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Time Perception : Some Implications For The Development Of Scale Values In Measuring Health Status And Quality Of Life

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.. psychological time is extremely complex: There appear to be no simple answers nor any innocent questions.

R.A. Block, 1990

Subjective time is an entity that, like the path of the atom's elementary particles, is not separable from its measurement.

D. Zakay, 1990

Anyone who thinks psychological time is the same as clock time has forgotten childhood; has never convalesced in hospital; has never flown economy class across the Pacific; and has certainly never been hopelessly in love.

C. Burrows, 1991

Time Perception: Some Implications For The Development Of Scale Values In Measuring Health Status And Quality Of Life

The Time Factor in Health Status/Quality of Life

1 Introduction

Time enters the development of health status measures in four main areas.

1. Respondents may be asked questions relating to the **frequency** with which a given event, condition or feeling occurred over a specified or unspecified past time period.

   Examples include
   [1]The Social Health Battery (Rand Corporation, 1978); The General Well Being Schedule (Dupry, 1977); The Mental Health Inventory (Rand Corporation, 1979); The General Health Questionnaire (Goldberg, 1972); The Arthritis Impact Measurement Scale (Meehan, 1980); Nottingham Health Profile (Martini and Hunt, 1981).

2. They may be asked **when** such events or conditions occurred.
   For example: [1] The Quality of Well Being Scale (Bush et al, 1976); The General Health Questionnaire (Goldberg, 1972); The Mental Health Inventory (Rand Corporation, 1979); The QALY Toolkit (Gudex and Kind, undated).

3. Questions may be asked about the **duration** of a condition or feeling.

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[1] References other than those cited in the bibliography are available in McDowell and Newell 1987.

Examples include [1]The Mental Health Inventory (Rand Corporation, 1979); The Quality of Life Index (Spitzer, 1980); The Arthritis Impact Measurement Scale (Meehan, 1980); Nottingham Health Profile (Martini and Hunt, 1981); MAUT Measurement of Social Preferences (Torrance et al, 1982)

4. Respondents may be asked to compare directly quantities and values of future time. This refers to measures that use time trade-off or healthy-year-equivalents; see, e.g., Furlong, Feeney, Torrance et al 1990; Torrance and Feeney 1989; Mehrez and Gafni 1989).

The first three categories make reference to past time periods. Sometimes these periods are defined (e.g. past month) sometimes not. Often the respondent is faced with a combination of undefined time periods and frequency words such as "usually", "often", and "more". A few, very few, are explicit with respect to time period and frequency (e.g. The Social Health Battery).

The responses are used to say something about the current state of health or well being of respondents or, if third parties are used (doctors, nurses, care-givers, family members or some notion of the general public), the health or well being of a particular reference group.

The fourth category requires respondents to formulate internal measurements of future time periods and compare them in terms of some notion of value, worth or utility. Depending on the particular method used, they are then required, somehow, to trade off periods of different value to reach an equivalence of values or utilities.

The picture is, in fact, a good deal more complicated than this. Event time, frequency and duration are interrelated through the necessity to construct a period of elapsed time and through the processes of memory acquisition and retrieval (see, e.g., Linton, 1982; Brown, Rips and Shevell, 1985; Wagenaar, 1986; Jackson, 1990). Similarly, future cognitive time is not independent of the past and the present and probably operates as an adaptive process integrated with learned sequential relations in the respondents' environment (e.g. Michon, 1985; Block, 1985; Friedman, 1989; Melges, 1990).

When we decided to write a paper on the concept and measurement of time in the context of developing health status measures, the purpose seemed simple enough. It seemed to us that time was treated superficially and mechanistically in most of the literature on health status and quality of life measures.

Certainly there is an abundance of material in the literature of allied fields, especially survey methodology, and underlying disciplines such as psychophysics and cognitive psychology, to indicate that time is both an elusive phenomenon and a matter of great practical concern.

