUMINOUS	417
EXTENDED		LONG	203	BOGGY		MARSHY	347
EXTENSIVE		LONG	203	DIRTY		MARSHY	347
BRIGHT	*	LUMINESCENT	420	DREGGY		MARSHY	347
COLORFUL	*	LUMINESCENT	420	FENNY		MARSHY	347
FLUORESCENT	*	LUMINESCENT	420	MARSHY	*	MARSHY	347
INCANDESCENT	*	LUMINESCENT	420	MIRY		MARSHY	347
LUMINESCENT	*	LUMINESCENT	420	MOORISH		MARSHY	347
LUMINOUS	*	LUMINESCENT	420	MOORY		MARSHY	347
NEON		LUMINESCENT	420	MOSSY		MARSHY	347
PHOSPHORESCE		LUMINESCENT	420	MUCKY		MARSHY	347
RADIANT	*	LUMINESCENT	420	MUDDY	*	MARSHY	347
SHINING		LUMINESCENT	420	MUSHY		MARSHY	347
WELL-LIT		LUMINESCENT	420	OOZY	*	MARSHY	347
ABLAZE		LUMINOUS	417	POACHY		MARSHY	347
AFLAME		LUMINOUS	417	QUAGGY		MARSHY	347
AGLOW		LUMINOUS	417	SILTY		MARSHY	347
BEAMING		LUMINOUS	417	SLABBY	*	MARSHY	347
BLINDING		LUMINOUS	417	SLIMY		MARSHY	347
BLUSHING		LUMINOUS	417	SLUSHY		MARSHY	347
BRIGHT	*	LUMINOUS	417	SOGGY		MARSHY	347
BRILLIANT		LUMINOUS	417	SPONGY	*	MARSHY	347
COLORED		LUMINOUS	417	SQUASHY	*	MARSHY	347
COLORFUL	*	LUMINOUS	417	SQUELCHY		MARSHY	347
DAZZLING		LUMINOUS	417	SWAMPY		MARSHY	347
EFFULGENT		LUMINOUS	417	WATER LOGGED		MARSHY	347
FIERY		LUMINOUS	417	WATERY		MARSHY	347
FLAMING		LUMINOUS	417	CONCRETE		MATERIAL	319
FLARING		LUMINOUS	417	MASSY	*	MATERIAL	319

WEIGHTY		MATERIAL	319
ADULTERATED		MIXED	43
ALLOYED		MIXED	43
BLENDED		MIXED	43
COMPOSITE		MIXED	43
DAPPLED		MIXED	43
FUSED		MIXED	43
IRIDESCENT		MIXED	43
JUMBLED		MIXED	43
KALEIDOSCOPI		MIXED	43
LINSEY-WOOLS	*	MIXED	43
MOTLEY		MIXED	43
MULTIFORM		MIXED	43
PATCHED		MIXED	43
PATCHY	*	MIXED	43
STIRRED		MIXED	43
TANGLED		MIXED	43
WATERED		MIXED	43
BANDED		MOTTLED	437
BARRED		MOTTLED	437
BLEMISHED		MOTTLED	437
BRINDED		MOTTLED	437
BRINDLED	*	MOTTLED	437
CLOUDY	*	MOTTLED	437
DUSTY	*	MOTTLED	437
FRECKLED		MOTTLED	437
JASPERED		MOTTLED	437
LINED		MOTTLED	437
MARBLED		MOTTLED	437
POCKMARKED		MOTTLED	437
SPECKLED		MOTTLED	437
SPECKLEDY		MOTTLED	437
SPOTTED		MOTTLED	437
SPOTTY	*	MOTTLED	437
STREAKED		MOTTLED	437
STREAKY		MOTTLED	437
STRIATED		MOTTLED	437
STRIPED		MOTTLED	437
TABBY		MOTTLED	437
VEINED		MOTTLED	437
MANIFOLD	*	MULTIFORM	82
MOSAIC		MULTIFORM	82
MOTLEY		MULTIFORM	82
MULTIFOLD		MULTIFORM	82
VARIFORM		MULTIFORM	82
DANGLING		NON-ADHESIVE	49
DECOMPOSED		NON-ADHESIVE	49
DRY	*	NON-ADHESIVE	49
FLAPPING		NON-ADHESIVE	49
FLOPPING		NON-ADHESIVE	49
FLOPPY		NON-ADHESIVE	49
FLUID		NON-ADHESIVE	49
IMMISCIBLE		NON-ADHESIVE	49
LAX		NON-ADHESIVE	49
LIQUID		NON-ADHESIVE	49
LOOSE	*	NON-ADHESIVE	49
LOOSE-KNIT		NON-ADHESIVE	49
PENDENT		NON-ADHESIVE	49
PENDULOUS		NON-ADHESIVE	49
RELAXED		NON-ADHESIVE	49
RUNNY		NON-ADHESIVE	49
SEMIDETACHED		NON-ADHESIVE	49
SEPARATE		NON-ADHESIVE	49
SLACK	*	NON-ADHESIVE	49
SLIPPERY	*	NON-ADHESIVE	49
SMOOTH	*	NON-ADHESIVE	49
STREAMING	*	NON-ADHESIVE	49
WATERY	*	NON-ADHESIVE	49
AMORPHOUS		NON-UNIFORM	17
BUMPY	*	NON-UNIFORM	17
PATTERNLESS		NON-UNIFORM	17
ROUGH	*	NON-UNIFORM	17
UNIQUE		NON-UNIFORM	17
CRENATE		NOTCHED	260
DENTATE	*	NOTCHED	260
JAGGED	*	NOTCHED	260
JAGGY		NOTCHED	260
NOTCHY		NOTCHED	260
SERRATED		NOTCHED	260
SHARP		NOTCHED	260
TOOTHED		NOTCHED	260
BLANK		OPAQUE	423
CLOUDED		OPAQUE	423
CLOUDY	*	OPAQUE	423
COATED		OPAQUE	423
DIM		OPAQUE	423
DIRTY	*	OPAQUE	423
DRUMLY		OPAQUE	423
FILMY	*	OPAQUE	423
FOGGY		OPAQUE	423
FROSTED		OPAQUE	423
HAZY	*	OPAQUE	423
IMPERVIOUS	*	OPAQUE	423
MISTED		OPAQUE	423
MISTY	*	OPAQUE	423
MUDDY	*	OPAQUE	423
MURKY	*	OPAQUE	423
OPACIOUS		OPAQUE	423
PUDDLED		OPAQUE	423
SMOKY	*	OPAQUE	423

