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Selected abstracts and citations



Daniel Kahneman's work on cognitive processes

The Centre for Clinical Governance Research in Health undertakes strategic research, evaluations and research-based projects of national and international standing with a core interest to investigate health sector issues of policy, culture, systems, governance and leadership.

***Daniel Kahneman's work on cognitive processes
Selected abstracts and citations***

Duration of project

February 2004

Search period

1892 to 2nd February 2004

Key words searched

Kahneman D. as author

Databases searched

Medline from 1966 and PsycINFO from 1892

Criteria applied

Kahneman's work

Articles that met the criteria were included in the project. A bibliography including citations and abstracts of these articles is presented on the next pages.

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Ariely, D., D. Kahneman and G. Loewenstein (2000). "Joint comment on "When does duration matter in judgment and decision making?" *Journal of Experimental Psychology: General* 129(4): 524-529.

Abstract Recent research has demonstrated that people care about the temporal relationships within a sequence of experiences. There is considerable evidence that people pay particular attention to the way experiences improve or deteriorate over time and to their maximum (peak) and final values. D. Kahneman and coauthors suggested in earlier articles that people ignore or severely underweight duration (which they referred to as duration neglect). In the preceding article, D. Ariely and G. Loewenstein (see record 2000-16324-010) challenged the generalizability of these findings and their normative implications. In the current commentary, D. Ariely, D. Kahneman, and G. Loewenstein jointly examine the issue to provide a better understanding of what they feel they have learned from this literature and to discuss the remaining open questions.

Beatty, J. and D. Kahneman (1966). "Pupillary changes in two memory tasks." *Psychonomic Science* 5(10): 371-372.

Abstract 5 Ss recalled telephone numbers from long-term and short-term memory while pupil diameter was measured. Major pupillary changes were found in both tasks. Pupil diameter seems to vary with momentary load on S.

Breiter, H. C., I. Aharon, D. Kahneman, A. Dale and P. Shizgal (2001). "Functional imaging of neural responses to expectancy and experience of monetary gains and losses." *Neuron* 30(2): 619-39.

Abstract Neural responses accompanying anticipation and experience of monetary gains and losses were monitored by functional magnetic resonance imaging. Trials comprised an initial "prospect" (expectancy) phase, when a set of three monetary amounts was displayed, and a subsequent "outcome" phase, when one of these amounts was awarded. Hemodynamic responses in the sublenticular extended amygdala (SLEA) and orbital gyrus tracked the expected values of the prospects, and responses to the highest value set of outcomes increased monotonically with monetary value in the nucleus accumbens, SLEA, and hypothalamus. Responses to prospects and outcomes were generally, but not always, seen in the same regions. The overlap of the observed activations with those seen previously in response to tactile stimuli, gustatory stimuli, and euphoria-inducing drugs is consistent with a contribution of common circuitry to the processing of diverse rewards.

Flom, M. C., F. W. Weymouth and D. Kahneman (1963). "Visual resolution and contour interaction." *Journal of the Optical Society of America* 53(9): 1026-1032.

Abstract Detecting the position of the gap in a Landholt C is adversely affected by black bars placed tangentially to the C and at a certain distance from it. The maximum bar separation affording interaction is proportional to the minimum angle of resolution even in cases of amblyopia where resolution presumably is not limited by optical spread of the image. It is suggested that this contour interaction is related to the size of the receptive field (and hence to the resolving capacity) associated with the retinal region used to fixate the target.

Fredrickson, B. L. and D. Kahneman (1993). "Duration neglect in retrospective evaluations of affective episodes." *Journal of Personality & Social Psychology* 65(1): 45-55.

Abstract Documented with 2 experiments a phenomenon of duration neglect in people's global evaluations of past affective experiences. In Study 1, 32 Ss viewed aversive film clips and pleasant film clips that varied in duration and intensity. Ss provided real-time ratings of affect during each clip and global evaluations of each clip when it was over. In Study 2, 96 Ss viewed these same clips and later ranked them by their contribution to an overall experience of pleasantness (or unpleasantness). Experimental Ss ranked the films from memory; control Ss were informed of the ranking task in advance and encouraged to make evaluations on-line. Effects of film duration on retrospective evaluations were small, entirely explained by changes in real-time affects and further reduced when made from memory. Retrospective evaluations appear to be determined by a weighing average of "snapshots" of the actual affective experiences, as if duration did not matter.

Fox, C. R. and D. Kahneman (1992). "Correlations, causes and heuristics in surveys of life satisfaction." *Social Indicators Research* 27(3): 221-234.

Abstract Hypothesized (in 2 studies) that the correlation between judgments of social comparison (SC) and of global satisfaction (GS) may be especially high in domains where people know little about others. Such inferences are most likely in private domains (love life, friends), where social information is scarce and relatively unimportant as a determinant of satisfaction. Study 1 replicated R. A. Emmons and E. Diener's findings (1985), but also found that 149 university students judged recent changes more important than social standing as a determinant of life satisfaction, especially in private domains. Study 2 examined an order effect in judgments of satisfaction using 125 undergraduates. As hypothesized, the correlation between SC and GS was higher (in private domains only) when GS was judged 1st than when the order of judgment was reversed.

Gilovich, T., D. Griffin and D. Kahneman (2002). *Heuristics and biases: The psychology of intuitive judgment*. New York, Cambridge University Press.

Abstract (from the book) This book compiles research in the heuristic and biases tradition since the initial collection of 1982 (D. Kahneman, P. Slovic and A. Tversky). The various contributors develop and critically analyze the initial work on heuristics and biases, supplement these initial statements with emerging theory and empirical findings, and extend the reach of the framework to new real-world applications.

Gilovich, T., V. H. Medvec and D. Kahneman (1998). "Varieties of regret: A debate and partial resolution." *Psychological Review* 105(3): 602-605.

Abstract Different interpretations of an apparent temporal pattern to the experience of regret were addressed through joint research. T. Gilovich and V. H. Medvec (1995a) argued that people regret actions more in the short term and inactions more in the long run because the sting of regrettable action diminishes relatively quickly, whereas the pain of regrettable inaction lingers longer. D. Kahneman (1995) disagreed, arguing that people's long-term regrets of inaction are largely wistful and therefore not terribly troublesome. Three studies that examined the emotional profile of action and inaction regrets established considerable common ground. Action regrets were found to elicit primarily "hot" emotions (e.g., anger), and inaction regrets were found to elicit both feelings of wistfulness (e.g., nostalgia) and despair (e.g., misery). Thus, some inaction regrets are indeed wistful (as Kahneman argued), whereas others are troublesome (as Gilovich and Medvec maintained).

Gopher, D. and D. Kahneman (1971). "Individual differences in attention and the prediction of flight criteria." *Perceptual & Motor Skills* 33(3): 1335-1342.

Abstract Constructed a dichotic listening test which requires S to monitor a relevant message and to ignore a concurrent message presented to the other ear. Results with 195 air force cadets and pilots show that the test has promising validity for predicting different criteria of proficiency in flying high-performance aircraft. An analysis of the most valid type of errors suggests that a change in an existing orientation was accompanied by a transient instability of selective attention. Most errors in continuous attention were omissions, which indicate a failure of the listening set. Intrusions, which indicate a failure of selectivity, were rare and their frequency was not correlated to flight criteria.

Green, D. P., D. Kahneman and H. Kunreuther (1994). "How the scope and method of public funding affect willingness to pay for public goods." *Public Opinion Quarterly* 58(1): 49-67.

Abstract Investigated the willingness to pay (WTP) for certain public benefits as indicated by responses to a questionnaire on environmental issues. Visitors to a science museum were asked about funding 2 projects (preventing oil spills to save seabirds and teaching English to immigrants) either by donations or by

means of a tax increase. When the questionnaire included a reminder of the number of persons who would be asked to make a donation or agree to a tax increase, the WTP estimates dropped by 50% or more. Thus, subtle changes in question order and wording can affect the distribution of survey responses.

