Preface

FUNCTIONAL THEORY AND MORAL SCIENCE

Two self-evident propositions are basic in psychological science. The *Axiom of Purposiveness* recognizes that thought and action are functional, directed toward goals. The *Axiom of Integration* recognizes that thought and action depend on joint operation of multiple variables. Two cognitive processes—*valuation* of stimulus informers to construct their functional, goal-relevant values and *integration* of multiple values into a unitary response—are thus basic in thought and action as shown in the Information Integration Diagram (Figure 1.1).

By inestimable good fortune, integration has been found to follow three simple mathematical laws—averaging, adding, multiplying—in most areas of human psychology. These laws also solve the long-recalcitrant problem of true measurement, not only *response* measurement, but especially measurement of functional, goal-oriented *stimulus* values, including nonconscious values. These integration laws are an effective foundation for unification of psychological science.

Moral science can be developed on this base of mathematical law. Dedicated investigators have made applications to deserving and fairness/unfairness (Chapter 2), blame and apology (Chapter 3), legal psychology (Chapter 4), and moral development (Chapter 5).

Moral science can unify the fragmented field of psychology. Person science, social attitudes, learning/memory, emotion, judgment–decision, language, and life-span development are all important in moral thought and action. Unification has much to offer all (Chapters 7 and 8).

Chapter 1

FUNCTIONAL THEORY AND MORAL SCIENCE

Psychological science requires a functional framework. People are purposive, oriented toward goals; thought and action are to be understood in terms of their functions in pursuing goals.

Psychological science thus differs essentially from physical science in which goal teleology has long been abandoned. Unfortunately, modes of thinking derived from physical science have obstructed recognition of goal-oriented function and induced narrow conceptual fixedness in major areas of psychology.

The thesis of this book is that moral science can unify the now-fragmented field of psychology—both substantively and theoretically. Moral considerations pervade all aspects of our lives including family, friendship, school, work, group interaction, politics, religion, and law. Fairness/unfairness, praise/blame, self-interest/obligation, and reward/punishment are ubiquitous phenomena of high importance to each of us.

It would be expected, therefore, that morality would be a primary concern of psychology. This is far from true. Moral learning, of high significance, is virtually unheard of in current learning theory which is grounded on animal learning and reproductive human memory (see *Functional Theory of Learning*, Chapter 8). Moral attitudes are rarely considered in social psychology, which has lacked capability with functional analysis of strong attitudes (*Functional Theory of Attitudes*, Chapter 8). Personality theory remains entangled in typological thinking that has distant relevance to moral thought and action and usually buries the individual person in a group average (see *Person Science and Personality*, Chapter 7). And judgment-decision analysis is dominated by normative considerations and remains largely ignorant of its opportunities with functional measurement of subjective values (see *Functional Theory of Judgment-Decision*, Chapter 8).

Morality provides a substantive base that can unify all these disparate areas of psychology. Indeed, morality can free these areas from their narrow, historical ruts to help build a more human psychology.

Theoretical base for unifying psychology is available in Information Integration Theory (IIT). Three simple algebraic laws have been found in most areas of human cognition. In particular, these laws have done well in several areas of moral cognition as illustrated in Chapter 2-5. These laws provide analytic capability to deal with two fundamental obstacles: integration of multiple variables and true psychological measurement.

TWO AXIOMS FOR PSYCHOLOGY

Information Integration Theory (IIT) is grounded on two propositions whose self-evident nature warrants the term *axiom*. The *Axiom of Purposiveness* recognizes that thought and action are functional, oriented toward goals. The *Axiom of Integration* recognizes that thought and action typically result from integration of multiple determinants.

AXIOM OF PURPOSIVENESS

The purposiveness of our everyday activities is one manifestation of general goal-directedness of life. Purposiveness goes far deeper than consciousness to include biological and affective–cognitive processes developed in evolution. The Axiom of Purposiveness recognizes the biosocial functions of thought and action.

The Axiom of Purposiveness entails a functional perspective that focuses on goals. One major function of purposiveness is to place subjective, goal-oriented values on objective stimulus informers (see leftmost GOAL in the Integration Diagram below). Judgments of deserving, whether positive as in praise or negative as in blame, are one important function, common in daily life (Chapters 2 and 3).

The Axiom of Purposiveness has an important analytical implication: purposiveness imposes a one-dimensional, approach–avoidance metric on much thought and action. This metric is considered to have an evolutionary origin in sensory–motor processes for survival in the external world. Approach–avoidance tendencies of everyday life, the moral right–wrong axis in particular, are hypothesized to involve melding this general metric sense with particular affective qualities.

Purposiveness has obvious attractions as a base for general theory. This teleological attractiveness appeared in Aristotle's concept of final cause and reappears in modern attempts to understand thought and action in terms of their goals. Various conjectures about goal-oriented motivations, hopeful analogs to the concept of force in physics, are one manifestation. These conjectures pointed to important problems, but they lacked analytic power (see *Goal Theory*, Chapter 7). An effective approach is available with the three laws of information integration.

Moreover, these laws can dis-integrate an integrated response to measure functional, goal-oriented values of each individual stimulus informer. This functional measurement is central in studying valuation, a primary function of purposiveness.

AXIOM OF INTEGRATION

Information integration is fundamental in cognition. Thought and action generally depend on joint influence of two or more variables. Thus, blame for a harmful act may depend on intent behind the act as well as on amount of harm. Blame theory must address the problem of how intent and harm are integrated. Similarly, fair share may depend on effort and need as well as contribution. Similar integration considerations hold for all thought and action.

The *Axiom of Integration* is basic in every field of psychology; multiple variables are generally operative. How are these multiple variables integrated to arrive at a unified response? An answer to this integration question was found with the discovery that much integration follows simple mathematical laws.

THE MATHEMATICAL INTERNAL WORLD

PSYCHOLOGICAL ALGEBRA

The internal world of thought and action has mathematical structure. Much integrated action of two or more stimulus variables obeys one of three simple algebraic laws: averaging, adding, and multiplying. These three mathematical laws are found in almost every area of human psychology, from perception/psychophysics, learning/memory, and judgment–decision to social-moral attitudes, thought, and action. These mathematical laws of the internal world are found in young children and in nonliterate cultures. These mathematical laws of the internal world are a foundation for science of psychology.