SOOTY	*	OPAQUE	423
THICK	*	OPAQUE	423
TURBID		OPAQUE	423
VAPOROUS	*	OPAQUE	423
AWRY		ORDERLESS	61
SHUFFLED		ORDERLESS	61
SLACK	*	ORDERLESS	61
CLEAR	*	ORDERLY	60
SMOOTH	*	ORDERLY	60
ENAMELED		ORNAMENTED	844
GLITTERING	*	ORNAMENTED	844
POLISHED		ORNAMENTED	844
DANGLING		PENDENT	217
DROOPING		PENDENT	217
HANGING		PENDENT	217
LOOSE	*	PENDENT	217
PENDULOUS		PENDENT	217
PENSILE		PENDENT	217
SUSPENDED		PENDENT	217
FLAWLESS		PERFECT	646
BORED		PERFORATED	263
DRILLED		PERFORATED	263
HOLEY		PERFORATED	263
HONEYCOMBED		PERFORATED	263
PEPPERED		PERFORATED	263
RIDDLED		PERFORATED	263
CLEAR	*	PERSPICUOUS	567
DEFINITE	*	PERSPICUOUS	567
LIMPID		PERSPICUOUS	567
LUCID		PERSPICUOUS	567
TRANSPARENT		PERSPICUOUS	567
CHECKERED		PIED	437
DAPPLED		PIED	437
GRIZZLED	*	PIED	437
PATCHY		PIED	437
PIEBALD	*	PIED	437
PIED	*	PIED	437
PINTO		PIED	437
ROAN	*	PIED	437
BARE	*	PLAIN	573
CLEAN		PLAIN	573
LEAKY		POROUS	263
PERCOLATING		POROUS	263
SPONGY		POROUS	263
BRANNY		POWDERY	332
BRITTLE		POWDERY	332
CRUMBLED		POWDERY	332
CRUMBLING		POWDERY	332
CRUMBLY		POWDERY	332
DIRTY		POWDERY	332
DUST-COVERED		POWDERY	332
DUSTY	*	POWDERY	332
FLOCCULENT	*	POWDERY	332
FLOURY	*	POWDERY	332
FRIABLE		POWDERY	332
GRANULAR	*	POWDERY	332
GRANULATED		POWDERY	332
GRATED		POWDERY	332
GRAVELLY		POWDERY	332
GRITTY		POWDERY	332
GROUND	*	POWDERY	332
MILLED		POWDERY	332
POWDERY	*	POWDERY	332
SANDY	*	POWDERY	332
SIFTED		POWDERY	332
SMOKY	*	POWDERY	332
SOOTY		POWDERY	332
FLABBY	*	PULPY	356
FLESHY	*	PULPY	356
MARSHY	*	PULPY	356
PASTY	*	PULPY	356
PULPY	*	PULPY	356
SOGGY	*	PULPY	356
SPONGY	*	PULPY	356
STAGNATING		QUIESCENT	266
RADIANT	*	RADIATING	417
REFLECTING	*	RADIATING	417
AERIFIED		RARE	325
AERATED		RARE	325
COMPRESSIBLE		RARE	325
ELASTIC		RARE	325
FINE	*	RARE	325
FLIMSY	*	RARE	325
GASEOUS		RARE	325
HOLLOW		RARE	325
INSUBSTANTIA		RARE	325
LIGHT	*	RARE	325
SPONGY		RARE	325
SUBTILE		RARE	325
TENUOUS		RARE	325
THIN		RARE	325
WISPY		RARE	325
BAGGY		RECEPIENT	194
CONFORMABLE		REGULAR	81
SMOOTH	*	REGULAR	81
STANDARDIZED		REGULAR	81
ASPHALTIC		RESINOUS	357
BITUMINOUS		RESINOUS	357
GUMMOUS		RESINOUS	357
MYRRHY		RESINOUS	357