Griffin, D. and D. Kahneman (2003). "Judgmental heuristics: Human strengths or human weaknesses?" Aspinwall, Lisa G (Ed); Staudinger: DC, US: American Psychological Association.

Abstract (from the chapter) Many philosophers, economists, and political scientists, as well as quite a few psychologists, hold the strong belief that normal educated human judgment is rational. We believe that this rationality presumption is unduly constraining and that descriptive models of judgment that abandon this presumption do indeed belong in a psychology human strengths. Good and poor judgments are both normal, and the processes that produce brilliant intuitive insights are also the cause of systematic biases. The study of judgment errors provides a map of regions of danger where fast and confident intuition should give way to slower reasoning processes and where automatized cognitive skills should give way to formal rules and guidelines. In this chapter, we consider how one descriptive approach to human judgment, the heuristics and biases program, fits into the positive psychology perspective.

Jacowitz, K. E. and D. Kahneman (1995). "Measures of anchoring in estimation tasks." Personality & Social Psychology Bulletin 21(11): 1161-1166.

Abstract Describes a method for the quantitative study of anchoring effects in estimation tasks and reports a study of anchoring in an estimation that illustrates these methods of analysis with 156 college students. Ss in the anchored condition first judged whether a specified number (the anchor) was higher or lower than the true value before estimating each quantity. The anchors were set at predetermined percentiles of the distribution of estimates in the calibration group (15th and 85th percentiles in this study). This procedure permitted the transformation of anchored estimates into percentiles in the calibration group, allowed pooling of results across problems, and provided a natural measure of the size of the effect. The initial judgment of the anchor is susceptible to an anchoringlike bias.

Kafry, D. and D. Kahneman (1977). "Capacity sharing and refractoriness in successive reactions." Perceptual & Motor Skills 44(1): 327-335.

Abstract 40 male Israeli college students and 20 Israeli Air Force flight cadets performed 2 rapidly successive tasks. They first pressed a key to stop a digital counter at 1 of 3 stopping times. The key-press was followed after a variable interval by the presentation of 1 of 3 lights, which required a choice response. Both responses showed impairment in the dual-task condition. The

delay of the choice response was affected by the stopping time and by the interval between the key-press and the 2nd stimulus. Complete refractoriness for a period of 200 msec was observed only for the shortest stopping-time. In the other conditions, the delay of the 2nd response decreased gradually with decreasing response-stimulus interval. The results do not support single-channel theory and are better explained by a capacity-sharing model on the assumption that preparation for a choice-response requires effort.

Kahneman, D. (1963). "The semantic differential and the structure of inferences among attributes." *American Journal of Psychology* 76(4): 554-567.

Abstract The paper reports an attempt to develop a precise algebraic model to aid in evaluation of correlational results with groups of concepts relating to connotative meaning. 60 Os (psychology students) rated 40 concepts on a semantic differential consisting of 12 scales. In a 2nd study, 30 Os rated inferences among attributes. The model developed is similar to a standard situation in psychophysical research. The studies illustrate the need for a separation of 2 confounded problems, the study of ecological relationships by sampling of concepts and the study of the cognitive system of raters.

Kahneman, D. (1964). "Temporal summation in an acuity task at different energy levels. A study of the determinants of summation." *Vision Research* 4(11): 557-66.

Kahneman, D. (1965). "Exposure duration and effective figure-ground contrast." *Quarterly Journal of Experimental Psychology* 17(4): 308-314.

Abstract The pre- and post-exposure fields in the tachistoscopic presentation are assumed to reduce the apparent contrast of the figure by brightness summation. A matching procedure was used to measure this effect. Apparent contrast rises linearly with duration, but only in the upper range. Further observations confirm the suggestion that the pre- and post-exposure fields retard the formation of bounding contours with a further reduction of apparent contrast at short durations as a result. It is indicated that the contrast-matching method provides a short-cut technique for the measurement of the temporal range of brightness summation.

Kahneman, D. (1965). "Control of spurious association and the reliability of the controlled variable." *Psychological Bulletin* 64(5): 326-329.

Abstract The techniques of matched groups, analysis of covariance, and partial correlation represent various approaches to the prevention of a spurious association between X-sub(1) and X-sub(2) due to a confounding variable, X-sub(3). In all these techniques the use of an unreliable measure for X-sub(3) leads to a systematic bias of undercorrection. Adequate corrections are possible

for the case of known reliability of X -sub(3). Groups should be matched on true scores rather than observed scores, but no correction is possible for the factorial design in which groups are formed on the basis of unreliable correlated measures. Partial correlations should be corrected for the effects of unreliability of the controlled variable. Spuriously high partials are usually obtained when this correction is not applied.

Kahneman, D. (1966). "Time-intensity reciprocity under various conditions of adaptation and backward masking." *Journal of Experimental Psychology* 71(4): 543-549.

Abstract Conditions under which duration-intensity reciprocity holds for acuity performance were investigated. Reciprocity fails to hold for the resolution of a Landolt C at 40 mL X msec when it is immediately followed or preceded by a 2-sec flash of 1 mL: performance then increases with exposure duration. Reciprocity holds when the interval between target and flash is increased to 1.5 sec. When the target is superimposed on the adapting field, reciprocity is found, but the critical duration is considerably shorter. Results are discussed in terms of recent theorizing which attributes masking by light to effects of brightness summation. The existence of an additional interference effect is indicated. The nature of this interference is discussed, with emphasis on the close similarity found between results for forward and backward masking by light.

Kahneman, D. (1966). "Time-intensity reciprocity in acuity as a function of luminance and figure-ground contrast." *Vision Research* 6(3): 207-15.

Kahneman, D. (1967). "An Onset-Onset Law for One Case of Apparent Motion and Metacontrast." *Perception & Psychophysics* 2(12): 577-584.

Abstract Undergraduate ss rated the quality of apparent motion and metacontrast in computer-controlled sequences of 2 or 3 outlined squares. For brief stimuli, the dependence of the 2 effects on temporal factors of stimulation is virtually identical. Motion and metacontrast depend solely on the asynchrony of onsets between the 2 exposures (stimulus-onset asynchrony) over a wide range of duration and interstimulus intervals. Metacontrast suppression is interpreted as a case of impossible motion. The temporal determinants of apparent motion are summarized in a model in which the effect occurs when the temporal overlap between the perceptual responses to the successive stimuli is intermediate in value.

Kahneman, D. (1968). "Method, findings, and theory in studies of visual masking." *Psychological Bulletin* 70(6): 404-425.

Abstract Classifies the various paradigms in the study of visual masking and relates them to cases of interference among cotemporaneous stimuli. The dependent variables in masking studies are described. A distinction between

criterion content and criterion level is introduced in the discussion of detection under masking and metacontrast. Various conceptions of identification of forms under masking and the contributions of masking effects to the study of psychological time are reviewed.

Kahneman, D. (1970). "Remarks on attention control." *Acta Psychologica* 33: 118-131.

Abstract Discusses recent trends in studies on optimality in the allocation of attention and on determinants of attentional performance, and gives brief reports of some new experiments. The discussion of allocation includes resistance to distraction and performance in multiple tasks. It is suggested that optimal allocation of attention is often achieved in both types of task. With regard to determinants of attentional performance, the role of spatial orientation is discussed and comments are made on results of experiments on shadowing.

Kahneman, D. (1991). "Judgment and decision making: A personal view." *Psychological Science* 2(3): 142-145.

Abstract Presents a personal view of the study of judgment and choice/decision making by discussing its history, accomplishments and limitations, and possible future. The development in which the author, with A. Tversky, took part is sometimes called the "heuristics and biases" approach. The results of 2 decades of research on heuristic and biases have yielded a substantial list of explanatory processes or mechanisms (e.g., the representativeness heuristic) and a longer list of empirical generalizations or "effects." The current research emphasis on errors and biases is attributed to the method of psychological research rather than to a generally negative view of human nature.