The difficulty of discovering these laws may be seen by stating the hypothesis of additivity in terms of the Integration Diagram (p.6):

$$\psi_A + \psi_B = \rho.$$

All three entities, ψ, $+$, and ρ, are unobservable. Can testing this additive hypothesis really be possible?

The answer is *yes*–**if** our observable response R is a true linear measure of the unobservable response ρ. Simply vary S_A and S_B in a two-way factorial design. Then the factorial graph of R will be a set of parallel lines if the additive hypothesis is true (see *Parallelism Theorem* below).

Of course, this problem of true metric response measurement has been considered insoluble by nearly everyone. The common rating method, in particular, suffers well-known nonlinear biases. Hence the innumerable applications of analysis of variance failed to establish the simple adding law (Note 0). Indeed, nearly all psychological measurement theories have condemned metric response and relied on ordinal, greater than/less than response (see Chapter 6).

Success depended on two determinants. Primary was Nature's miraculous beneficence in making these three mathematical laws organic to thought and action. The other was development of simple experimental procedures to eliminate biases in the rating method (see *Method of Functional Rating* in Chapter 6).

Several difficulties also had to be resolved, especially unequal-weight averaging and prior state discussed below. However, contributions by dedicated workers in many nations have shown that the mind exhibits these mathematical laws in most areas of human psychology.

MATHEMATICAL MIND IS INNATE

The mind has innate mathematical ability (see *Innate Mathematical Mind,* Chapter 7). That the algebraic integration laws are learned disagrees with the fact that reinforcement or information feedback from the environment is typically absent. As one example, there is no normative base for exact adding-type rules in judgments of fair shares (Chapter 2) or blame (Chapter 3).

The averaging law is a further argument against learning the mathematical form of the law. Many adding-type integrations are actually averaging, but averaging differs qualitatively from adding. In particular, physical addition of a positive good can actually decrease the value of the whole (see *Opposite Effects* below). This initial finding (Anderson, 1965, 1981, Table 2.2, p. 114) has been supported by many investigators cited in Anderson (1982, Section 2.3). Innateness is also supported by the appearance of exact adding-type rules in children as young as 3+ years (see work by Diane Cuneo summarized in Anderson, 1996, pp. 257ff) and in nonliterate African farmers (Ouédraogo & Mullet, 2001).

Multiplication laws, which have been widely conjectured, were finally put on a solid base using the linear fan theorem of functional measurement (see Figures 1.13–1.19, pp. 47-59, Anderson, 1981). The multiplication law is exact, beyond mere qualitative amplification of one variable by another, further support for innateness.

FUNCTIONAL THEORY

Every area of psychology faces the same two fundamental problems. The *Axiom of Purposiveness* recognizes that thought and action are goal-directed functions of each individual person. The *Axiom of Integration* recognizes that multiple variables must be valuated and integrated to construct thought and action. How these two problems are resolved is a basic issue for every branch of psychological science. The nature of this issue is shown in the Integration Diagram of Figure 1.1.

INTEGRATION DIAGRAM

The Integration Diagram of Figure 1.1 sets out the problems posed by the two axioms. Physical stimuli, S_A and S_B, impinge on the person and are transmuted into goal-oriented, psychological values, ψ_A and ψ_B, by the valuation operator, **V**. These psychological values are integrated to construct a unified response, ρ, by the integration operator, **I**. Finally, this internal response is externalized by the action operator, **A**, to become the observable response, R.

The Axiom of Purposiveness is represented in the Integration Diagram by GOAL, which functions in all three operations. Primary is *valuation*, which constructs goal-relevant functional values (ψ_A and ψ_B) within the internal, psychological world of the individual.

The Axiom of Purposiveness entails a functional conception of psychological measurement. The psychological value of any stimulus informer depends on operative goals. The same stimulus may have different values relative to different goals. Measurement of functional, goal-specific values is essential for psychological science. Such functional measurement is possible with the three algebraic laws.

Purposiveness continues with the *integration* operation, which constructs a unitary, goal-oriented response, ρ, from the several values. Finally, the *action* operation transforms this internal response into some overt response, R.

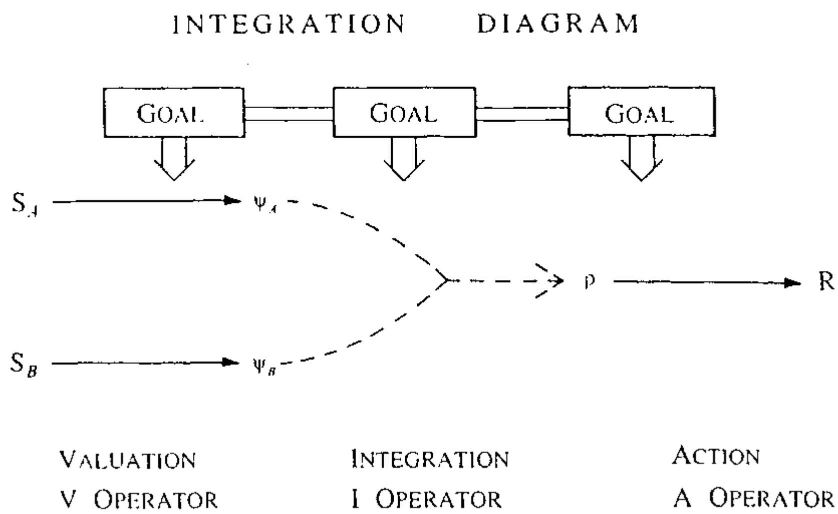

Figure 1.1. Information integration diagram. Chain of three operators, **V – I – A,** leads from observable stimulus field, {S}, to observable response, R.
Valuation operator, **V**, transmutes stimuli, S, into subjective representations, ψ_i.
Integration operator, **I**, transforms subjective field, {ψ}, into internal response, ρ.
Action operator, **A**, transforms internal response, ρ, into observable response, R.
(After N. H. Anderson, *Foundations of information integration theory*, 1981a).

INFORMATION INTEGRATION THEORY

Information Integration Theory (IIT) rests on three concepts.

1. *Integration Graphs*. An integration graph shows joint action of two or more variables, illustrated in Figure 1.2 below and in the later chapters. Pattern in the observable response of an integration graph is a key to nonobservable cognitive processes by which the variables are valuated and integrated.

2. *Functional Measurement*. Observable responses may be biased—R being a nonlinear image of underlying response, ρ. How to avoid such bias and obtain true measurement of underlying response (R = ρ) had stymied psychologists for well over a century.