PITCHY	*	RESINOUS	357	POT-HOLED		ROUGH	259
RESINY		RESINOUS	357	RIPPLING		ROUGH	259
TAPRY		RESINOUS	357	ROUGH	*	ROUGH	259
VARNISHED		RESINOUS	357	ROUGH-HEWN	*	ROUGH	259
ADHESIVE	*	RETENTIVE	778	SCABBY		ROUGH	259
CLINGING		RETENTIVE	778	STONY	*	ROUGH	259
COHESIVE		RETENTIVE	778	STUDDED		ROUGH	259
FIRM		RETENTIVE	778	WRINKLED		ROUGH	259
GLUEY		RETENTIVE	778	EMBOSSED		SALIENT	254
GUMMY		RETENTIVE	778	IMPERMEABLE		SCREENED	421
INDISSOLUBLE		RETENTIVE	778	IMPERVIOUS	*	SCREENED	421
STICKY		RETENTIVE	778	SHADOWY		SCREENED	421
FIRM		RIGID	326	SHADY		SCREENED	421
FIRM-PACKED		RIGID	326	UMBRAGEOUS		SCREENED	421
FIRM-SET		RIGID	326	AIR-PROOF		SEALED-OFF	264
INCOMPRESSIB		RIGID	326	AIR-TIGHT		SEALED-OFF	264
INELASTIC	*	RIGID	326	CLOTTED	*	SEMILIQUID	354
INEXTENSIBLE		RIGID	326	COLLOIDAL		SEMILIQUID	354
INFLEXIBLE		RIGID	326	CREAMY	*	SEMILIQUID	354
INTRACTABLE		RIGID	326	CURDLED		SEMILIQUID	354
OBDURATE		RIGID	326	EMULSIVE	*	SEMILIQUID	354
SPRINGLESS		RIGID	326	GELATINOUS		SEMILIQUID	354
STARCHED		RIGID	326	JELLIED		SEMILIQUID	354
STARCHY		RIGID	326	JUICY		SEMILIQUID	354
STIFF	*	RIGID	326	LACTEAL		SEMILIQUID	354
TAUT	*	RIGID	326	LACTESCENT		SEMILIQUID	354
TENSE		RIGID	326	LUMPY	*	SEMILIQUID	354
TIGHT	*	RIGID	326	MARSHY		SEMILIQUID	354
TIGHT-STRUNG		RIGID	326	MILKY	*	SEMILIQUID	354
BALLED		ROTUND	252	MUDDY	*	SEMILIQUID	354
BEADLIKE		ROTUND	252	MUSHY		SEMILIQUID	354
BEADY		ROTUND	252	PULPY	*	SEMILIQUID	354
COLUMNAR		ROTUND	252	ROPY	*	SEMILIQUID	354
GLOBULAR		ROTUND	252	SAPPY		SEMILIQUID	354
BLISTERED		ROUGH	259	SEMIFLUID		SEMILIQUID	354
BROKEN	*	ROUGH	259	SILTY		SEMILIQUID	354
BUMPY	*	ROUGH	259	SLABBY	*	SEMILIQUID	354
COARSE	*	ROUGH	259	SLIMY		SEMILIQUID	354
COARSE-GRAIN		ROUGH	259	SLUSHY		SEMILIQUID	354
CORRUGATED	*	ROUGH	259	SOUPY		SEMILIQUID	354
CRAGGY	*	ROUGH	259	SQUASHY	*	SEMILIQUID	354
CROSS-GRAINE		ROUGH	259	SQUELCHY		SEMILIQUID	354
GNARLED	*	ROUGH	259	STARCHY	*	SEMILIQUID	354
JAGGED	*	ROUGH	259	STODGY		SEMILIQUID	354
KNOBBY		ROUGH	259	THAWING		SEMILIQUID	354
KNOTTED	*	ROUGH	259	THICK	*	SEMILIQUID	354
LUMPY	*	ROUGH	259	CLOUDY	*	SEMITRANSPAR424	
NODULAR		ROUGH	259	OPALESCENT	*	SEMITRANSPAR424	
NUBBLY		ROUGH	259	OPALINE	*	SEMITRANSPAR424	
PITTED	*	ROUGH	259	MILKY	*	SEMITRANSPAR424	