We hoped the paper would have, at least in part, a practical bent: a highlighting of those parts of the **processes** of developing health status measures where attention should be addressed to the effects of time on the measurement of events, states or values.

This has proved to be extremely difficult. In the first place, the concept of time itself in human thought and behaviour is abstract, multi-faceted and derivative. It is inextricably associated with perception and information processing (Michon, 1990) and is represented as a construct or metaphor which fulfills an essentially functional role of explaining some phenomenon or behaviour (see, e.g., Gould, 1990; Lawrence, 1975; Fraisse, 1963, pp 280-287).

In formal representation, it has been constructed as inter alia, clock metaphor (e.g. Szamosi, 1986); relativistic spacetime (e.g. Hawking, 1988; Park, 1975); succession, which encompasses simultaneity and temporal order in memory (e.g. Fraisse, 1984, Hintzman et al, 1975, Tzeng and Cotton, 1980); experienced or recalled duration (e.g. Brown and Stubbs, 1988); chronobiological models of cyclical behaviour (e.g. Aschoff, 1984); internal clock mechanisms (e.g. Cohen, 1967, Church 1984), attentional models of temporal information processing (e.g. Underwood, 1975); memory storage and memory change models (e.g. Block and Reed, 1978; Predebon, 1984); and time as temporal perspective (Block, 1990, Chapter 1) which involves cognitive relationships among present, past and future.

Much of the existing research is only peripherally related to time in the context addressed here (e.g. biological rhythms) and, for reasons given later, attention in this paper is directed to psychological time or the relationship between time and cognition. This introduces the second major difficulty in writing the paper.

Although psychologists began empirical investigations of time-related behaviour well over one hundred years ago (Fraisee, 1963; Block, 1990), until quite recently this research has been carried out almost entirely within an "internal clock" or "clock and regulator" paradigm. It has been characterised as "the psychophysics of duration" (Michon, 1990), "time measurement" or "chronometry" (Fraser, 1982). It has been concerned chiefly with the **measurement of duration** (i.e. past time) and has generated much knowledge of absolute and relative thresholds of perceived enduring moments as functions of physiological and cognitive variables. A lot of this work has been carried out in the domains of developmental psychology and the psychology of the ageing (see, e.g. Levin and Zakay, 1989; Green,

1974; Kastenbaum, 1974).

In the last two or three decades, this has changed markedly with time perception, time measurement and cognition coming together as a unified research area (Michon and Jackson, 1985; Zackay, 1989; Johnson-Laird, 1983). However, the field *is* new. Research has been carried out using several conceptual structure models or constructs and by "schools" whose work should, but often does not, overlap. For example, while mainstream memory psychologists such as Block, Michon and Jackson have published numerous papers on the relationship between memory and duration, it is mainly behavioural decision theorists such as Fischhoff and Beyth (1975) who have investigated hindsight bias; and Kahneman and Tversky (e.g., 1982) have led the way in identifying the heuristics people develop from past events in making decisions. Similarly, it is only in the last very few years that psychologists, social scientists and survey researchers have begun to join forces to discuss problems associated with the collection and interpretation of retrospective data in social surveys (see, e.g., Jabine, Straf, Tanur and Tourangeau, 1984).

The third problem encountered in relating existing research to the particular context of health status measures is the areas in which research has been conducted or, more importantly, where it has not. Block (1990) sees psychological time as consisting of three major aspects: succession, duration and temporal perspective.

> "*Succession* refers to the sequential occurrence of events (i.e., changes), from which an organism may perceive successiveness and temporal order. *Duration* refers to several different characteristics of events. Every event persists for a certain duration, which an individual may encode and remember. Events are separated by time periods, or intervals, that may contain other events, and the length of intervals plays a role in various aspects of psychological time. A relatively unified series of events forms an episode that continues for a certain duration, which an individual may encode and remember. *Temporal perspective*, the third aspect of psychological time discussed here, refers to an individual's experiences and conceptions concerning past, present and future time."
>
> (Block, 1990, p.1)

All three aspects have direct relevance to health status measures (see below) but temporal perspective has particular relevance to those quality of life variants that require comparisons of past, present and future time — especially models using multi-attribute utility, time trade-off and healthy-year-equivalents.