Functional measurement methodology can eliminate such response biases (Chapter 6). Then the observable pattern visible in an integration graph will be a faithful image of pattern in unobservable cognition.

3. *Algebraic Laws*. Each algebraic law corresponds to specific pattern in an integration graph. Most useful is the parallelism pattern, which corresponds to an add-ave law, as in Figure 1.2 below. Experimental

studies by many investigators have revealed algebraic laws in almost every area of human psychology.

These algebraic laws are a base for unified psychology. The same laws found with young children also appear at older ages and in other cultures. These laws have been established in most areas of psychology, including person science, social attitudes, child development, learning, perception, language, emotion, and judgment–decision (see Chapter 8). These mathematical laws can unify our now-fragmented field.

BLAME THEORY

Blaming is a common moral judgment. To illustrate the problems posed by the Integration Diagram, consider the hypothesis that blame for a harmful act is the sum of two values, the intent behind the act and the harm it caused:

$$\text{Blame} = \text{Intent} + \text{Harm}. \tag{1a}$$

This is more properly rewritten in psychological terms of the foregoing Integration Diagram as

$$\rho_{\text{Blame}} = \psi_{\text{Intent}} + \psi_{\text{Harm}}. \tag{1b}$$

An experimental test could manipulate Intent of a rock throwing child (e.g., malice, carelessness) and Harm (e.g., bruised shin, black eye) as in Figure 1.2 below.

To test this blame hypothesis, somehow we must measure all three terms in Equation 1b to see if they add up. Can this really be possible? All three terms are subjective values, not directly observable. Some ψ values are not even conscious. To establish the blame hypothesis as law, we need to develop a science of the internal world. This is possible with the following parallelism theorem.

PARALLELISM THEOREM

Although the idea of moral algebra is age-old, it could not be established without capability for true psychological measurement, illustrated with the blame hypothesis of Equation 1b. The parallelism theorem offers a remarkably simple way to resolve this measurement crux.

INTEGRATION GRAPHS

An integration graph shows the response to two (or more) variables jointly manipulated, just an ordinary row × column factorial graph. The pattern in such a graph can reveal what law governs the integration of the separate variables into a unified response. This is illustrated with the adding-type law in Figure 1.2.

Add-Ave Laws. *Parallelism pattern* supports an adding-type integration, either averaging or strict adding. The integration graph of Figure 1.2 shows hypothetical blame judgments of two real developmental psychologists, F. W. and A. S., in an Intent × Harm integration design. Their task was to judge appropriate blame for a story child who threw a stone that harmed another child. Harm is varied across three levels listed on the horizontal: bruised shin, bloody nose, and black eye. The intent of the harmdoer is varied across the three levels listed by the three curves: intent to harm, intent to scare, and carelessness. Note that each point on this integration graph represents a different story child, unrelated to the others except through the common task situation.

Parallelism of Figure 1.2 supports the add-ave law of Equations 1. The scare curve lies a constant distance above the careless curve—scare adds a constant amount of blame, *regardless of amount of harm*. Every pair of curves shows a similar additive pattern. Parallelism is direct evidence for an add-ave law.

Value Measurement. Parallelism pattern can go further to reveal personal values of each person. Figure 1.2 shows that F. W. considers bloody nose and black eye equally bad; both points have the same elevation on his topmost curve. The same appears in each lower curve.

A. S., in contrast, considers black eye much worse; this point is much higher than bloody nose on each of the three curves. Perhaps she considered that a rock that caused a black eye could easily have put out the eye.

Second, F. W. considers intent to scare substantially less blamable than intent to harm, but substantially more blamable than carelessness. This is shown by the relative elevations of these three curves. A. S., in contrast, considers intent to scare only slightly more blamable than carelessness whereas intent to harm is much more blamable than either.

These personal values are measured by the integration graph. Thus, the top curve for A.S. in Figure 1.2 yields her personal values for the three amounts of harm. And—by virtue of the parallelism—these same relative values reappear in each lower curve. The same holds for F. W.

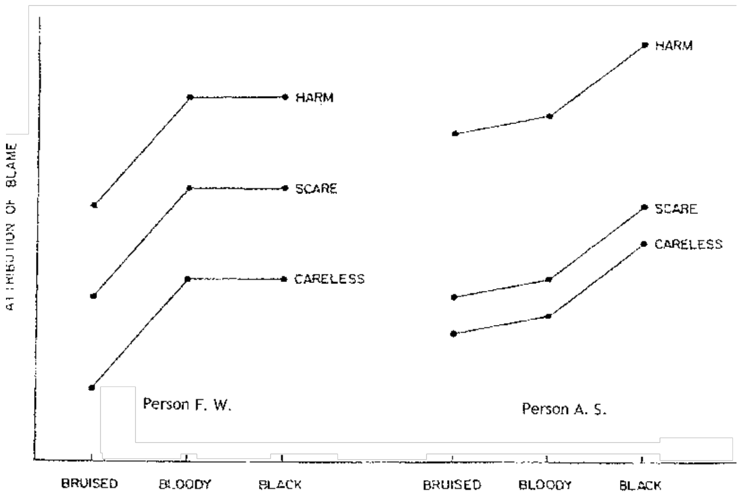

Figure 1.2. Parallelism analysis illustrated with hypothetical data. The three curves in each integration graph represent attribution of blame for bad deeds of story children specified by an Intent × Harm design. Intent is listed as the curve parameter, Harm on the horizontal. Parallelism reveals an adding-type model: Blame = Intent + Harm for both persons F. W. and A. S.. Different shapes of the graphs reflect different personal values of Intent and Harm. (After Anderson, 1990.)

These stimulus values are *functional*; these values functioned in each person's blaming process. Empirical applications are given in Chapter 3.

PARALLELISM THEOREM

The graphical reasoning of the previous section is formalized with the parallelism theorem. Consider a two-variable, row x column integration design like that of Figure 1.2. Denote the row stimuli by S_{Aj} and the column stimuli by S_{Bk}. Two premises are needed:

Premise 1: Additive integration: $\rho_{jk} = \psi_{Aj} + \psi_{Bk}$.

Premise 2: Linear response: $R_{jk} = \rho_{jk}$.

Premise 1 says that the response to the stimulus combination $\{S_{Aj}, S_{Bk}\}$ in row j, column k of the integration design is the sum of their subjective ψ values. Linear response in Premise 2 means that observable response, R_{jk}, is a faithful measure of unobservable response, ρ_{jk} (Note 1). Granted these two premises, two conclusions follow:

Conclusion 1: The integration graph will exhibit parallelism.