MISTY	*	SEMITRANSPAR	424	FLAT		SMOOTH	258
PEARLY	*	SEMITRANSPAR	424	FLEECY		SMOOTH	258
BLURRY		SHADOWY	419	FLUSH		SMOOTH	258
FUZZY		SHADOWY	419	GLASSY	*	SMOOTH	258
INDISTINCT		SHADOWY	419	GLAZED		SMOOTH	258
SHADED		SHADOWY	419	GREASED		SMOOTH	258
SHADY		SHADOWY	419	GREASY	*	SMOOTH	258
VAGUE		SHADOWY	419	LACQUERED		SMOOTH	258
LIGHT		SHALLOW	212	LANATE		SMOOTH	258
ACUTE		SHARP	256	LEVEL		SMOOTH	258
ARROWY		SHARP	256	LUBRICATED		SMOOTH	258
BARBED		SHARP	256	POLISHED		SMOOTH	258
BRAMBLY		SHARP	256	SATINY		SMOOTH	258
BRIERY	*	SHARP	256	SHINY	*	SMOOTH	258
BRISTLING		SHARP	256	SILKEN		SMOOTH	258
BRISTLY	*	SHARP	256	SILKY	*	SMOOTH	258
COMBLIKE		SHARP	256	SLEEK	*	SMOOTH	258
CRAGGY	*	SHARP	256	SLICK		SMOOTH	258
CUSPED		SHARP	256	SLIPPERY	*	SMOOTH	258
EDGED		SHARP	256	SLITHERY		SMOOTH	258
HAIRY		SHARP	256	SMOOTH	*	SMOOTH	258
JAGGY		SHARP	256	SMOOTH-TEXTU		SMOOTH	258
KEEN		SHARP	256	SOAPY	*	SMOOTH	258
NEEDLELIKE		SHARP	256	SOFT	*	SMOOTH	258
NOTCHED		SHARP	256	OILED	*	SMOOTH	258
PECTINATED		SHARP	256	OILY	*	SMOOTH	258
PRICKLY		SHARP	256	VARNISHED		SMOOTH	258
SNAGGY	*	SHARP	256	VELVETY	*	SMOOTH	258
SPIKED		SHARP	256	WAXED		SMOOTH	258
SPIKY	*	SHARP	256	WELL-BRUSHED		SMOOTH	258
SPINOUS		SHARP	256	WOOLLY	*	SMOOTH	258
SPINY	*	SHARP	256	EEL-LIKE		SNAKY	251
SPURRED		SHARP	256	PERISTALTIC		SNAKY	251
STUDDED		SHARP	256	SERPENTINE		SNAKY	251
THISTLY		SHARP	256	SNAKY	*	SNAKY	251
THORNY	*	SHARP	256	WRIGGLING		SNAKY	251
WHETTED		SHARP	256	BENDABLE		SOFT	327
BARE	*	SIMPLE	44	COMPRESSIBLE		SOFT	327
ELEMENTAL		SIMPLE	44	CUSHIONY		SOFT	327
HOMESPUN		SIMPLE	44	DOUGHY		SOFT	327
HOMOGENEOUS		SIMPLE	44	DOWNY	*	SOFT	327
MONOLITHIC		SIMPLE	44	ELASTIC		SOFT	327
UNIFIED		SIMPLE	44	FLABBY	*	SOFT	327
UNIFORM		SIMPLE	44	FLACCID		SOFT	327
UNRAVELED		SIMPLE	44	FLEECY		SOFT	327
DAINTY		SMALL	33	FLOCCULENT	*	SOFT	327
DRIBBLING		SMALL	33	FLOPPY		SOFT	327
DOWNY	*	SMOOTH	258	FLUIDAL		SOFT	327
ENAMELED		SMOOTH	258	GIVING		SOFT	327
EVEN	*	SMOOTH	258	GRASSY	*	SOFT	327