Unfortunately, future time has attracted very little research, especially in contexts that yield results

interesting for our purposes. For reasons that are embedded in the history of cognitive research, inquiry has been restricted mainly to the past or the existing moment. This should not be surprising, given the early emphasis on time measurement and the central place in cognitive psychology of memory and perception. The past is, too, easier to deal with: criterion validation makes for cleaner results and elegance in the design of experiments.

The comparative paucity of future time in the experimental psychology literature is illustrated by the few references thereto in the most recent books. Block (1990) contains one paper dealing largely with future time but that is directed to the relationship between temporal perspective and sense of identity; Levin and Zakay (1989) and Michon and Jackson (1985) have no references at all to future time perspective or measurement in their subject indexes. The work that has been done in the area is fragmentary, very recent and scattered through journal articles and working papers in several disciplinary areas.

These difficulties have dictated that we be not too ambitious in writing one paper for a conference.

First, there is no attempt to consider in detail the many problems involved in eliciting information by survey that have *some* bearing on time. This would take us into most areas of survey methodology because many sources of error and bias, such as the judgemental heuristics of availability, representativeness and anchoring and adjustment (Kahneman and Tversky, 1973; Kahneman, Slovic and Tversky, 1982) are themselves a function of memory acquisition and retrieval.

Secondly, the paper will not be concerned with procedures and processes to control or measure the effects of biases and errors in applied settings. Much information is available in books, manuals and articles on survey methodology, including many concerned specifically with health surveys (e.g. Jabine, Straf, Tanur and Tourangeau, 1984; Sudman and Bradburn, 1982; Schuman and Presser, 1981). With some exceptions, it is fair to say that researchers in health status measurement and especially quality of life measurement have given too little attention to these problems.

Thirdly, we will say nothing directly on an area of concern to economists: the question of discounting. Discounting deals with the relationship between future values and time preferences. In conventional economic analyses, these are treated as independent and, because the future events are money flows (or equivalent), the object of interest has been time preferences, the discount rate, which is assumed to be constant through all time periods.

Evidence from the little health-related research and the voluminous behavioural decision theory

research indicates clearly that this is too simplistic. Value itself appears to be a function of temporal distance itself (e.g. Kok, 1983; Boniecki, 1978) and emotional involvement (e.g. Lundsberg et al, 1975) as are probabilities of occurrence of events (e.g. Kok, 1983). Similarly, probabilities are affected by, inter alia, positive or negative outcomes (e.g. Milburn, 1978). It is likely, too, that preference for future health-related events will change over the time of the treatment or condition and current preferences for long-term teatments do not necessarily correspond with longer-term values (Christensen-Szalanski, 1984; Christensen-Szalanski and Northcraft, 1985).

In his introduction to a recent paper on the place of cognitive scenes in survey methodology, Tourangeau (1984) remarked:

> Much that is relevant will be overlooked. The territory is just too large and too varied for a single foray to include more than a few salient landmarks" (p. 73).

We, too, will adopt that stance. On the argument that research in time perception and measurement in this context is fragmentary, often sparse and sometimes non-existent, the paper will simply outline some major areas of concern as we see them and summarise the general findings of research where research has been carried out. This will not solve too many problems but it may alert researchers to the *existence* of problems, reduce the incidence of over-simplistic assumptions and, we hope, encourage research in areas of particular concern to this area.

Cognitive Time : A General Framework

Developed models of psychological time are concerned almost entirely with the past, i.e. with aspects of memory and recall. To the extent that frameworks have been suggested for future time, they are fragmentary and tentative, usually set within the study of time perspective and are characterised by Svenson (1983) as being of generally poor design. They contain elements not emphasised in models of past time, such as time horizons, but tend to be based on models developed by memory psychologists. Not surprisingly, it is assumed that cognitive future time is essentially an extension of past time through present time (see, e.g. Melges, 1990, Block, 1990).