Conclusion 2: Mean response in each row (column) of the integration graph measures the true value of ψ_{Aj} (ψ_{Bk}).

Proof that these two conclusions follow from the two premises is simple and is omitted here.

SIX BENEFITS OF PARALLELISM

The parallelism theorem shows the logic of functional measurement:

measurement is derivative from empirical law.

Pattern in an empirical integration graph can diagnose underlying process. The long-standing dual cruxes of psychological measurement—of *response* and of *stimuli*—can be solved with a pattern of parallelism. These and other benefits of parallelism are itemized next.

1. Additive Integration. Since the two premises predict parallelism, observed parallelism supports both premises, additivity in particular. Of course, no single experiment goes very far by itself. Confidence only builds up from a group of interrelated experiments.

2. True Response Measurement. Premise 2 (linear response) is critical. Premise 1 (additivity) refers to unobservable addition: $\rho = \psi_A + \psi_B$. Could you look inside the head of F. W. or A. S., you would see a parallel integration graph.

For this unobservable pattern to appear in the observable integration graph, you need a linear response measure. Conversely, observed parallelism supports Premise 2 of response linearity, that the observed R is a true measure of the unobservable ρ (see Note 1).

True response measurement had been unsuccessfully pursued by numerous investigators for over a century. Actualizing this goal depended on development of experimental procedures to eliminate certain response biases in the rating method, making it a true linear scale (*Method of Functional Rating*, Chapter 6). Most important, of course, actualizing this goal depended on empirical reality of algebraic law (Notes 2a,b).

3. True Stimulus Measurement. An almost magic property of parallelism theory is that only the *response* need be measured. This is enough to test additivity. Prior *stimulus* measures of ψ_A and ψ_B are not needed.

No less magical, true measures of ψ_A and ψ_B are available from the integration graph. This stimulus measurement follows from Conclusion 2, already illustrated in the discussion of Figure 1.2. This measurement capability is a godsend; stimulus values may not even be conscious. This measurement is called *functional* for it measures the values that functioned in the response.

4. Meaning Invariance. Observed parallelism goes further in analysis of information processing. Parallelism implies that the stimulus informers do not interact to change one another's values. Each S_A adds the same fixed amount, ψ_A, regardless of S_B—contrary to certain strong introspectionist claims of meaning change.

5. Cognitive Unitization. Complex stimulus fields can be treated as cognitive units by virtue of the parallelism theorem. Unitization allows exact measurement of effects of complex stimulus fields (see *Analytic Context Theory,* Chapter 7).

Unitization, which follows from the Axiom of Purposiveness and an algebraic law, is invaluable for cognitive theory. The valuation operation of a complex stimulus field may be unknowably complex, much of it not conscious. Yet all your complex processing is reduced to a single number in the algebraic law—which can be exactly measured.

One notable example of Cognitive Unitization is given with Armstrong's study of wife–husband assignment of blame (Figure 3.2). The parallelism in her figure implies that the discussion of each spouse, however complex, may be measured as a single number in the integration law.

Unitization is a fundamental property of information processing. It would seem hard to pin down without an algebraic law. Once established, however, unitization may be hypothesized to hold more generally in situations that do not follow any simple integration rule.

6. Idiographic–Nomothetic Theory. The integration laws are idiographic; they apply to individual persons. And they are nomothetic; the same laws apply generally across different persons, with exact allowance for individual values. These laws thus offer a proper foundation for areas such as social attitudes and personality theory which have typically obscured the individual person in an agglomerate group average. These laws are similarly a base for cross-cultural analysis.

AVERAGING

Averaging has been by far the most common integration process in empirical studies. Most tasks that were expected to exhibit strict addition have instead exhibited averaging. Two variants of the averaging model require comment.

Averaging Model With Equal Weights. The averaging model for two variables with equal weighting may be written

$$\rho = \frac{\omega_A \psi_{Aj} + \omega_B \psi_{Bk}}{\omega_A + \omega_B}. \tag{2}$$

Here ψ_{Aj} and ψ_{Bk} denote polarity values of stimulus informers S_{Aj} and S_{Bk}, as in the Integration Diagram of Figure 1.1. Their importance weights are denoted ω_A and ω_B.

The numerator of Equation 2 is the weighted sum of stimulus values. This weighted sum is converted to an average by dividing by the sum of weights in the denominator (Note 3).

In Equation 2, all ψ_{Aj} have equal weight, ω_A, and similarly all ψ_{Bk} have equal weight, ω_B. With equal weights, the sum of weights in the denominator of Equation 2 is constant; hence it may be absorbed into the unit of the response scale. With equal weights, therefore, the averaging model obeys the parallelism theorem.

With equal weights, accordingly, all six benefits listed above for the parallelism theorem apply. The simplicity of parallelism analysis and its several benefits suggest using experimental procedures conducive to equal weighting. Most important would be to equalize amount of information across different S_{Aj} and similarly across different S_{Bk}. Further details on experimental procedure are given in Chapter 6.

Averaging Model With Unequal Weights. Equal weights will not always obtain. If S_{A1} conveys more information than S_{A2}, its importance weight will be larger. In Equation 2, ω_A would have to be replaced by ω_{Aj}, ω_B by ω_{Bk} (see Chapter 6). Parallelism theory does not apply; unequal weights cause systematic nonparallelism (Notes 4 and 5).

Unequal weights was a blessing in disguise for it allowed analyses of what seemed intractable phenomena. Many integrations do involve unequal weights and thus come under exact analysis.

Moreover, unequal weights made possible measurement of importance weight (ω) separate from value polarity (ψ), a stumbling block for previous attempts. Also, unequal weights showed that previous theories of psychological measurement were deficient conceptually (see *Measurement Theory*, Chapter 6, Appendix).

EXPERIMENTAL EVIDENCE

Information Integration Theory has done well in almost every field of human psychology. The parallelism theorem has succeeded across the age range from 4 years to old age and across diverse cultures. Some difficult problems had to be resolved, seven of which will be briefly noted (see *Twelve Theoretical Issues*, pp. 54-68, in Anderson, 2008; more detailed discussion is given in Chapters 2-4 in Anderson, 1981a).

A task of *person cognition* was used in much of this early work. Participants receive a list of personality trait adjectives that describe a person; they judge that person on likableness, a response that facilitates equal weighting and hence parallelism.