Kahneman, D. (1992). "Reference points, anchors, norms, and mixed feelings." *Organizational Behavior & Human Decision Processes* 51(2): 296-312.

Abstract Reviews theoretical analyses and research data to show that it is useful to view the messages that negotiators exchange as attempts by each side to communicate its reference point and to affect the other side by inducing anchors and norms. The relevant psychological principles include the automatic function of anchors and other salient experiences in affecting impressions of normality and the role of impressions of normality in moral and normative judgments. Other principles are the asymmetric emotional response to losses and to gains relative to reference points and the moral standing of reference transactions. This analysis suggests as an important problem for future research the study of how multiple reference points compete and combine, both at the level of individual preference and in the context of negotiations.

Kahneman, D. (1995). "Varieties of counterfactual thinking." Roese, Neal J (Ed); Olson: 408pp.

Abstract (from the chapter) focus on topics that may further enlarge the domain that students of counterfactual thinking call their own counterfactual thoughts: automatic and elaborative / mental simulation of complex causal systems / counterfactuals and causality / distance and mutability / omission-commission / counterfactual worlds and virtual knowledge.

Kahneman, D. (1999). Objective happiness. Well-being: The foundations of hedonic psychology. D. Kahneman and E. D. Diener. Princeton, NJ: 3-25.

Abstract (from the chapter) The goals of this chapter are to identify some of the logical and technical problems that need to be solved to turn the measurement of objective happiness into a practical possibility; to identify some of the biases that affect individuals' global judgments of their experiences; and to present an account of the bottom-up approach that is sufficiently clear to advance the discussion of how this approach should be modified, or perhaps to identify fatal flaws that should cause it to be abandoned. Topics addressed in the chapter include a bottom-up approach to the analysis of well-being; a logic for objective happiness; the good/bad (GB) dimensions; is there one GB value at a time; toward a common metric of GB value; does the GB dimension have a zero point; norms and standards; the hedonic treadmill; a satisfaction treadmill; the predicted utility of states: evaluation by changes; the decision utility of changes: gains and losses; remembered utility: episodes and moments; and heuristics and biases in satisfaction and happiness.

Kahneman, D. (2003). "Experiences of collaborative research." American Psychologist 58(9): 723-730.

Abstract The author's personal history of the research that led to his recognition in economics is described, focusing on the process of collaboration and on the experience of controversy. The author's collaboration with Amos Tversky dealt with 3 major topics: judgment under uncertainty, decision making, and framing effects. A subsequent collaboration, with the economist Richard Thaler, played a role in the development of behavioral economics. Procedures to make controversies more productive and constructive are suggested.

Kahneman, D. (2003). "A perspective on judgment and choice: Mapping bounded rationality." American Psychologist 58(9): 697-720.

Abstract Early studies of intuitive judgment and decision making conducted with the late Amos Tversky are reviewed in the context of two related concepts: an analysis of accessibility, the ease with which thoughts come to mind; a distinction between effortless intuition and deliberate reasoning. Intuitive thoughts, like percepts, are highly accessible. Determinants and consequences

of accessibility help explain the central results of prospect theory, framing effects, the heuristic process of attribute substitution, and the characteristic biases that result from the substitution of nonextensional for extensional attributes. Variations in the accessibility of rules explain the occasional corrections of intuitive judgments. The study of biases is compatible with a view of intuitive thinking and decision making as generally skilled and successful.

Kahneman, D. and J. Beatty (1966). "Pupil Diameter and Load on Memory." *Science* 154(3756): 1583-1585.

Abstract During a short-term memory task, pupil diameter is a measure of the amount of material which is under active processing at any time. The pupil dilates as the material is presented and constricts during report. The rate of change of these functions is related to task difficulty.

Kahneman, D. and J. Beatty (1967). "Pupillary Responses in a Pitch-Discrimination Task." *Perception & Psychophysics* 2(3): 101-105.

Abstract Pupils were measured while os made pitch judgments under the method of constant stimuli. A substantial dilation occurs immediately after the presentation of the comparison tone, and the size of this response is closely correlated to the difficulty of the discrimination. Baseline changes occur within each block of trials, but have little effect on the magnitude of dilations. Responses to redundant stimuli, including the standard itself, decrease during the experimental session. The results support the validity of pupillary measurements as an index of processing load.

Kahneman, D. and E. Shafir (1998). "Obituary: Amos Tversky (1937-1006)." *American Psychologist* 53(7): 793-794.

Abstract Reports the death of Amos Tversky. Tversky received his bachelor of arts from Hebrew University in Jerusalem in 1961, majoring in philosophy and psychology. He received his doctor of philosophy degree from the University of Michigan in 1965. Tversky taught at Hebrew University (1966-1978) and at Stanford University. (1978-1996), where he was the inaugural Davis-Brack Professor of Behavioral Sciences and principal investigator at the Stanford Center on Conflict and negotiation. Since 1992 he held an appointment as senior visiting professor of economics and psychology and permanent fellow of the Sackler Institute of Advanced Studies at Tel Aviv University. Tversky's main research interests were in the study of similarity, judgment under uncertainty, and decision making. His last major contribution, support theory, focused on 2 observations that had been reported in the literature: The independently judged probabilities of an event and its complement add up to approximately one, whereas the judged probabilities of separate constituents of an inclusive event usually add up to much more than the judged probability of that event.

Kahneman, D., J. Beatty and I. Pollack (1967). "Perceptual Deficit During a Mental Task." *Science* 157(3785): 218-219.

Abstract Monitored for a visual signal while engaged in a demanding mental task. The probability of detecting the signal depends on the time of its presentation during the 8 sec. Of the task. A similar time course is observed for failures to detect and for changes of pupil size. Momentary variations in the load that the task imposes on the s are reflected in both indices. Detection failures are not explained by the pupillary changes.

Kahneman, D., R. Ben-Ishai and M. Lotan (1973). "Relation of a test of attention to road accidents." *Journal of Applied Psychology* 58(1): 113-115.

Abstract Related a test of auditory selective attention, previously validated against criteria of flight proficiency, to the accident rate of 39 professional bus drivers. The test required the listener to monitor a relevant message and ignore a concurrent message presented to the other ear. A change in selective orientation was accompanied by a transient disruption of attention. Raven's Progressive Matrices was also administered, but results were not significantly correlated with the attention test. A measure of proneness to this type of disruption was significantly related to accident rate.

Kahneman, D. and D. Chajczyk (1983). "Tests of the automaticity of reading: Dilution of Stroop effects by color-irrelevant stimuli." *Journal of Experimental Psychology: Human Perception & Performance* 9(4): 497-509.

Abstract In 4 experiments with 60 undergraduates, Ss viewed color bars and words that were conflicting, congruent, or neutral. A color word shown next to a color bar facilitated color naming if it was congruent with the correct response; otherwise it interfered with color naming. The congruence and conflict effects were both diminished (diluted) by the presentation of a color-neutral word elsewhere in the field. A row of X's also produced some dilution. The dilution effects represent attentional interference rather than sensory interaction or response conflict. Because Stroop effects were susceptible to interference, the involuntary reading of color words does not satisfy one of the standard criteria of automaticity--the absence of attention demands.

Kahneman, D., E. D. Diener and N. Schwarz (1999). *Well-being: The foundations of hedonic psychology*. Princeton, NJ.