IMPRESSIBLE		SOFT	327
JUICY		SOFT	327
LIGHT	*	SOFT	327
LIMP	*	SOFT	327
MARSHY		SOFT	327
MELLOW		SOFT	327
MELTING		SOFT	327
MOSSY	*	SOFT	327
MUSHY		SOFT	327
PADDED		SOFT	327
PILLOWY		SOFT	327
PITHY		SOFT	327
PLUSHY		SOFT	327
PULPY	*	SOFT	327
SILKY	*	SOFT	327
SMOOTH	*	SOFT	327
SOFT	*	SOFT	327
SOGGY		SOFT	327
SPONGY	*	SOFT	327
SPRINGY	*	SOFT	327
SQUASHY	*	SOFT	327
SQUELCHY		SOFT	327
TENDER		SOFT	327
TURFY		SOFT	327
VELVETY	*	SOFT	327
WAXY	*	SOFT	327
YIELDING		SOFT	327
BLACK		SOFT-HUED	425
CREAMY	*	SOFT-HUED	425
DARK		SOFT-HUED	425
DELICATE		SOFT-HUED	425
DINGY	*	SOFT-HUED	425
DRAB	*	SOFT-HUED	425
DULL	*	SOFT-HUED	425
DUSTY	*	SOFT-HUED	425
FADED	*	SOFT-HUED	425
FLAT		SOFT-HUED	425
LIGHT	*	SOFT-HUED	425
MAT		SOFT-HUED	425
PALE	*	SOFT-HUED	425
PASTEL		SOFT-HUED	425
PATINATED		SOFT-HUED	425
PEARLY	*	SOFT-HUED	425
SOFT		SOFT-HUED	425
TENDER	*	SOFT-HUED	425
WEATHERED		SOFT-HUED	425
CLEFT		SPACED	201
CLOVEN		SPACED	201
CRACKED	*	SPACED	201
LATTICED		SPACED	201
MESHED		SPACED	201
SPLIT		SPACED	201
BAGGY		SPACIOUS	183
BRANCHING		SPACIOUS	183
IMMOBILE		STILL	266
IMMOVABLE		STILL	266
PETRIFIED		STILL	266
EVEN	*	STRAIGHT	249
INFLEXIBLE		STRAIGHT	249
RIGID		STRAIGHT	249
UNBENT		STRAIGHT	249
STEELY	*	STRONG	162
TOUGH	*	STRONG	162
TOUGHENED		STRONG	162
CRYSTALLINE	*	SYMMETRICAL	245
LANCE-SHAPED		TAPERING	256
ALLUVIAL		TERRITORIAL	344
CHALKY		TERRITORIAL	344
CLAYEY		TERRITORIAL	344
LOAMY		TERRITORIAL	344
CLOSE-WOVEN		TEXTURAL	331
COARSE	*	TEXTURAL	331
COARSE-GRAIN		TEXTURAL	331
CROSSED		TEXTURAL	331
DELICATE		TEXTURAL	331
FILMY	*	TEXTURAL	331
FINE	*	TEXTURAL	331
FINE-GRAINED		TEXTURAL	331
FINE-SPUN		TEXTURAL	331
FINE-WOVEN		TEXTURAL	331
GOSSAMERY		TEXTURAL	331
GRAINED		TEXTURAL	331
GRANULAR	*	TEXTURAL	331
GRITTY		TEXTURAL	331
HODDEN		TEXTURAL	331
HOMESPUN		TEXTURAL	331
LINSEY-WOOLS	*	TEXTURAL	331
RIBBED	*	TEXTURAL	331
ROUGH		TEXTURAL	331
SATINY		TEXTURAL	331
SILKY	*	TEXTURAL	331
SMOOTH		TEXTURAL	331
SUBTILE		TEXTURAL	331
TEXTILE		TEXTURAL	331
TEXTURAL	*	TEXTURAL	331
TWILLED		TEXTURAL	331
WOVEN	*	TEXTURAL	331
ROPY	*	THICK	205
SOLID		THICK	205
STRONG		THICK	205