A useful general contextual framework that summarises important factors influencing psychological time is suggested by Block (1990) as a basis for explanation and further research. This is not a formal model but simply "emphasises factors surrounding an event or episode which influence an organism's encoding of, conceiving of, and responding to the event or episode" (p.29). These (four) factors are contents of a time period; activities during that period; time-related behaviours and judgements; and characteristics of the time experiencer. It is assumed that these factors interact.

This framework is useful in attempts to synthesise current knowledge because most studies have been carried out within a model framework that incorporates only one or two factors, or subsets of characteristics within these generalised factors.

Within Block's framework, we have attempted to summarise the results of research that impinges directly on instruments and processes designed to measure health status and quality of life. First, however, it is useful to disaggregate a couple of typical questions faced by respondents to illuminate the cognitive tasks required of them.

The Arthritis Impact Measurement Scale (Meehan, 1980) is a self-administered scale containing forty-five questions directly concerned with the effects of the illness. One question asks: "How much time during the last month were you able to relax without difficulty?" To answer this, the respondent must mark off in memory a month of the most recent past; then estimate the sum of individual durations (frequency) that were filled with recalled relaxation that can be defined as not difficult.

Problems of veridicality of response include:

(i) Temporal memory is not structured in a way that permits easy marking of an arbitrary point in past time. Temporal memory is not structured serially (see, e.g. Michon, 1985; Schaffer, 1985).

(ii) Memory encoding is event-related, within a then-existing context, and determined by some schema (or general knowledge structure) that functions as a framework for the orderly encoding of information (e.g. Hastie, 1987).

(iii) Retrieval is influenced by the effects of contextual cues, both internal and external; expectations about the task and the interviewer; and reconstruction within some set of schemata (e.g. Strube, 1987; Tulving, 1983).

(iv) Durations are filled with different types of activities and remembered durations are affected by changes in activities within a period (e.g. Block, 1985).

(v) Although experiments suggest that people have a good memory for relative frequency of occurrence for concrete events such as verbal items over very short periods (e.g. Hasher and Zacks, 1979; Barsalou and Ross 1986), in surveys a strong and consistent bias is evident for

event frequency (Bradburn and Danis, 1984). Little research has been devoted to frequency of subjective states such as "good health" or "feeling lonely" (Bradburn and Danis, 1984).

If a time period is not specified (and usually it is not), the respondent must also interpret, for each response, both time-period and frequency and often the requirements of frequency adverbs such as "often" and "usually". For example, on a typical open temporal query, the Sickness Impact Profile asks for a response to "I stay away from home for brief periods of time".

The time-trade-off approach used by the McMaster University group is described in detail in a working paper (Furlong et al, 1990). The design is structurally simple. The respondent is asked, for states considered better than death, to state the length of life in perfect health that he/she considers is equivalent to spending a longer time in the existing, but less desirable condition.

In operation it has a number of characteristics designed to minimise certain biases and the process of elicitation is carried out using visual aids such as scaled sliders, chance boards and "feeling thermometers".

The task of the respondents, who may be patients, health professionals or members of the public, is cognitively demanding.

(i) They are faced with cards describing the functional level of each life, including healthy life; the time of death; and the number of years lost to early death.

(ii) Through a series of iterations, they express their preferences for number of years of life with the defined condition over fewer years in perfect health and arrive at an equivalence.

TTO scores are, with certain assumptions, equivalent to utility scores but, cognitively, the approach is atheoretical and there has been little, if any, research on the cognitive processes involved. It relies for its acceptance on validation against other methods, most notably the standard gamble which is, itself, of very doubtful cognitive validity (see, e.g. Schoemaker, 1982; Slovic and Lichenstein 1983). It necessarily involves, within a holistic judgement, estimation of investigator-nominated future time periods, valuations of life-states as described on the cards, some combination rule and a personal preference. Where people other than patients are used, there are also ethical and social judgements.