Abstract (from the jacket) This book draws upon the latest scientific research to transform our understanding of the nature of well-being. With contributions from authorities in psychology, social psychology, and neuroscience, the volume presents an account of current scientific efforts to understand human pleasure and pain, contentment, and despair. The contributions combine an analysis of

human sensations, emotions, and moods with a broad assessment of the many factors, from heredity to nationality, that bear on our well-being. Why do we grow accustomed and desensitized to changes in our lives, both good and bad? Does our happiness reflect the circumstances of our lives or is it determined by our temperament and personality? By examining the roots of our everyday likes and dislikes, the book also sheds light on some of the more extreme examples of attraction and aversion, such as addiction and depression. The authors deploy an array of methods, from the surveys and questionnaires of social science to psychological and physiological experiments, to develop a comprehensive new approach to the study of well-being. Rather than relying upon the biases of self-assessments to which most people are prone, they develop more reliable measures of well-being that compensate for our flawed self-knowledge.

Kahneman, D. and S. Frederick (2002). Representativeness revisited: Attribute substitution in intuitive judgment. *Heuristics and biases: The psychology of intuitive judgment*. T. Gilovich, D. Griffin and e. al. New York, Cambridge University Press: 49-81.

Abstract (from the chapter) The first section introduces a distinction between 2 families of cognitive operations, called System 1 and System 2. The second section presents an attribute-substitution model of heuristic judgment, which elaborates and extends earlier treatments of the topic (D. Kahneman and A. Tversky, 1982; Tversky and Kahneman, 1974, 1983). The third section introduces a research design for studying attribute substitution. The fourth section discusses the controversy over the representativeness heuristic. The last section situates representativeness within a broad family of prototype heuristics, in which properties of a prototypical exemplar dominate global judgments concerning an entire set.

Kahneman, D., B. L. Fredrickson, C. A. Schreiber and D. A. Redelmeier (1993). "When more pain is preferred to less: Adding a better end." *Psychological Science* 4(6): 401-405.

Abstract Tested whether the process of adding a period of diminishing comfort to an aversive episode can lead Ss to prefer more pain over less pain in a direct choice. 32 male undergraduates were exposed to 2 aversive experiences. In a short trial, they immersed one hand in water at 14 C for 60 secs. In a long trial, they immersed the other hand at 14 C for 60 secs, then kept the hand in the water 30 secs longer as the temperature of the water was gradually raised to 15 C, still painful but distinctly less so for most Ss. Ss were later given a choice of which trial to repeat. A significant majority chose to repeat the long trial, apparently preferring more pain over less. Results suggest that duration plays a small role in retrospective evaluations of aversive experiences.

Kahneman, D. and E. Ghiselli (1962). "Validity and nonlinear heteroscedastic models." *Personnel Psychology* 15(2): 1-11.

Abstract Use of the Pearsonian coefficient in validation studies implies that linear homoscedastic relationships hold between test scores and criteria, that the accuracy of prediction of criteria from test scores is the same throughout the entire range of scores, and that both success and failure on a job are the result of the same factors. Examination of the relationships between test scores and criteria for 3 groups--executives, office workers, and autobus repairmen--indicated that descriptions of the predictive power of the tests and of the traits important in job success and failure as given by the Pearsonian validity coefficient were not as meaningful and useful as when using theta. Success and failure are often due to different trait patterns.

Kahneman, D. and D. T. Miller (1986). "Norm theory: Comparing reality to its alternatives." *Psychological Review* 93(2): 136-153.

Abstract Presents a theory of norms and normality and applies the theory to phenomena of emotional responses, social judgment, and conversations about causes. Norms are assumed to be constructed ad hoc by recruiting specific representations. Category norms are derived by recruiting exemplars. Specific objects or events generate their own norms by retrieval of similar experiences stored in memory or by construction of counterfactual alternatives. The normality of a stimulus is evaluated by comparing it with the norms that it evokes after the fact, rather than to precomputed expectations. Norm theory is applied in analyses of the enhanced emotional response to events that have abnormal causes, of the generation of predictions and inferences from observations of behavior, and of the role of norms in causal questions and answers.

Kahneman, D. and D. T. Miller (2002). Norm theory: Comparing reality to its alternatives. *Heuristics and biases: The psychology of intuitive judgment*. T. Gilovich, D. Griffin and e. al. New York, Cambridge University Press: 348-366.

Abstract (from the chapter) This chapter is concerned with category norms that represent knowledge of concepts and with stimulus norms that govern comparative judgments and designate experiences as surprising. The central idea of the present treatment is that norms are computed after the event rather than in advance. Topics discussed in this chapter include the following: mutability and the availability of counterfactuals, affective role of counterfactuals, codes and category norms in person perception, and causal questions and answers.

Kahneman, D. and J. Norman (1964). "The time-intensity relation in visual perception as a function of observer's task." *Journal of Experimental Psychology* 68(3): 215-220.

Abstract The duration-intensity relationship was investigated for a task in which triads of digits were to be identified. Critical durations ($t_{sub(c)}$) of 200-350

msec. were found for 5 Ss. Under identical stimulus conditions t -sub(c) for subjective brightness, determined by a matching method, was about 100 msec. for 2 of the Ss. It was concluded that t -sub(c) varies as a function of perceptual task and that it does not represent the duration of an early "sensory" phase of the visual process.

Kahneman, D., J. Norman and M. Kubovy (1967). "Critical Duration for the Resolution of Form: Centrally or Peripherally Determined?" *Journal of Experimental Psychology* 73(3): 323-327.

Abstract Bloch's law is shown to hold for a visual acuity task with monocular and binocular viewing as well as in a condition where the target was presented to the right and left eyes in immediate succession. The critical duration in the latter condition was found to be approximately double that in the other experimental conditions. It is concluded that the critical duration for the resolution of form is not determined at a visual station where binocular summation occurs, i.e., a station in the visual cortex. Moreover, the hypothesis that the critical duration corresponds to a central "moment" fails to be supported.

Kahneman, D., L. Onuska and R. E. Wolman (1968). "Effects of grouping on the pupillary response in a short-term memory task." *Quarterly Journal of Experimental Psychology* 20(3): 309-311.

Abstract Heard strings of 9 digits for immediate recall, either at a monotone 1/sec rate or in groups of 3 digits separated by pauses. Concurrent measurements of pupil size show a steady dilation in the monotone condition, and brief dilation-constriction waves during the pauses of grouped presentation. The results are consistent with hypotheses concerning rehearsal in the 2 modes of presentation. Pupillary dilations apparently accompany episodes of covert rehearsal.

Kahneman, D. and W. Peavler (1969). "Incentive effects and pupillary changes in association learning." *Journal of Experimental Psychology* 79(2): 312-318.

Abstract Obtained pupillary measurements for 10 undergraduate Ss during a learning task. On a trial, 8 digit-noun pairs were presented aurally for immediate recall. The digit, even or odd, determined the monetary incentive for retaining the pair. The same nouns were paired to the Digits 2-9 for 8 trials, with a different pairing on every trial. High-reward (HR) items were learned more often than low-reward (LR) items, and occasioned larger pupillary dilations following the presentation of the response noun. Within an incentive class, pupil responses at study did not predict recall. The differential pupil response of Ss to HR and LR items corresponded closely to a behavioral index of preference for HR items.

Kahneman, D., W. Peavler and L. Onuska (1968). "Effects of Verbalization and Incentive on the Pupil Response to Mental Activity." *Canadian Journal of Psychology* 22(4): 186-196.

Abstract Studied measurements of pupil size during performance of a short-term memory task (add 0) and a digit transformation task (add 1). In exp. I, ss either repeated their answer twice (speaking) or thought the answer 1st then said it aloud once (thinking). Small dilatations occurred on the 1st utterance of a digit string. In exp. II, the risk associated with the task was varied by monetary incentive and penalty. High incentive only increased the pupil response to the easier task. In both experiments, the largest effects were associated with task difficulty. Results confirmed the validity of pupil measures as indicators of the load imposed by mental activity.

Kahneman, D. and W. S. Peavler (1969). "Incentive effects and pupillary changes in association learning." *Journal of Experimental Psychology* 79(2): 312-8.