MEANING INVARIANCE

Meaning invariance, benefit 4 of the parallelism theorem, has been and sometimes remains unbelievable. To introspection, it seems compellingly clear that trait adjectives in a person description interact to change one another's meanings. Some writers still adhere to this introspective change-of-meaning hypothesis despite repeated disproof with parallelism analysis (see also next section).

A different objection is that a given stimulus may have different values in different contexts. This is not actually an objection; the context may influence the GOAL for the valuation operation in the Integration Diagram. Hence the context will also influence the value. Thus, the trait *happy-go-lucky* could be positive in a picnic companion but negative in a research assistant (Anderson, 1968a, pp. 232ff). Within either role, however, traits would have fixed value (see also next section).

Verbal reports can be priceless clues about conscious and nonconscious cognition. They can be obstinately wrong, however, as with the disbelief in meaning invariance (Note 6).

The psychological laws provide a validity criterion for verbal reports. These laws can adjudicate phenomenological claims, as with the change-of-meaning hypothesis. Such validity criteria can help develop *Science of Phenomenology* (Chapter 7).

COMPLEX PROCESSING

A specific objection to meaning invariance was that the personality adjective task may suffer from superficial processing. More natural complex processing, it was argued, would yield meaning changes that would produce deviations from parallelism.

To test this hypothesis, one group of participants was instructed to write a paragraph describing the person in their own words before they rated likableness. They are thus forced to interrelate the trait adjectives. Their integration graphs, however, still showed parallelism. Indeed, these graphs were virtually identical to those of the no-paragraph comparison group (Anderson, 1981a, pp. 168f; see especially the cogent series of experiments on this issue by Simpson & Ostrom, 1975).

OPPOSITE EFFECTS

The same stimulus may have opposite effects, additive or subtractive. Such opposite effects might seem to rule out *any* algebraic model. In fact, opposite effects is predicted by averaging theory: adding a medium stimulus will average up a low stimulus, average down a high stimulus.

Such opposite effects have given extensive support to averaging theory (e.g., Figures 4.2 and 5.2). Besides the two cited figures, the numerous examples include attitudes towards U. S. presidents (Figure 6.1), judgments of persons described by personality traits (Anderson, 1981a, Figure 1.20, p. 59), females' judgments of prospective dates (Lampel & Anderson, 1968), adjective–predicate language integration (Anderson, 1996a, Figure 12.4, p. 406), divorced women's judgments of marriage satisfaction (Anderson, 1996a, Figure 5.12, p. 178), and children's judgments of probability (Schlottmann, 2000).

SET-SIZE EFFECT

A complication for averaging theory appeared with the *set-size effect*: more informers, all of equal value, will yield a more extreme response. An attractive interpretation, pursued by some writers, was with an adding model with diminishing returns.

Averaging theory can account for this set-size effect by including the concept of initial impression, an expectation prior to receiving information that is also averaged in with given informers. Then the importance weight of each informer should be constant, regardless of set size. This analysis succeeded (see *The Set-size Effect*, Section 2.3 in Anderson, 1982; see also *Prior State* in Chapter 6).

HALO THEORY

Suppose you are given a set of personality traits that describe a person, make some integrated judgment of the person, such as likableness, and then judge the value of one specified trait of that person. This judgment will be closer to the overall judgment of the person than if it had been judged alone (Anderson & Lampel, 1965).

This effect might well seem solid proof of change of meaning. Instead, it is a halo effect; the integrated judgment of the whole reacts back on the subsequent judgment of the part. These two different interpretations imply different flow of information processing, shown in Figure 4.2, page 113 of Anderson (1996a) together with experimental evidence. Integration theory thus allows experimental analysis of halo effects, which have been a concern in personnel evaluation in business and industry but whose analysis has been hobbled by reliance on correlation analysis.

PRIMACY AND RECENCY

That first impressions have greater influence is a common belief, and was the essential base for the anchoring and adjustment heuristic of Kahneman and Tversky (see Kahneman, Slovic, & Tversky, 1982). This belief about first impressions is incorrect. IIT studies have instead shown recency, that later information has greater influence in most tasks.

A known exception is the personality trait task. This task shows substantial *primacy*—greater effects of earlier adjectives (e.g., Figure 8.2). Meaning-change was one interpretation: the initial adjectives exert an assimilation effect on the values of the later adjectives. Instead, this primacy effect was found to result from decreased attention to later adjectives (*Primacy Effect*, Section 3.3, Anderson, 1981a; Note 7 below).

INTERACTION AND CONFIGURALITY

The integration laws provide a base for studying interaction and configurality. The statistical interactions common in the literature are deviations from an additive model and are commonly assumed to have substantive reality, an assumption lovingly fostered by nearly all statistics texts. But these statistical interactions may merely be artifacts of a nonlinear response, devoid of empirical significance (see *Understanding "Interactions,"* Chapter 6).

One benefit of the many empirical findings of parallelism is their support for linearity of the *method of functional rating* (see Chapter 6). When this response method is used, deviations from parallelism may reasonably be interpreted as genuine. The negativity effect (greater importance of more negative information) was discovered from such a deviation from parallelism (Anderson, 1965).

PSYCHOLOGICAL LAWS

Can psychology aspire to true laws like those in physical science? The precision of the three laws of information integration and their generality across task and individual persons warrant a claim to an answer of *yes*.

This question was considered by the philosopher Silverberg (2003). Silverberg gave cogent, detailed evaluation of experimental evidence on Information Integration Theory and concluded (p. 299):

> N. H. Anderson and his colleagues' achievements are relevant . . . to much discussion in philosophy of cognitive science. For example, there has been much controversy whether there can be a science of ordinary psychology, that is, of higher cognition and propositional attitudes, that would bear comparison with the sorts of developments that have been achieved in the natural sciences. There has been much controversy as to whether such a psychological science would contain laws.
>
> N. H. Anderson's work presents strong grounds for affirmative answers to these questions.

UNIFIED FUNCTIONAL THEORY

The laws of information integration lead to functional modes of thinking throughout psychology. Thought and action are functional, goal-directed, as indicated by the triple GOAL of the Integration Diagram (Figure 1.1). The integration laws solve all three operations in the Integration Diagram: *valuation* of external stimuli to construct internal, goal-oriented values; *integration* of multiple values into a unitary internal response; and *externalization* of this internal response to become observable. Lacking a foundation of integration laws, previous approaches had to adopt conceptual frameworks that, however useful, often led to conceptual fixedness that severely narrowed their usefulness and relevance. This conceptual fixedness is illustrated in the following five fields.