Importantly it assumes linear future time.

Past Time and Memory

If there is a shortage of unequivocal findings in some areas of research into past time, there is no shortage of models. Figure 1 and the accompanying explanation are useful for summarising problem areas and potential errors or biases in elicited responses.

Figure 1

Stimulus ("outside")	**Process ("inside")**	**Sources of influence ("process variables")**
AT TIME OF EXPERIENCE:		
event	(encoding)	then existing schemata, context, expectations, etc.
	(restructuring of representation)	interfering influences
AT TIME OF INTERVIEW:		
question	(understanding)	current schemata, context and expectations
	(retrieval and reconstruction)	(ditto) and search strategies
	(judgement and decision)	strategies, heuristics and combination rules
response	(editing)	intentional self-presentation etc.

Source: (Strube, 1987, p.87)

Retrieval can make use only of what has been encoded. It is probable that automatic encoding exists in short-term memory for some types of relative order, such as lists of words (Jackson, 1985) but, in general, it does not (Estes, 1985). Temporal information is very demanding when attempts are made to encode it directly and, in everyday activities, other aspects of the environment are usually more salient than times and dates (Zakay, 1990). The salience of an event (or even the boundaries of an event —

Strube, 1987) in the stream of events is determined by its nature (e.g. episodic or repetitious), expectations at that time and the situational frame, where frame may refer to factors such as physical context or sequence of events.

A currently-popular construct to illuminate this process is that of schemata, of which there may be several types, any one of which may be activated by the occurrence of an event. In effect, a schema is a coherent internal knowledge framework derived from experience or learning, that "fits" the target event and permits entry for encoding in memory. The accuracy and salience of the remembered event is dependent on the schema activated and the extent to which the event corresponds with a stereotyped action framework. Although there is still little research on everyday memory among memory psychologists, the familiar availability and representative heuristics (Kahneman and Tversky, 1982) can be thought of as sitting within a schema structure.

Restructuring or representation refers to "everyday vicissitudes that befall memory traces between storage and recall" (Strube, 1987). Two cases are likely to be important in this context: (a) experiencing similar events; and (b) remembering similar events between encoding and recall, listening to similar accounts of others or discussing the event in question. The result is a confusion and blurring of events or, at times, "repisodic" memory (Neisser, 1981): recall that draws on a mixture of event representations and times (Loftus, 1979). It would seem that frequent "experiences" of similar events generate knowledge-like (semantic) representations in memory, in which specific locations such as time and place are blurred or lost.

Veridicality of retrieval can never be better than the information encoded and several influences act to reduce accuracy. With respect to memory, rather than information processing, two important factors are reconstruction and cues (Strube, 1987). Schemata not only shape the encoding of information, they also lead to reconstruction of memorised events in recall (Bramsford, 1979). These may be not only specific event-related schemata but frameworks reflecting personal attitudes and beliefs. Cues guide memory search, they are the links between encoding and retrieval. Retrieval will be successful if there is a good fit between the features of the representation in memory and the recall cue. In health status/qualify of life measurement, cues are provided through the wording of questions, their context and sequencing and almost certainly characteristics of the relationship between interviewer and respondent (Bradburn and Danis, 1984).

Strube (1987) hypothesises two aspects of cueing in recall. The first is broad and contextual: the conduct of the interview, respondents' beliefs about the interviewer's intentions, the field of question content etc. This gives a general area for memory search. The second consists of specific cues in

particular questions which probe the encoding of particular information. Because of the many opportunities for misunderstanding, bias and error on the part of respondent and interviewer (or structure and wording of self-administered surveys), this receives much attention in survey methodology (se, e.g. Bradburn, Rips and Shevell, 1987; Sudman and Bradburn 1982).