STUBBY	*	THICK	205	FACING		TRANSIENT	114
THICK-RIBBED		THICK	205	VOLATILE		TRANSIENT	114
THICKSET	*	THICK	205	CLEAR	*	TRANSPARENT	422
VISCID	*	THICK	205	CRYSTAL		TRANSPARENT	422
FAST		TIED	45	CRYSTALLINE	*	TRANSPARENT	422
GATHERED		TIED	45	FINE	*	TRANSPARENT	422
INEXTRICABLE		TIED	45	GLASSY	*	TRANSPARENT	422
INTERVOLVED		TIED	45	HYALINE		TRANSPARENT	422
KNOTTED		TIED	45	LIMPID	*	TRANSPARENT	422
LASHED		TIED	45	LIQUID	*	TRANSPARENT	422
SECURE		TIED	45	SHEER	*	TRANSPARENT	422
SEWN		TIED	45	THIN	*	TRANSPARENT	422
STITCHED		TIED	45	TRALUCENT		TRANSPARENT	422
TANGLED	*	TIED	45	TRANSLUCENT	*	TRANSPARENT	422
TAUT	*	TIED	45	TRANSPARENT	*	TRANSPARENT	422
TENSE		TIED	45	TRANSPICUOUS		TRANSPARENT	422
TIGHT		TIED	45	VITREOUS		TRANSPARENT	422
WELL-TIED		TIED	45	BRANCHING		UNASSEMBLED	75
COGGED		TOOTHED	256	CARIOUS		UNCLEAN	649
FANGED		TOOTHED	256	COARSE	*	UNCLEAN	649
HORNED		TOOTHED	256	DUNGY		UNCLEAN	649
NOTCHED	*	TOOTHED	256	FECAL		UNCLEAN	649
SERRATED		TOOTHED	256	FESTERING		UNCLEAN	649
TOOTHY		TOOTHED	256	FETID		UNCLEAN	649
TUSKED		TOOTHED	256	FOUL		UNCLEAN	649
TUSKY		TOOTHED	256	MAGGOTY		UNCLEAN	649
ADHESIVE	*	TOUGH	329	ROTTED		UNCLEAN	649
CLINGING	*	TOUGH	329	SCABBY		UNCLEAN	649
CLOSE-WOVEN		TOUGH	329	SLUMMY		UNCLEAN	649
COHESIVE		TOUGH	329	SQUALID		UNCLEAN	649
CORIACEOUS		TOUGH	329	BROWNED		UNCOOKED	670
FIBROUS		TOUGH	329	BARE	*	UNCOVERED	229
GRISTLY		TOUGH	329	BASTED		UNCTUOUS	357
GUMMY	*	TOUGH	329	GREASED		UNCTUOUS	357
INELASTIC	*	TOUGH	329	GREASY	*	UNCTUOUS	357
LEATHERY	*	TOUGH	329	LUBRICATED		UNCTUOUS	357
RIGID		TOUGH	329	OILED	*	UNCTUOUS	357
RUBBERY		TOUGH	329	OILY	*	UNCTUOUS	357
SEMILIQUID		TOUGH	329	SLIPPERY	*	UNCTUOUS	357
SPRINGLESS		TOUGH	329	BRIGHT	*	UNDIMMED	417
STICKY		TOUGH	329	BURNISHED		UNDIMMED	417
STRINGY	*	TOUGH	329	CLEAR	*	UNDIMMED	417
STRONG-FIBER		TOUGH	329	CLOUDLESS		UNDIMMED	417
TOUGH	*	TOUGH	329	DIAPHANOUS		UNDIMMED	417
TOUGHENED		TOUGH	329	FAIR	*	UNDIMMED	417
VISCID		TOUGH	329	GLASSY	*	UNDIMMED	417
VULCANIZED		TOUGH	329	GLEAMING		UNDIMMED	417
AIRLESS		TRANQUIL	266	LUCID		UNDIMMED	417
CHANGEABLE		TRANSIENT	114	PELLUCID		UNDIMMED	417
CHANGEFUL		TRANSIENT	114	POLISHED		UNDIMMED	417