Kahneman, D., I. Ritov, K. E. Jacowitz and P. Grant (1993). "Stated willingness to pay for public goods: A psychological perspective." *Psychological Science* 4(5): 310-315.

Abstract Compared an economic and a psychological interpretation of willingness to pay (WTP) for the provision of a good. 311 adults indicated their WTP to prevent or to remedy threats to public health or to the environment, attributed either to human or to natural causes. WTP was significantly higher when the cause of a harm was human, though the effect was not large. The means of WTP for 16 issues were highly correlated with the means of other measures of attitude, including a simple rating of the importance of the threat. The responses are better described as expressions of attitudes than as indications of economic value, contrary to the assumptions of the contingent valuation method.

Kahneman, D. and J. S. Snell (1992). "Predicting a changing taste: Do people know what they will like?" *Journal of Behavioral Decision Making* 5(3): 187-200.

Abstract College students in 2 experiments made predictions of their future liking for stimuli to which they were then exposed for 1 wk. The stimuli were ice cream in a pilot study (with 16 Ss), plain yogurt in the main study (with 151 Ss), and short musical pieces in both studies. Decreased liking was the modal prediction, even when the true outcome was increased liking, or reduced dislike. There was substantial stability of tastes, but there were also substantial individual differences in the size and the sign of changes in liking with repeated exposure. There was little or no correlation between the predictions of hedonic change that Ss made and the changes they actually experienced.

Kahneman, D., A. Treisman and J. Burkell (1983). "The cost of visual filtering." *Journal of Experimental Psychology: Human Perception & Performance* 9(4): 510-522.

Abstract In 5 experiments with 51 university students who viewed various combinations of words, colors, and shapes on a computer terminal, speeded choice responses (reading or naming) to a relevant stimulus under conditions of spatial uncertainty were delayed by the simultaneous occurrence of other events. This filtering cost occurred despite high discriminability of target and distractors, which allowed parallel detection of the target in search through the same displays. Reading was also delayed when the removal of irrelevant objects from the field coincides with the onset of the target. Filtering costs were caused by the processing of events rather than by the mere presence of irrelevant items. They were eliminated by advance information about the location of the target or by advance presentation of maintained distractors. Results are discussed in terms of "object files," a mode of representation that occurs in structures that are episodic, temporary, and addressable by spatiotemporal coordinates and physical attributes rather than by semantic properties.

Kahneman, D., A. Treisman and B. J. Gibbs (1992). "The reviewing of object files: Object-specific integration of information." *Cognitive Psychology* 24(2): 175-219.

Abstract Seven experiments (N = 205) explored a form of object-specific priming. A preview field containing 2 or more letters was followed by a target letter to be named. Displays were designed to produce perceptual interpretation of the target as a new state of an object that previously contained one of the primes. The link was produced by a shared location, a shared relative position in a moving pattern, or successive appearance in the same moving frame. An object-specific advantage was consistently observed: naming was facilitated by a preview of the target if the 2 appearances were linked to the same object. Amount and object specificity of the preview benefit were not affected by extending preview duration to 1 sec or by extending the temporal gap between fields to 590 msec.

Kahneman, D., B. Tursky, D. Shapiro and A. Crider (1969). "Pupillary, heart rate, and skin resistance changes during a mental task." *Journal of Experimental Psychology* 79(1): 164-167.

Abstract 10 undergraduates performed a paced mental task at 3 levels of difficulty, while time-locked recordings of pupil diameter, heart rate, and skin resistance were made. A similar pattern of sympathetic-like increase was found in the 3 autonomic functions during information intake and processing, followed by a decrease during the report phase. The peak response in each measure was ordered as a function of task difficulty.

Kahneman, D. and A. Tversky (1972). "Subjective probability: A judgment of representativeness." *Cognitive Psychology* 3(3): 430-454.

Abstract Explores a heuristic device-representativeness-according to which the subjective probability of an event, or a sample, is determined by the degree to which it is similar in essential characteristics to its parent population, and reflects the salient features of the process by which it is generated. This device is explicated in a series of empirical examples demonstrating predictable and systematic errors in the evaluation of uncertain events. In particular, since sample size does not represent any property of the population, it is expected to have little or no effect on judgment of likelihood. This prediction is confirmed in studies showing that subjective sampling distributions and posterior probability judgments are determined by the most salient characteristic of the sample (e.g., proportion or mean) without regard to the size of the sample. The present heuristic approach is contrasted with the normative (Bayesian) approach to the analysis of the judgment of uncertainty.

Kahneman, D. and A. Tversky (1973). "On the psychology of prediction." *Psychological Review* 80(4): 237-251.

Abstract Considers that intuitive predictions follow a judgmental heuristic-representativeness. By this heuristic, people predict the outcome that appears most representative of the evidence. Consequently, intuitive predictions are insensitive to the reliability of the evidence or to the prior probability of the outcome, in violation of the logic of statistical prediction. The hypothesis that people predict by representativeness was supported in a series of studies with both naive and sophisticated university students (N = 871). The ranking of outcomes by likelihood coincided with the ranking by representativeness, and Ss erroneously predicted rare events and extreme values if these happened to be representative. The experience of unjustified confidence in predictions and the prevalence of fallacious intuitions concerning statistical regression are traced to the representativeness heuristic.

Kahneman, D. and A. Tversky (1979). "On the interpretation of intuitive probability: A reply to Jonathan Cohen." *Cognition* 7(4): 409-411.

Abstract Argues that J. Cohen's (see record 1981-04405-001) critique of the present authors' work (1979) is unfounded, and that his Baconian formalism has little normative and descriptive appeal.

Kahneman, D. and A. Tversky (1982). "A reply to Evans." *Cognition* 12(3): 325-326.

Abstract Replies to J. St. B. Evans's (see record 1983-24906-001) critique of the present authors' (see record 1982-24674-001) discussion of statistical

intuitions. The present authors' disagreement concerning Evans's belief that only errors require explanation is discussed.

Kahneman, D. and A. Tversky (1982). "Variants of uncertainty." *Cognition* 11(2): 143-157.

Abstract In contrast to formal theories of judgment and decision that employ a single notion of probability, psychological analyses of responses to uncertainty reveal a variety of processes and experiences that may follow different rules. Elementary forms of expectation and surprise in perception are reviewed. A phenomenological analysis is described that distinguishes external attributions (disposition) from internal attributions of uncertainty (ignorance). Assessments of uncertainty can be made in different modes, by focusing on frequencies, propensities, the strength of arguments, or direct experiences of confidence. These variants of uncertainty are associated with different expressions in natural language and are suggestive of competing philosophical interpretations of probability.

Kahneman, D. and A. Tversky (1982). "On the study of statistical intuitions." *Cognition* 11(2): 123-141.

Abstract The study of intuitions and errors in judgment under uncertainty is complicated by several factors: discrepancies between acceptance and application of normative rules; effects of content on the application of rules; Socratic hints that create intuitions while testing them; demand characteristics of within-S experiments; and Ss' interpretations of experimental messages according to standard conversational rules. It is argued that the positive analysis of a judgmental error in terms of heuristics may be supplemented by a negative analysis that seeks to explain why the correct rule is not intuitively compelling. A negative analysis of nonregressive prediction is outlined.

Kahneman, D. and A. Tversky (1982). "The psychology of preferences." *Scientific American* 246(1): 136-143.

Abstract Presents examples in which a decision, preference, or emotional reaction is controlled by factors that may appear irrelevant to the choice made. The difficulty people have in maintaining a comprehensive view of consequences and their susceptibility to the vagaries of framing illustrate impediments to rational decision making. However, experimental surveys indicate that such departures from objectivity tend to follow regular patterns that can be described mathematically. The descriptive study of preferences also challenges the theory of rational choice, as it is often unclear whether the effects of decision weights, reference points, framing, and regret should be considered as errors or biases or whether they should be accepted as valid elements of human experience.