SOCIAL PSYCHOLOGY

Functional theory distinguishes between attitudes as enduring *knowledge systems* (AKSs) and *attitudinal responses* (ARs) constructed from these AKSs to meet demands of specific situations. The traditional view, in sharp contrast, conceptualized attitudes as one-dimensional evaluative reactions that represented enduring properties of individuals (see quotes from prominent authorities in Anderson, 2008, p. 109, Note 2).

This conceptual confusion of AR with AKS failed to understand the adaptive function of AKSs to deal with situational factors. This conceptual fixedness also roadblocked development of functional theory of attitudes, widely admitted to be desirable, beyond its original appearance in the 1950s (see *Functional Theory of Attitudes*, Chapter 8).

This same conceptual fixedness also obstructed the study of integration of multiple variables, which is essential to understand situational construction of ARs from AKSs. Thus, in the fifth edition of the *Handbook of social psychology*, Wilson, Aronson, and Carlsmith (2010, p. 79) called for a new synthesis:

> Such a synthesis that will require . . . an emphasis on assessing the relative importance of several variables, which all influence an aspect of multiply-determined behavior . . .

Such synthesis had been repeatedly demonstrated over the previous 40-odd years. "Multiply-determined behavior" is the essence of IIT, which also solved the treacherous problem of measuring "relative importance."

LEARNING/MEMORY

Reproductive memory, assessed by accuracy of reproducing specific stimulus materials, has been the dominant conception in the field of memory. *Functional* memory, in contrast, is not assessed by reproductive accuracy but by the contribution of memory to other activities. It was long an "article of faith" that such contribution rested on the contents of reproductive memory.

A radically different view arose in early work on person cognition. Participants received a list of trait adjectives that described a hypothetical person, judged the person on likableness, and then gave casual recall of the adjectives that remained in memory. These two measures should show similar curves according to the "article of faith." In fact, they showed very different curves—*dissociation* of functional memory from traditional reproductive memory.

The serial curve of *recall* showed the standard recency, the most recent adjectives being best recalled. The serial curve of *likableness*, determinable from the integration law, showed the opposite effect, strong primacy, the earlier adjectives having greater effects (Figure 8.2). Functional memory, far more important than reproductive verbal memory, requires a different conceptual foundation.

New capability for functional theory of learning/memory is provided by the integration laws. How informer stimuli given on one trial influence response on later trials can be exactly measured (e.g., Figure 8.3). Traditional learning curves can be replaced by methods that are not only more analytic but more relevant to the phenomena.

JUDGMENT–DECISION

Judgment–decision needs grounding on descriptive theory that studies how people actually function. Living involves continual judgment–decisions about the best of two or more courses of action. In principle, this is simple: calculate the expected value of each course of action and choose the one with highest expected value. Of course, success in analyzing such thought and action depends substantially on knowing the true values and probabilities involved.

Without capability for such true measurement, judgment–decision has been dominated by a normative approach based on simplistic situations in which the values and probabilities are assumed known, as in games of chance. This normative approach is attractive because it leads to definite mathematical results—of indefinite relevance to real life.

It would be more meaningful, of course, if the actual subjective values and probabilities could be measured. Such measurement became possible with the integration laws. As one example, the much-conjectured multiplication rule for Subjective Expected Value was established with the linear fan theorem of functional measurement (see *Cognitive Theory of Judgment–Decision*, Chapter 10 in Anderson, 1996a).

PERSON SCIENCE

Person cognition pervades everyday life: family, friendship, work, politics, TV, and self. Integration studies led to a theoretical framework very different from traditional personality theory.

Personality theory has been dominated by typological conceptions of traits as basic elements of personality and claimed success in establishing the "Big Five." Unfortunately, this typological framework became fixated, much like the foregoing conception of social attitudes, and did not get very far in dealing with situation and context.

A more effective approach to personality is possible with the laws of information integration. These laws avoid the standard reliance on group data to define traits. These laws apply to individual persons. These laws open a path to developing functional theory—how persons function in dealing with the many problems, small and large, of everyday life (see *Person Science and Personality*, Chapter 7).

PSYCHOLOGICAL MEASUREMENT

The integration laws provide the first effective solution to the long-baffling obstacle of true psychological measurement. Warmth of a cup of coffee or heaviness of a lifted weight, for example, seem intuitively quantifiable but true measurement resisted solution. Heavier/lighter seemed no problem, but equal units, as with gram weight, seemed unattainable. Indeed, a special committee of the *British Association for Advancement of Science* (Ferguson, 1940) concluded that true measurement was impossible in psychology.

True measurement of psychological quantities is possible based on laws of information integration (e.g., benefits 2 and 3 of the parallelism theorem). These laws, however, require a different mode of thinking from that common in physical science. One essential difference is that people are goal-directed (see triple GOAL in Integration Diagram). Hence value of a stimulus depends on the organism's goal. Teleological theory is necessary for psychological science as recognized in discussions of purposiveness and goal theory by many writers.

Traditional approaches to measurement theory focused on response measurement, failing to realize the vital role of stimulus measurement. Even had they succeeded, they would have missed half the problem. Success with both was possible with functional measurement theory.

This success was possible by an almost miraculous beneficence of Nature—algebraic laws of information integration. Establishing these laws was by no means as simple as the parallelism theorem seems to say. One obstacle was to find how to remove known biases of the common rating method (see *Method of Functional Rating*, Chapter 6). Other obstacles are noted above in *Experimental Evidence* and in Chapter 6. These experimental studies by many dedicated investigators are the true foundation of psychological measurement (see *Dedication*).

FUNCTION AND TYPOLOGY

Function and *typology* represent very different organizing principles in science. Studying Nature by classification into types of phenomena has been universally popular from the ancient four elements (earth-air-water-fire) and the related medieval theory of four personality humors to modern concepts of drives, motives, needs, emotions, and personality types. Some typologies are useful, as with taste qualities (e.g., sweet, sour, bitter, salt, umami), but many are just waste, as with the four humours or the long-popular derivative temperaments (sanguine, choleric, melancholic, phlegmatic) from ancient/medieval medicine. Indeed, the medical practice of bleeding, practiced on George Washington on his deathbed, rested on four-temperament rationale.