Judgement and decision refer to the processes that transform the retrieved events into a structured response. This is an area of much fruitful research and it is probable that a variety of rules may be used. A brief but useful summary is given by Montgomery and Svenson (1976) and they highlight the chance component in choice process. An overriding characteristic of judgement and choice is a well-documented willingness to settle for something less than ideal i.e. "satisficing" behaviour (Simon and Stedry, 1969).

An important omission in the above framework is motivation. Here there is not much research in the context of surveys but there is a lot of evidence of reporting biases. In general, there is a desire to be consistent in responses (Salancik and Conway, 1975), to present oneself in a favourable light (Nisbett and Ross, 1980) and to meet the perceived expectations of the investigator (Orne, 1972).

Other useful structures that complement Strube's framework include information processing models which illuminate the complex networks of acquisition, storage and retrieval of information (e.g. Hastie, 1987).

Time and Frequency Judgements

Requirements for frequency judgements may be explicit or implicit. Respondents are often asked how often something happened or how frequently they did something or had particular feelings. Sometimes the frequency judgements are clouded by general descriptions such as `usually' or `often'. Similarly, the time period may be specified or it may have to be inferred by the respondent. Then two separate estimates are required; duration and event frequency where both may be couched in ambiguous terms.

Ignoring, for the present, the matter of time period ambiguity, there is a good deal of available research on frequency judgements per se, though most of it relates to experimental rather than naturalistic settings. In general, it can be concluded that people are not accurate in judgements of **absolute** frequency, though they appear to be good at many **relative** frequency judgements (Bradburn and Davis, 1984), even when learning is incidental rather than directed.

In experimental studies, the common finding is that people overestimate low frequencies and

underestimate high frequencies (e.g. Hasher and Cromiak, 1977; Lichtenstein et al, 1978). There is also evidence of higher accuracy for low frequency than for high frequency items (Alber, Cromiak et al, 1980) and a decline with age in ability to make such judgements (Warren and Mitchell, 1980). There is some evidence that suggests learning has little effect (e.g. Hasher and Chromiak, 1977).

A number of sources of inaccuracy have been identified. Frequency of recall is affected by frequency of presentation (Strube, 1987); by spacing of repeated occurrences of the event itself i.e. number of intervening events (Bradburn and Danis, 1984); and by the length of the interval between successive presentations in the elicitation (Hintzman, 1969; Rose, 1980).

Lichtenstein et al (1978), in a study of frequency of lethal events, found that emotional involvement had a strong effect. They identified two highly significant variables: the frequency with which respondents report learning about the event as a cause of suffering and the frequency with which they report the death of a friend or relative caused by the event.

Context is important with frequency judged higher if the context of an event is different on repeated presentations (Hintzman and Stern, 1978; Rose, 1980) and, one assumes, in repeated occurrences.

Reasons advanced for the strong general finding of over- and under-estimation are many and usually interrelated. Brown, Shevell and Rips (1985), among others, suggest a variety of strategies that mean, in essence, people will use whatever information they can recall to generate a satisfactory answer, but most can be subsumed into two broad categories (Bradburn, et al, 1984): decomposition with aggregation additively or multiplicatively; and synthesis of sheer bulk of information.

The first involves strategies such as estimating a short period rate and multiplying by a given (or self-generated) longer period (e.g. MacGregor et al, 1984). The second resolves itself into some sort of availability heuristic (Tversky and Kahneman, 1982) where the more people can recall; or the more easily; or the more supporting associated information; the more frequent, recent and likely the event will be. This is regarded by Bradburn et al (1984) as a particularly important biasing effect in typical survey responses.

Strube (1987) and Lichtenstein et al (1978) explain over- and under-estimations more simply in terms of ceiling and regression-to-the-mean effects.

Time Dating

Apart from requirements for information about **when** particular events occurred, time dating affects responses in two ways at least. In recalling event occurrences or frequencies, an explicit or implicit time period is defined by a past point in time (e.g. last two months). Secondly, event *sequences* may be important, especially in health histories or in responses to "often-type" questions.