Kahneman, D. and A. Tversky (1983). "Can irrationality be intelligently discussed?" Behavioral & Brain Sciences 6(3): 509-510.

Abstract In response to I. Levi's (see record 1984-22329-001) commentary, the present authors (see record 1973-03699-001) clarify their position on base rates and Bayesian norms of rationality. The present authors contend that their work has been concerned with systematic errors produced by fallible heuristics, but that they have never attributed irrationality to their Ss. They reassert that heuristics such as availability or representativeness are useful and often yield reasonable estimates and that, while they do not ensure accuracy or coherence, they are neither intrinsically fallacious nor programmed for irrationality.

Kahneman, D. and A. Tversky (1996). "On the reality of cognitive illusions." Psychological Review 103(3): 582-591.

Abstract The study of heuristics and biases in judgment has been criticized in several publications by G. Gigerenzer, who argues that "biases are not biases" and "heuristics are meant to explain what does not exist" (1991, p. 102). This article responds to Gigerenzer's critique and shows that it misrepresents the authors' theoretical position and ignores critical evidence. Contrary to Gigerenzer's central empirical claim, judgments of frequency-not only subjective probabilities-are susceptible to large and systematic biases. A postscript responds to Gigerenzer's (see record 199601780-008) reply.

Kahneman, D. and A. Tversky (2002). "Choices, values and frames: Book review." Journal of Behavioral Decision Making 15(5): 469-473.

Abstract Review of book: Choices, Values and Frames, Daniel Kahneman and Amos Tversky (Eds.), Cambridge: Cambridge University Press, 840 pp., ISBN 0521627494 (pb), 0521621720 (hc). Reviewed by Daniel Read.

Kahneman, D. and C. A. Varey (1990). "Propensities and counterfactuals: The loser that almost won." Journal of Personality & Social Psychology 59(6): 1101-1110.

Abstract Close counterfactuals are alternatives to reality that "almost happened." A psychological analysis of close counterfactuals offers insights into the underlying representation of causal episodes and the inherent uncertainty attributed to many causal systems. The perception and representation of causal episodes is organized around possible focal outcomes, evoking a schema of causal forces competing over time. A distinction between 2 kinds of assessments of outcome probability is introduced: dispositions, based on causal information available prior to the episode, and propensities, based on event cues obtained from the episode itself. The distinction is critical to the use of almost, which requires the attribution of a strong propensity to the counterfactual outcome. The final discussion focuses on characteristic differences between psychological and

philosophical approaches to the analysis of counterfactuals, causation, and probability.

Kahneman, D. and R. E. Wolman (1970). "Stroboscopic motion: Effects of duration and interval." *Perception & Psychophysics* 8(3): 161-164.

Abstract Presents an extension of a study by D. Kahneman (see record 1968-06484-001) accounting for the effects of temporal factors on a stroboscopic motion. The quality of stroboscopic motion induced by the successive presentation of 2 illuminated squares obeys 2 rules. For all stimulus durations shorter than 100 msec., optimal motion occurs when the stimulus onsets differ by about 120 msec. For stimulus durations longer than 100 msec., optimal motion occurs when the 2nd stimulus begins at the termination of the 1st stimulus. The 2 rules relating quality of motion to duration suggest a single principle, i.e., that the quality depends only on the interval between the visual responses to the 2 stimuli. The interresponse interval at which motion is optimal is independent of stimulus duration.

Kahneman, D. and P. Wright (1971). "Changes of pupil size and rehearsal strategies in a short-term memory task." *Quarterly Journal of Experimental Psychology* 23(2): 187-196.

Abstract 12 paid volunteer housewives learned lists consisting of 3 groups of 4 items each drawn from vocabularies of digits, color names, or boys' names. There were total or partial conditions of recall, and 3- and 7-sec retention intervals. A view of the function of rehearsal suggests that rehearsal for total recall should be more intense than for partial recall, but only with a brief retention interval. Measurements of pupillary diameter confirm this prediction. Conditions under which pupillary measurements can serve to test theories of psychological processes are discussed.

Keinan, G., N. Friedland, D. Kahneman and D. Roth (1999). "The effect of stress on the suppression of erroneous competing responses." *Anxiety, Stress, & Coping* 12(4): 455-476.

Abstract Examined the effects of stress-induced mental load on the ability to control and suppress thoughts. In Exp 1, 103 students (aged 18-44 yrs) completed arithmetic, estimation, number series (NU), and analogies (AN) tasks under conditions of either high or low stress. Ss also reported perceived resultant stress levels. Exp 2 replicated Exp 1 with 111 male navy personnel (aged 17.5-18.5 yrs). Results show Ss completing tasks in the high stress condition perceived the NU and AN tasks as more difficult than those Ss in the low stress condition. Interference effects were observed in the performance of both the addition and multiplication exercises. It is concluded that stress heightens the difficulty of suppressing or filtering out competing responses that interfere with task performance.

Lovallo, D. and D. Kahneman (2000). "Living with uncertainty: Attractiveness and resolution timing." *Journal of Behavioral Decision Making* 13(2): 179-190.

Abstract This study extends G. Loewenstein's (1987) notions of savoring and dread to the domain of uncertainty. Measures of attractiveness and of willingness to delay the resolution of uncertainty were obtained for 16 2-outcome gambles with expected value of \$1,000 and for reflected versions of the same gambles. 345 Ss participated in 3 experiments. In both sets, the correlation between the means of the 2 measures was almost perfect. Positively skewed gambles were most attractive, and associated with the highest tolerance for delayed resolution. A measure of willingness to pay for early resolution showed a similar pattern.

Lovallo, D. and D. Kahneman (2003). "Delusions of success. How optimism undermines executives' decisions." *Harvard Business Review* 81(7): 56-63, 117.

Abstract The evidence is disturbingly clear: Most major business initiatives--mergers and acquisitions, capital investments, market entries--fail to ever pay off. Economists would argue that the low success rate reflects a rational assessment of risk, with the returns from a few successes outweighing the losses of many failures. But two distinguished scholars of decision making, Dan Lovallo of the University of New South Wales and Nobel laureate Daniel Kahneman of Princeton University, provide a very different explanation. They show that a combination of cognitive biases (including anchoring and competitor neglect) and organizational pressures lead managers to make overly optimistic forecasts in analyzing proposals for major investments. By exaggerating the likely benefits of a project and ignoring the potential pitfalls, they lead their organizations into initiatives that are doomed to fall well short of expectations. The biases and pressures cannot be escaped, the authors argue, but they can be tempered by applying a very different method of forecasting--one that takes a much more objective "outside view" of an initiative's likely outcome. This outside view, also known as reference-class forecasting, completely ignores the details of the project at hand; instead, it encourages managers to examine the experiences of a class of similar projects, to lay out a rough distribution of outcomes for this reference class, and then to position the current project in that distribution. The outside view is more likely than the inside view to produce accurate forecasts--and much less likely to deliver highly unrealistic ones, the authors say.

Mellers, B., R. Hertwig and D. Kahneman (2001). "Do frequency representations eliminate conjunction effects? An exercise in adversarial collaboration." *Psychological Science* 12(4): 269-275.

Abstract Offers an approach to scientific debate called adversarial collaboration. The approach requires both parties to agree on empirical tests for resolving a dispute and to conduct these tests with the help of an arbiter. In dispute were R. Hertwig's claims that frequency formats eliminate conjunction effects and that the conjunction effects previously reported by D. Kahneman and A. Tversky occurred because some participants interpreted the word "and" in "bank tellers and feminists" as a union operator. Hertwig proposed two new conjunction phrases, "and are" and "who are," that would eliminate the ambiguity. Kahneman disagreed with Hertwig's predictions for "and are," but agreed with his predictions for "who are." B. Mellers served as arbiter. Frequency formats by themselves did not eliminate conjunction effects with any of the phrases, but when filler items were removed, conjunction effects disappeared with Hertwig's phrases. Kahneman and Hertwig offer different interpretations of the findings. The benefits of adversarial collaboration over replies and rejoinders is discussed, and suggested protocol for adversarial collaboration is suggested.