In psychology, the "Big Five" personality types is the most prominent example of typological inadequacy. This approach has poor predictive power; the so-called "Big Five" personality traits are really the "Dinky Five." Moreover, it neglects the great importance of situation and context. Typologizing situations has also been attempted, but this has been ineffectual.

One basic inadequacy of typologies of personality is inability to deal with multiple variables. Thought and action generally involve valuation and integration of multiple variables. A person may be "conscientious," for example, but expression and extent of conscientiousness will depend on multiple variables specific to each context or situation.

The field of morality has also been approached with typological frameworks, most extensively in Kohlberg's developmental sequence of moral stages. Among other failures noted elsewhere in this book, Kohlberg's theory has zero capability with the basic problems of valuation and integration of multiple variables.

The functional approach followed in IIT focuses on dynamics of thought and action. This dynamic approach begins by recognizing that thought and action involve valuation and integration of multiple variables. This functional theory is effective by virtue of the three mathematical laws of information integration. These three mathematical laws have done well in most fields of human psychology. They hold across age, situation, and culture. They hold for individuals, with due allowance for personal values, a joint nomothetic-idiographic theory. These mathematical laws are a foundation for psychological science.

MORAL ALGEBRA

Moral algebra rests on solid empirical ground. Moral algebra is operative by 4 years of age and continues throughout the life span. Moral algebra has cross-cultural generality. Moral algebra offers powerful methods for studying social–moral cognition. A brief overview of issues covered in later empirical chapters is given here.

FAIRNESS AND EQUITY

The social maxim of fairness—people should get what they deserve—seems universal. But how do we judge what people deserve?

Systematic attempts to uncover algebraic rules of fairness and justice began in the 1960s but were roadblocked by lack of capability for true psychological measurement of deserving. This difficulty may be illustrated with the popular hypothesis that a person's fair share depends on effort as well as actual contribution:

$$\text{Fair share} = \text{contribution} + \text{effort}.$$

Testing this hypothesis requires measurement of effort. But effort is not an objective variable; how can its functional value be measured? Just apply parallelism analysis (benefit 3 of the parallelism theorem).

Functional measurement theory revealed exact algebraic laws in several such tasks, even with young children (Chapters 2 and 5). This moral algebra led to a new conceptual framework. Moreover, *un*fairness, previously submerged under fairness ideals, was recognized as a basic social motivation. Unfairness also follows algebraic laws.

BLAME

Blame, ubiquitous in everyday life, follows the basic blame law for a harmful act committed with some intent:

$$\text{Blame} = \text{Intent} + \text{Harm}.$$

Blame and other negative reactions are basic social tools. They deserve study to decrease their personal aversiveness and increase their social effectiveness. This direction has been pursued in extensions of the blame law to study apology, recompense, and extenuation (Chapter 3).

LEGAL PSYCHOLOGY

Moral algebra has done rather well in legal psychology (Chapter 4). Arduous, pioneering work by Ebbesen and Konečni uncovered sharpest contrast between Superior Court judges' ideals and their practice. In setting bail, for example, judges ideally gave high importance to community ties; in practice, community ties were completely ignored. The cogent work of these two investigators is a powerful argument for conjoint experimental–field investigation in the moral field.

Extensive dedicated work by Martin Kaplan yielded cogent clarification of several basic issues in personality theory and in juror cognition. A scientific base for the 7-year age limit for responsibility in civil liability was begun by Wilfried Hommers using integration experiments.

Understanding social–moral systems of sociological deviants and criminals is interesting in its own right and useful for improving social control. Integration experiments have advantages of objectivity and generality lacking in case reports as shown by Etienne Mullet, Yuval Wolf, and their associates. Their approach can reveal personality functioning of deviant individuals and criminals, a fascinating opportunity.

MORAL DEVELOPMENT

Moral development has central importance because social morality resides largely in the transitory knowledge systems of individuals who are born, develop, and die.

Piagetian Theory. Systematic study of blame was begun in pioneering work by Piaget who concluded that young children have strong cognitive limitations. Given the harm caused by an act and the intent of the actor, they cannot integrate the two.

Instead, said Piaget, they *center* on one or the other and judge on the basis of that one alone. Young children thus have severely limited cognitive capabilities, not only in moral cognition but generally in cognition about the external world. Only at Piaget's stage of formal operations, at 10–12 years of age, would integration laws be possible.

An entirely different picture emerged as soon as IIT was applied in the 1970s by Manuel Leon and Colleen Surber Moore. Young children can integrate very nicely—they follow algebraic laws in moral cognition, judgment–decision, and naïve physics. Such integration studies showed that young children have far higher cognitive capabilities than previously realized (Chapters 2 and 5).

Moral Stage Theories. Moral theory has been dominated by stage views that moral development progresses through a succession of distinct stages, each of which involves qualitative reorganization of the previous stage. These theories suffer crippling inadequacies, largely a consequence of their reliance on people's verbal rationalizations for their choices in moral dilemmas (see *Moral Stage Theories* in Chapter 5).

Information Integration Theory. A new base for studying moral development was provided by finding algebraic moral laws at young ages. These same moral laws appear across the lifespan and in other cultures. Moral *values* differ widely, of course, but the *integration* laws allow for this. Indeed, these laws can measure values of individuals, a unique idiographic aid for cross-age and cross-cultural analysis.

MORAL SCIENCE

Cognitive moral theory is the main concern of this book. This work is a base for the fundamental problem of social betterment. A variety of issues in moral theory are discussed in Chapters 7 and 8. One class of issues concerns cognitive processes in moral thought and action. A second class of issues involve the dual, societal–individual functions of moral systems. Moral algebra has shown promise with many issues, including deserving, both positive and negative, social attitudes, conflict/compromise, and group dynamics.

Social betterment is the most important concern of moral science. Moral systems have improved markedly over the centuries but still leave much to be desired. Further progress requires empirical grounding to which every area of psychology can contribute. Moral science offers an empirical base that can unify the now fragmented field of psychology.

FAMILY LIFE

Family life is a fundamental domain for moral science. Basic components of our moral knowledge systems develop in infancy and childhood and have been studied by many investigators. Much of our moral thought and action develop and function in family life.

The family is a natural laboratory for empirical analysis with paramount importance. The family offers invaluable opportunities for many areas of psychology (see *Family Life and Personal Design*, Chapter 6 in Anderson, 1991c).