As in other related areas, little research is available on subjective dates in longer-term memory. To some extent, the problem overlaps that of duration estimation (see below) but, especially in surveys, it exists as a problem and research question in its own right. Fortunately, if the quantity of research is not large, the studies that have been carried out yield many clear results and some have been conducted in naturalistic settings. Some, too, have investigated the effects of providing event landmarks and date boundaries on the amount and accuracy of recall — both important in health status elicitation.

In general, retrieval from autobiographical memory is subject to substantial forgetting and inaccuracy, even for events that are selected at the time of occurrence as important, where the event is easily distinguishable from surrounding events, or where numerous cues are provided (see Bradburn, Rips and Shevell, 1987). Some interesting recent studies flesh out the general findings. Neisser's (1981) analysis of John Dean's testimony before the Watergate Commission revealed errors in dates and sequences of meetings and other events, despite intensive preparation for the hearings. Pillemer, Rhinehart and White (1986) found that remembered events over a year for college students clustered around the beginnings and ends of vacations and school periods, presumably because these are highly salient features of the year's duration. Brown, Rips and Shevell (1985) investigated remembering of significant public events such as the attempted assassination of Ronald Reagan and the Three-Mile Island nuclear reactor incident, within a five-year period dating back from the then-present. They included in the study effects of media reports; remembrances of events in a very recent event-filled nine-day period; and approximate datings of vivid events. Findings included: (i) date-timing of an event depended on how much subjects could recall about it — better known events happen more recently; (ii) media coverage had little effect; (iii) in the nine-day period, the recency effect was maintained and recall did not correspond well with actual temporal ordering; and (iv) the perceived time of a well-known event was more recent than its calendar date while lesser-known events were perceived as earlier than calendar time.

These are manifestations of the general "telescoping" effect which is commonly found in surveys, whether reference periods are bounded or unbounded. In unbounded recall, there is usually a net forward-telescoping effect i.e. more events are shifted forward in time within the period or erroneously included in the period than the converse. In bounded recall, telescoping occurs within the reference period itself, with a net forward effect greater for the most recent part of the period (Sirkin and

Fuchsberg, 1984).

Thompson (1982) conducted a similar study for a fourteen-week period, in which were included effects for rehearsal, memorability of events and explicit recording of events. Only event-recorders knew they were to be tested; others were told only one week before the test. Thompson found that (i) accuracy in dating events declined over the retention period significantly and systematically; (ii) dating accuracy and rated memory of recorders was no better than that of other subjects; (iii) memorable events were better encoded but the forgetting rate was much the same (confirming laboratory experiments, e.g. Underwood, 1964); (iv) personal events were better remembered than those relating to others; and (v) increased rehearsals slowed the forgetting rate; in particular, increasing the intervals between successive rehearsals had higher retention effects.

Underwood (1977), in the first of a series of experiments concerned primarily with ordering of temporal coding, had subjects date a list of twenty-four momentous events over the previous seven years (e.g. resignation of Nixon; shooting of Robert Kennedy). Relative ordering was generally high but correct dating of the month of events was poor. Average error was about fifteen months with a range of 1.38 to 35.38 months and individual differences were large.

Three other long-term studies of memory of every day events are of considerable interest because of the nature of the events themselves and the conduct of the research. They involved systematic studies of the investigator's own memories.

Two of these will not be dealt with in any detail. Many of the results are in broad agreement with those of the third (Wagenaar, 1986) which was better designed to yield results of interest in the context of this paper. The Linton (1975, 1978) study involved a systematic (daily) recording of events in the life of the investigator on cards, with rating of events on three dimensions: confusability-distinguishability, emotionality and importance. Testing was carried out monthly over several years. The second study (White, 1982) was a smaller-scale repeat of Linton's research. Wagenaar's 1986 paper describes a study of the recall of 2400 events from his daily life over a period of six years, with all events recorded under four aspect headings: **what** the event was; **who** was involved; **where** it happened; and **when**. The events were scaled on dimensions of saliency, emotional involvement and pleasantness. Given this systematic recording and involvement, it probably presents an optimistic picture of autobiographical memory and serves as some sort of upper boundary to recall, of this type, in surveys.