SHADOWLESS		UNDIMMED	417	BLUFF		UNSHARPENED	257
TRANSLUCENT	*	UNDIMMED	417	BLUNT		UNSHARPENED	257
TRANSPARENT	*	UNDIMMED	417	BLUNTED		UNSHARPENED	257
CORRUGATED	*	UNDULATORY	251	BLUNT-NOSED		UNSHARPENED	257
CRIMPED		UNDULATORY	251	DULL		UNSHARPENED	257
CRINKLY		UNDULATORY	251	EDGELESS		UNSHARPENED	257
CURLY	*	UNDULATORY	251	FLAT		UNSHARPENED	257
FRIZZY	*	UNDULATORY	251	FLATTENED		UNSHARPENED	257
INDENTED		UNDULATORY	251	RUSTY	*	UNSHARPENED	257
KINKY		UNDULATORY	251	SNUB		UNSHARPENED	257
RAGGED		UNDULATORY	251	STUBBY	*	UNSHARPENED	257
SCALLOPED		UNDULATORY	251	TOOTHLESS		UNSHARPENED	257
WAVY		UNDULATORY	251	DISTORTED		UNSIGHTLY	842
WOOLLY		UNDULATORY	251	ALTERABLE		UNSTABLE	152
WRINKLED		UNDULATORY	251	FLOWING		UNSTABLE	152
DEFICIENT		UNEQUIPPED	670	FLUID	*	UNSTABLE	152
DISTORTED		UNEQUAL	29	LOOSE	*	UNSTABLE	152
ALIGNED		UNIFORM	16	MALLEABLE	*	UNSTABLE	152
ASSORTED		UNIFORM	16	MELTING		UNSTABLE	152
CONSISTENT		UNIFORM	16	MERCURIAL		UNSTABLE	152
DRAB	*	UNIFORM	16	PLASTIC	*	UNSTABLE	152
DRILLED		UNIFORM	16	PUFFY	*	UNSTABLE	152
EQUILATERAL		UNIFORM	16	ROCKY		UNSTABLE	152
FLAT		UNIFORM	16	RUNNING		UNSTABLE	152
FLUSH		UNIFORM	16	SOFT	*	UNSTABLE	152
GRAY	*	UNIFORM	16	UNATTACHED		UNSTABLE	152
INVARIABLE		UNIFORM	16	WHIFFLING		UNSTABLE	152
LEVEL		UNIFORM	16	WOBBLING		UNSTABLE	152
PATTERNED		UNIFORM	16	YIELDING		UNSTABLE	152
REGULAR		UNIFORM	16	BULKY		UNWIELDY	195
SIMILAR		UNIFORM	16	BOMB-PROOF		UNYIELDING	162
SMOOTH	*	UNIFORM	16	DAMP-PROOF		UNYIELDING	162
STANDARDIZED		UNIFORM	16	DENSE	*	UNYIELDING	162
SYMMETRICAL		UNIFORM	16	EVERGREEN		UNYIELDING	162
BECLOUDED		UNLIT	418	FIRE-PROOF		UNYIELDING	162
BEFOGGED		UNLIT	418	IMPERMEABLE		UNYIELDING	162
CLOUDY	*	UNLIT	418	INELASTIC		UNYIELDING	162
DIMMED		UNLIT	418	INFRANGIBLE		UNYIELDING	162
MISTED		UNLIT	418	DOG-EARED		USED	673
OBSCURED		UNLIT	418	WELL-THUMBED		USED	673
OPAQUE		UNLIT	418	WELL-WORN		USED	673
SCREENED		UNLIT	418	WORN	*	USED	673
CLARIFIED		UNMIXED	44	EVAPORABLE		VAPORIFIC	338
CLEAN	*	UNMIXED	44	GASSY		VAPORIFIC	338
CLEAR	*	UNMIXED	44	SMOKY	*	VAPORIFIC	338
PURE		UNMIXED	44	STEAMY		VAPORIFIC	338
UNDILUTED		UNMIXED	44	VAPORABLE		VAPORIFIC	338
DRY	*	UNPRODUCTIVE	172	VAPORISH		VAPORIFIC	338
FRAIL		UNSAFE	661	VAPORIZABLE		VAPORIFIC	338
BATED		UNSHARPENED	257	VAPOROUS	*	VAPORIFIC	338