Nickerson, C., N. Schwarz, E. Diener and D. Kahneman (2003). "Zeroing on the dark side of the American Dream: A closer look at the negative consequences of the goal for financial success." *Psychological Science* 14(6): 531-536.

Abstract Recent research has demonstrated that aspiring to the American Dream of financial success has negative consequences for various aspects of psychological well-being. The present longitudinal study examining the relation between the goal for financial success, attainment of that goal, and satisfaction with various life domains found that the negative impact of the goal for financial success on overall life satisfaction diminished as household income increased. The negative consequences of the goal for financial success seemed to be limited to those specific life domains that either concerned relationships with other people or involved income-producing activities, such as one's job; satisfactions with two of those life domains, however, were among the strongest predictors of overall life satisfaction in this sample of well-educated respondents in their late 30s. The negative consequences were particularly severe for the domain of family life; the stronger the goal for financial success, the lower the satisfaction with family life, regardless of household income.

Ninio, A. and D. Kahneman (1974). "Reaction time in focused and in divided attention." *Journal of Experimental Psychology* 103(3): 394-399.

Abstract Undergraduates listened to dichotic lists of words and responded to animal names by pressing a key. Group 1 (36 Ss) performed in a condition of focused attention to one of the messages and in a condition of divided attention, where both messages were relevant. Group 2 (8 Ss) performed in focused attention and in a single-message condition. It was found that there were many more omissions in divided than in focused attention, and mean reaction time (RT) was prolonged. There was no difference in RT between focused attention and the single-message condition. The occurrence of an animal name in the

irrelevant message occasionally caused errors. Results are consistent with an effort theory of attention.

Ratner, R. K., B. E. Kahn and D. Kahneman (1999). "Choosing less-preferred experiences for the sake of variety." *Journal of Consumer Research* 26(1): 1-15.

Abstract Data from several experiments show that, contrary to traditional models of variety seeking, individuals choose to switch to less-preferred options even though they enjoy those items less than they would have enjoyed repeating a more-preferred option. Two explanations for this finding are tested in 5 experiments using college students. Results indicate no evidence of a benefit to more-preferred options due to the contrast to less-preferred alternatives. However, the results of three studies suggest that retrospective global evaluations favor varied sequences that also include less-preferred items as opposed to sequences that only include more-preferred items, even though these more varied sequences result in diminished enjoyment during consumption.

Redelmeier, D. A. and D. Kahneman (1996). "Patients' memories of painful medical treatments: Real-time and retrospective evaluations of two minimally invasive procedures." *Pain* 66(1): 3-8.

Abstract This study (1) recorded in real-time the intensity of pain (IOP) experienced by patients undergoing colonoscopy (N = 154, mean age 56 yrs) and lithotripsy (N = 133, mean age 47 yrs), and (2) subsequently examined Ss' retrospective evaluations (Peak and End Evaluation and Duration Neglect) of the total pain of the medical procedure, and related these evaluations to the real-time recording obtained during the experience. It was found that Ss varied substantially in the total amount of pain they remembered. Ss' judgments of total pain were strongly correlated with the peak IOP and with the IOP recorded during the last 3 min of the procedure. Despite substantial variation in the duration of the experience, lengthy procedures were not remembered as particularly aversive. These results suggest that patients' memories of painful medical procedures largely reflect the IOP at the worst part and at the final part of the experience.

Redelmeier, D. A., J. Katz and D. Kahneman (2003). "Memories of colonoscopy: A randomized trial." *Pain* 104(1-2): 187-194.

Abstract Patients' memories of the past may influence their decisions about the future, yet memories are imperfect and susceptible to bias. We tested whether a memory failure observed in psychology experiments could be applied in a clinical setting to lessen patients' memories of the pain of an unpleasant medical procedure. We studied consecutive outpatients undergoing colonoscopy who were medically stable, mentally competent, and able to speak English (n = 682). By random assignment, half the patients had a short interval added to the end of their procedure during which the tip of the colonoscope remained in the

rectum. Memory following the procedure was measured using both a rating scale and a ranking task. Randomization resulted in two similar groups. Rates of returning for a repeat colonoscopy (median duration of follow-up 5.3 years) averaged 50.4% and were slightly higher (odds ratio = 1.41, $P = 0.038$) for those who underwent the longer procedure controlling for prior colonoscopy, procedure indications, and abnormal findings. Memory failures observed in experimental conditions can be found in clinical settings involving awake patients and may offer opportunities for improving patients' willingness to undergo future unpleasant medical procedures.

Redelmeier, D. A., P. Rozin and D. Kahneman (1993). "Understanding patients' decisions. Cognitive and emotional perspectives.[see comment]." JAMA 270(1): 72-6.

Abstract OBJECTIVE--To describe ways in which intuitive thought processes and feelings may lead patients to make suboptimal medical decisions. DESIGN--Review of past studies from the psychology literature. RESULTS--Intuitive decision making is often appropriate and results in reasonable choices; in some situations, however, intuitions lead patients to make choices that are not in their best interests. People sometimes treat safety and danger categorically, undervalue the importance of a partial risk reduction, are influenced by the way in which a problem is framed, and inappropriately evaluate an action by its subsequent outcome. These strategies help explain examples where risk perceptions conflict with standard scientific analyses. In the domain of emotions, people tend to consider losses as more significant than the corresponding gains, are imperfect at predicting future preferences, distort their memories of past personal experiences, have difficulty resolving inconsistencies between emotions and rationality, and worry with an intensity disproportionate to the actual danger. In general, such intangible aspects of clinical care have received little attention in the medical literature. CONCLUSION--We suggest that an awareness of how people reason is an important clinical skill that can be promoted by knowledge of selected past studies in psychology.

Schkade, D. A. and D. Kahneman (1998). "Does living in California make people happy? A focusing illusion in judgments of life satisfaction." Psychological Science 9(5): 340-346.

Abstract 1,993 students in the Midwest and in Southern California rated satisfaction with life overall as well as with various aspects of life, for either themselves or someone similar to themselves in one of the two regions. Self-reported overall life satisfaction was the same in both regions, but participants who rated a similar other expected Californians to be more satisfied than Midwesterners. Climate-related aspects were rated as more important for someone living in another region than for someone in one's own region. Mediation analyses showed that satisfaction with climate and with cultural opportunities accounted for the higher overall life satisfaction predicted for

Californians. Judgments of life satisfaction in a different location are susceptible to a focusing illusion: Easily observed and distinctive differences between locations are given more weight in such judgments than they will have in reality.

Schreiber, C. A. and D. Kahneman (2000). "Determinants of the remembered utility of aversive sounds." *Journal of Experimental Psychology: General* 129(1): 27-42.

Abstract Retrospective evaluations of aversive episodes were studied in the context of a general model of "judgment by prototype" that has been applied in other situations. Unpleasant sounds of variable loudness and duration were the stimuli. In Experiment 1, continuous reports of annoyance closely tracked variations of noise intensity. Hypotheses about the determinants of retrospective evaluation were examined in Experiment 2. Experiment 3 confirmed a prediction of judgment by prototype: The effects of sound duration and intensity are additive in multitrial experiments. Experiment 4 confirmed a robust preference for aversive episodes that are "improved" by adding a period of reduced aversiveness.

Treisman, A., D. Kahneman and J. Burkell (1983). "Perceptual objects and the cost of filtering." *Perception & Psychophysics* 33(6): 527-532.