EDUCATION

Elementary schools do valuable work teaching moral attitudes and moral behavior. This focus dwindles sharply in secondary schools whereas it should be increased. Here are unparalleled opportunities to improve the dual societal–individual functions of our moral systems.

Colleges and universities should also focus on now-neglected instruction, not only with adaptive transfer, their proper goal, but surely with marriage and parenting, which are a foundation for society (see *Education* in Chapter 7).

SOCIAL HEALING

Healing processes are needed to ameliorate negative feelings resulting from inequities inevitable in social organization and from selfishness, unfairness, and dishonesty, and maintain working levels of social interaction. Healing processes such as blame and apology (Chapter 3), retribution and recompense (Chapter 4), and forgiveness (Chapter 7) exhibit moral algebra.

Exceptional work on societal forgiving has been done by E. Mullet and his colleagues. As one example, Azar and Mullet (2001) showed that willingness to forgive a gunman who had shot a child during the civil wars in Lebanon was a neat additive function of four stimulus variables for all three Muslim sects and all three Christian sects. Forgiveness was substantial—nearly the same for gunmen of the same or opposite religion as the respondent (*Algebra of Forgiveness*, Figures 7.5 and 7.6).

UNIFICATION OF PSYCHOLOGY

Moral considerations operate at every turn of daily life, from simple courtesy to family interaction, in reactions to TV news on local and national politics, in balancing self-interest with other-obligation, and in seeking self-fulfillment. Morality should thus be a central concern in every social science, psychology especially.

But although dedicated work has been done by a number of persons, morality is hardly mentioned in the main fields of psychology. From learning to personality, morality is virtually ignored. Within each field, moreover, progress has led to increasing fragmentation, as various writers have complained.

Unification of most fields of psychology is possible by focus on the central problem of morality, to which every area can make valuable contributions. The three laws of information integration are an effective base for unifying the psychological field, discussed further in Chapter 8.

NOTES

Note 0. Ironically, much attention has been given to interaction terms in analysis of variance as though they are meaningful empirically, as in nearly all statistics texts. But of course such statistical interactions may merely be meanngless artifacts of nonlinear response (see *Understanding "Interactions"* in Chapter 6.

Note 1. Mathematically, the parallelism theorem is simple and proof is omitted here. The real problem is empirical proof. Premise 1 of the parallelism theorem contains an implicit assumption that the stimulus informers have independent effects. Hence observed parallelism supports meaning invariance (benefit 4).

This independence assumption may need to be implemented with task instructions. In the personality adjective task discussed in the text, standard instructions state that each adjective that describes the person had been contributed by a different acquaintance who knew the person well (see further Chapter 6).

Premise 2 of the parallelism theorem is a simplified statement of response linearity. The complete statement is $R = c_0 + c_1\rho$, where c_0 and c_1 are zero and unit constants. For simplicity, these constants are set at 0 and 1, respectively, here and in later chapters. This entails no restriction on the conclusions. Linear scale is a more appropriate name for what is often called an equal interval scale, a name that derives from the physicalist conception of measurement as additive units (see *Scale Types* under *Functional Measurement* in Appendix of Chapter 6).

Deviations from parallelism may be tested with the interaction term from analysis of variance to obtain a proper test of goodness of fit (Chapter 6).

Note 2a. The evidence for innateness of the three mathematical laws of information integration suggests they originate with infrahumans. Behavioral response measures have proved to be linear in some experiments with humans, bar press rate in rats, and peck rate in pigeons (e.g., Anderson, 1996a, pp. 104, 327, 401; 2002), most notably by Farley and Fantino (1978). Stimulus integration is important in infrahumans, as in sensory processing. Perhaps they also follow simple integration laws. Establishing a linear response measure, such as response rate, would be invaluable.

Note 2b. Functional measurement is possible with rank-order, monotone response measure and may be necessary with physiological or neural measures as well as with infrahumans. Practicable methods have been developed as discussed in *Monotone Analysis*, Chapter 6, Anderson (1982).

Note 3. Equation 2 for the averaging model omits the term $\omega_o I_o$, which represents the initial impression (prior state). For adding models or averaging models with equal weight, prior state acts as an additive constant and so may be omitted in parallelism analysis (see *Prior State*, Chapter 6). It must be included, however, to account for the set-size effect and for estimating weight and value with the Average program.

Note 4. Unequal weight averaging was troublesome in the early stages of IIT because it produces deviations from parallelism. These deviations could result from nonlinear response, from nonadditive integration, or from both together. Hence there was much uncertainty, because expectation for any simple model was low, because rating methods were widely condemned as being nonlinear, and because unequal weight averaging was not expected nor then considered desirable.

This tangle was unsnarled, in part because the averaging model with equal weights is common and yields parallelism, and in part because the procedures initially adopted for the method of functional rating (Chapter 6) were effective in eliminating nonlinear response bias. Most important, experimental manipulation of importance weights, as with amount or reliability of information, successfully predicted deviations from parallelism.

Note 5. With equal weights, averaging and adding models cannot be distinguished. The terms, *add-ave model*, or *adding-type model*, are accordingly used to avoid any implication of strict additivity in the integration process.

Note 6. Participants asked to explain their judgments in the personality adjective task typically give plausible accounts of how one trait adjective modified the meaning of another. The observed parallelism reveals the invalidity of these verbal reports. Instead, they appeared to be halo effects (see *Halo Theory*).

I regret that we have not made systematic study of these verbal reports. Aside from their interest for language cognition, deeper understanding of this difference between introspection and actual cognition would help develop science of phenomenology.

Note 7. Here are two of the 16 lists of personality trait adjectives used in the very careful experiment of Hendrick and Costantini (1971) to test whether the reliable primacy effect with this task of person cognition resulted from change of meaning, from inconsistency discounting, or from attention decrement:

energetic, vigorous, resourceful, stubborn, dominating, egotistical
energetic, vigorous, resourceful, withdrawn, silent, helpless

Primacy was assessed by presenting each set in high-low and low-high order. Note that the first and last three adjectives are consistent in the first list, inconsistent in the second. Hence change of meaning and inconsistency discounting predict greater primacy with the second list; attention decrement predicts no difference. Change of meaning and inconsistency discounting failed; attention decrement succeeded in this ingenious experiment, one of several basic articles by Clyde Hendrick in the early years of IIT. The adjectives and results for all 16 lists are given in Table 3.2, p. 189 of Anderson (1981a).