VAPURY		VAPCRIFIC	338	EFFERVESCENT		WATERY	339
VOLATILE		VAPCRIFIC	338	HYDROUS		WATERY	339
BICOLCR	*	VARIEGATED	437	MCIST	*	WATERY	339
CCLORFUL	*	VARIEGATED	437	WATERY	*	WATERY	339
FLCRID		VARIEGATED	437	WET		WATERY	339
MANIFOLD	*	VARIEGATED	437	COLCRLESS	*	WEAK	163
MOSAIC		VARIEGATED	437	DRCCPING		WEAK	163
MCTLEY		VARIEGATED	437	DRY		WEAK	163
MULTICOLORED		VARIEGATED	437	FLABBY		WEAK	163
MULTIFORM		VARIEGATED	437	FLACCIC		WEAK	163
PANED		VARIEGATED	437	FLOPPY		WEAK	163
PANELED		VARIEGATED	437	GIVING		WEAK	163
PARTICOLORED		VARIEGATED	437	INSUBSTANTIA		WEAK	163
PATCHED		VARIEGATED	437	LIGHT		WEAK	163
PLAID		VARIEGATED	437	LIGHTWEIGHT		WEAK	163
RAINBOW		VARIEGATED	437	LIMP		WEAK	163
TRICOLOR	*	VARIEGATED	437	LOOSE		WEAK	163
BUSHY		VEGETAL	366	PALE	*	WEAK	163
EVERGREEN		VEGETAL	366	RELAXED		WEAK	163
FLORAL		VEGETAL	366	RICKETY		WEAK	163
FLOWERY		VEGETAL	366	SLACK	*	WEAK	163
GRASSY	*	VEGETAL	366	SLIGHT		WEAK	163
GREEN	*	VEGETAL	366	SMALL		WEAK	163
HARD-GRAINED		VEGETAL	366	SOFT	*	WEAK	163
LUSH		VEGETAL	366	THIN		WEAK	163
MOSSY		VEGETAL	366	TOTTERY		WEAK	163
RANK		VEGETAL	366	UNSTABLE		WEAK	163
SOFT-GRAINED		VEGETAL	366	WATERY	*	WEAK	163
TURFEN		VEGETAL	366	WOBBLY		WEAK	163
TURFY		VEGETAL	366	YIELDING		WEAK	163
VERDANT		VEGETAL	366	BARE		WEAKENED	163
WEEDY		VEGETAL	366	BROKEN		WEAKENED	163
WOODY		VEGETAL	366	CRUMBLING		WEAKENED	163
ADHESIVE	*	VISCID	354	DECAYING		WEAKENED	163
CLAMMY	*	VISCID	354	DEFLATED		WEAKENED	163
COHESIVE		VISCID	354	DISTORTED		WEAKENED	163
GLUEY		VISCID	354	ROTTEN		WEAKENED	163
GUMMY	*	VISCID	354	RUSTING		WEAKENED	163
JAMMY		VISCID	354	STRIPPED		WEAKENED	163
MUCILAGINOUS	*	VISCID	354	WEATHER-BEAT	*	WEAKENED	163
MUCOUS	*	VISCID	354	WITHERED		WEAKENED	163
PHLEGMATIC		VISCID	354	WORN	*	WEAKENED	163
PITUITOUS		VISCID	354	LEADEN	*	WEIGHTY	322
STICKY	*	VISCID	354	MASSIVE	*	WEIGHTY	322
SYRUPY		VISCID	354	MASSY	*	WEIGHTY	322
TACKY		VISCID	354	WEIGHTED		WEIGHTY	322
TREACLY		VISCID	354	CLEAR	*	WELL-SEEN	443
DETECTABLE		VISIBLE	443	CONSPICUOUS		WELL-SEEN	443
PALPABLE		VISIBLE	443	DEFINITE	*	WELL-SEEN	443
PERCEPTIBLE		VISIBLE	443	DISTINCT		WELL-SEEN	443

EYE-CATCHING	WELL-SEEN	443
GLARING	WELL-SEEN	443
LUMINOUS	WELL-SEEN	443
PLAIN	* WELL-SEEN	443
SHINING	WELL-SEEN	443
STRIKING	WELL-SEEN	443
WELL-DEFINED	WELL-SEEN	443
WELL-MARKED	WELL-SEEN	443
AIRY	WINDY	352

REFERENCES

Bradley, James V. Distribution-Free Statistical Tests. Englewood Cliffs, New Jersey: Prentice-Hall, 1968.

Firor, J., and Liliequist, C. Solar Flares and Prediction. In: Bedwell, T. C., Jr., and Strughold, H. (Eds.), The Proceedings of the Third International Symposium on Bioastronautics and the Exploration of Space. Alexandria, Va.: Defense Documentation Center, 1965, 24-38.

Gibson, E. J. Principles of Perceptual Learning and Development. New York: Appleton-Century-Crofts, 1969.

Guilford, J. P. Psychometric Methods. 2nd edition. New York: McGraw-Hill, 1954.

Koss, Leopold G. Diagnostic Cytology and Its Histopathological Bases. 2nd edition. Philadelphia, Penna.: Lippincott, 1968.

Papanicolaou, G. N. Atlas of Exfoliative Cytology. Cambridge, Mass.: Harvard University Press, 1954.

Pickett, R. M. Response latency in a pattern perception situation. Acta Psychologica, 1967, 27, 160-169.

Pickett, R. M. Perceiving visual texture: A literature survey. Aerospace Medical Research Laboratories, Technical Report 68-12, March 1968.

Pickett, R. M. Visual Analyses of Texture in the Detection and Recognition of Objects. In: Lipkin, B. S. and Rosenfeld, A. (Eds.), Picture Processing and Psychopictorics. New York: Academic Press, 1970, 289-308.

Pickett, R. M. Psychological Factors in Solar Observing. Air Force Cambridge Research Laboratories, Technical Report - AFCRL-71-0166, April 1971.

Siegel, Sidney. Nonparametric Statistics for the Behavioral Sciences. New York: McGraw-Hill, 1956.

☆U.S.Government Printing Office: 1972 — 759-087/738