Abstract In 3 experiments with 32 college students, Ss were asked to read a tachistoscopically presented word and the latency of reading was measured. "Filtering costs" were induced by presenting a colored shape on the other side of fixation. The critical condition was one in which the word was framed by the colored shape instead of separated from it. Results show that the latency of reading a single word was increased by 20-40 msec when the colored shape was present in the display. The delay was affected by the spatial organization of the display: The colored frame caused less delay when it surrounded the word than when it was shown on the opposite side of fixation. A small gap in the frame was also more efficiently detected as a secondary task when the frame was around the word than when the 2 were spatially separate. The advantage of integrated over separate presentation suggests that a filtering cost is incurred when 2 distinct perceptual objects compete for attention. Attention in filtering tasks operates on perceptually distinct objects rather than on nodes in a semantic network.

Tursky, B., D. Shapiro, A. Crider and D. Kahneman (1969). "Pupillary, heart rate, and skin resistance changes during a mental task." *Journal of Experimental Psychology* 79(1): 164-7.

Tversky, A. and D. Kahneman (1971). "Belief in the law of small numbers." *Psychological Bulletin* 76(2): 105-110.

Abstract Reports that people have erroneous intuitions about the laws of chance. In particular, they regard a sample randomly drawn from a population as highly representative, i.e., similar to the population in all essential characteristics. The prevalence of the belief and its unfortunate consequences for psychological research are illustrated by the responses of 84 professional psychologists to a questionnaire concerning research decisions.

Tversky, A. and D. Kahneman (1973). "Availability: A heuristic for judging frequency and probability." *Cognitive Psychology* 5(2): 207-232.

Abstract Conducted a series of experiments with 877 Ss to explore a judgmental heuristic in which S evaluates the frequency of classes or the probability of events by availability (i.e., by the ease with which relevant instances comes to mind). In general, availability was correlated with ecological frequency, but it was also affected by other factors. Consequently, the reliance on the availability heuristic led to systematic biases. Such biases were demonstrated in the judged frequency of classes of words, of combinatorial outcomes, and of repeated events. The phenomenon of illusory correlation is explained as an availability bias. The effects of the availability of incidents and scenarios on subjective probability are discussed.

Tversky, A. and D. Kahneman (1974). "Judgment under uncertainty: Heuristics and biases." *Science* 185(4157): 1124-1131.

Abstract Describes 3 heuristics employed to assess probabilities and to predict values: (a) representativeness, (b) availability of instances, and (c) adjustment from an anchor. Biases to which these heuristics lead are enumerated, and the implied and theoretical implications are discussed. It is concluded that a better understanding of these heuristics and their resulting biases could improve judgments and decisions in situations of uncertainty.

Tversky, A. and D. Kahneman (1975). "Judgment under uncertainty: Heuristics and biases." *Catalog of Selected Documents in Psychology* 5: p182.

Tversky, A. and D. Kahneman (1981). "The framing of decisions and the psychology of choice." *Science* 211(4481): 453-458.

Abstract Presents evidence showing systematic reversals of preference by variations in the framing of problems, contingencies, or outcomes. Selected illustrations of preference reversals are presented. A common pattern is that choices involving gains are often risk averse and choices involving losses are often risk taking, even when the only effective difference between 2 problems is that one describes outcomes in terms of lives saved and the other, in terms of lives lost. This pattern also holds for choices regarding monetary outcomes, both hypothetical and real. The effects of frames on preferences are compared to the effects of perspectives on perceptual appearance. The dependence of

preferences on the formulation of decision problems is a significant concern for the theory of rational choice.

Tversky, A. and D. Kahneman (1983). "Extensional versus intuitive reasoning: The conjunction fallacy in probability judgment." *Psychological Review* 90(4): 293-315.

Abstract Perhaps the simplest and the most basic qualitative law of probability is the conjunction rule: The probability of a conjunction, $P(A\&B)$, cannot exceed the probabilities of its constituents, $P(A)$ and $P(B)$, because the extension (or the possibility set) of the conjunction is included in the extension of its constituents. Judgments under uncertainty, however, are often mediated by intuitive heuristics that are not bound by the conjunction rule. A conjunction can be more representative than one of its constituents, and instances of a specific category can be easier to imagine or to retrieve than instances of a more inclusive category. The representativeness and availability heuristics therefore can make a conjunction appear more probable than one of its constituents. This phenomenon is demonstrated in a variety of contexts, including estimation of word frequency, personality judgment, medical prognosis, decision under risk, suspicion of criminal acts, and political forecasting. Systematic violations of the conjunction rule are observed in judgments of lay people and of experts in both between- and within-Ss comparisons. Alternative interpretations of the conjunction fallacy are discussed, and attempts to combat it are explored.

Tversky, A. and D. Kahneman (2002). Extensional versus intuitive reasoning: The conjunction fallacy in probability judgment. *Heuristics and biases: The psychology of intuitive judgment*. T. Gilovich, D. Griffin and e. al. New York, Cambridge University Press: 19-48.

Abstract (from the chapter) Constructs problems in which a reduction of extension was associated with an increase in availability or representativeness, and tests the conjunction rule in judgments of frequency or probability. This chapter discusses the representativeness heuristic and contrasts it with the conjunction rule in the context of person perception. The authors describe conjunction fallacies in medical prognoses, sports forecasting, and choice among bets. They investigate probability judgments for conjunctions of causes and effects and describe conjunction errors in scenarios of future events. Manipulations that enable respondents to resist the conjunction fallacy are explored and implications of the results are discussed.

Tversky, A. and D. Kahneman (2002). Judgment under uncertainty: Heuristics and biases. *Foundations of cognitive psychology: Core readings*. D. J. Levitin. Cambridge, MIT Press: 585-600.

Abstract (from the chapter) This reprinted chapter originally appeared in *Science*, 1974 (Sep), Vol 185(4157), 1124-1131. (The following abstract of the

original article appeared in record 1975-06433-001.) Describes 3 heuristics employed to assess probabilities and to predict values: (1) representativeness, (2) availability of instances, and (3) adjustment from an anchor. Biases to which these heuristics lead are enumerated, and the implied and theoretical implications are discussed. It is concluded that a better understanding of these heuristics and their resulting biases could improve judgments and decisions in situations of uncertainty.

Varey, C. A. and D. Kahneman (1992). "Experiences extended across time: Evaluation of moments and episodes." *Journal of Behavioral Decision Making* 5(3): 169-185.

Abstract Utility integration is proposed as a normative rule for the evaluation of extended episodes. In Exp 1, 48 university students explicitly compared aversive experiences (AVEs) of varying durations. Several measures showed that disutility was a marginally decreasing function of episode duration, even for experiences that were thought to become increasingly aversive. This pattern is a qualitative violation of the integration rule. In Exp 2, 46 university students made global evaluations of a hypothetical person's AVEs based on a series of subjective ratings of discomfort made at periodic intervals. Results showed an extreme sensitivity to improving or deteriorating trend and a striking neglect of duration. The final moments of an extended episode appear to exert a strong influence on the overall judgment.

Wright, P. and D. Kahneman (1971). "Evidence for alternative strategies of sentence retention." *Quarterly Journal of Experimental Psychology* 23(2): 197-213.

Abstract Measured pupil size while 48 housewives listened to sentences and either tried to repeat (r) them or answered a question (qua) about them, after either a 3- or 7-sec retention interval. Pupil dilations were larger for r than for qua, both towards the end of presentation and during the retention interval. Similar results were obtained by D. Kahneman and P. Wright when comparing total and partial recall of word lists. They attributed the differences in pupil dilations to differences in rehearsal strategy. However, the recall condition * retention interval interaction was less convincing with sentential material, and an alternative explanation is suggested in terms of the level of abstraction at which the sentences are processed. This interpretation is supported by other evidence relating to the existence of alternative sentence retention strategies. Pupil dilations failed to reveal phrase juncture phenomena, although 2 levels of ambient illumination were used in the hope of detecting such effects. In a modified question condition, where the question was given before the sentence, pupil dilations varied as a function of the part of the sentence providing the answer. Data indicate that ss did not begin to frame their answer until they encountered in the sentence those words used in the question.