Retention curves assumed relatively simple power functions indicating a simple process of decay. There was substantial inaccuracy in dating events and the usual telescoping effect was present — but

for salient events only which are, one supposes, the focus of attention in health status/quality of life measurement. Events that were salient, emotionally involving and pleasant were better recalled and there were suggestions that unpleasant events were suppressed in memory. Cueing efficiency demonstrated clear effects. Overall, the ordering of cue efficiency was **what** (overwhelmingly), **where**, **who** and **when** with the last having almost no effect as a single cue — a worry to survey researchers where single-cue questions are commonly asked. **When** appears to have little validity as a search criterion.

The conclusion from theory and available evidence is that recalled sequences and dates are likely to be seriously inaccurate, especially if one uses simple and brutal head-on approaches involving direct time-dating questions.

Time Perception : Duration, Future Time and Time Management

Estimation of time periods is central to the development of health status/quality of life measures. Subjective duration is experienced whenever we are referred to a situation in the past or in the future. Therefore it involves memory in all its manifestations — actions, events, attention, empty time etc. — and time horizons, both past and future. In applied settings such as the present context, it also involves time measurement because we ask people questions about events or feelings in given or implicit time periods[2], length of time spent in given states within time periods[3] and values of experienced or to be experienced periods[4].

Unfortunately, almost all of the voluminous research on duration has had very short reference periods, from milliseconds up to a few minutes (see e.g. Block, 1990; Levin and Zakay, 1989 for summaries). A few experiments have studied ranges up to a few hours (Block, 1989) but virtually none over extended past time periods (but see reference to Aschoff below). The matter of chief concern to us — specific durations within longer-term durations — has, to the best of our knowledge, not been studied as a duration phenomenon, though it has received much attention in the context of memory encoding and retrieval.

Some strong and some tentative but suggestive findings from studies of very short durations will be

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[2] "do you often feel lonely?"

[3] "how much of the time during the last month were you able to relax without difficulty?"

[4] preferences for years in different health states.

given. The extent to which they can be extrapolated to longer durations, especially particular durations within a longer period, are not known but some comments are pertinent.

First, there is evidence from research by Aschoff (1984, 1985) that long-term and short-term estimation operate under different mechanisms. The research involved duration estimations by subjects living in isolation for periods from a week to more than a month. Judgements were made of subjective one-hour periods and short periods of ten seconds to two minutes. In the former, estimates were significantly longer than one hour (on average) and were correlated with circadian rhythms and actual duration of wakefulness. Short-time estimations were fairly accurate and the judgements were not correlated with the one-hour judgements, circadian rhythms or wakefulness. There were, too, high individual variations.

Secondly, evidence from time estimation studies (see later), would lead one to suppose that unaided subjective durations would be inaccurate. Thirdly, memory encoding and retrieval research lead to the same conclusions. Fourthly, the logic of the theoretical bases of much-researched very short-time durations would made veridical longer-time estimations very surprising.

The body of recent research on short-time duration indicates that remembered duration is highly contextual. Models with a specific focus have been empirically informative but deficient in coping with a range of factors. Attentional models propose, inter alia, that experienced duration is related to the degree of selective attention paid to the stimuli in information processing, and to time itself (Underwood, 1975); the amount of presented information (Vroon, 1970); momentary arousal (Kahneman, 1973); and the division of attention between temporal and non-temporal information processors (Thomas and Brown, 1975; Thomas and Weaver, 1975).

Memory-change/contextual change models posit that salient changes during a reference period alter the cognitive context of information processing, where these changes may be simple environmental factors such as temperature or physical location, or process context changes — cognitive reconstruction of a task incorporating retrieval of contextual information encoded in memory (see Block, 1990).

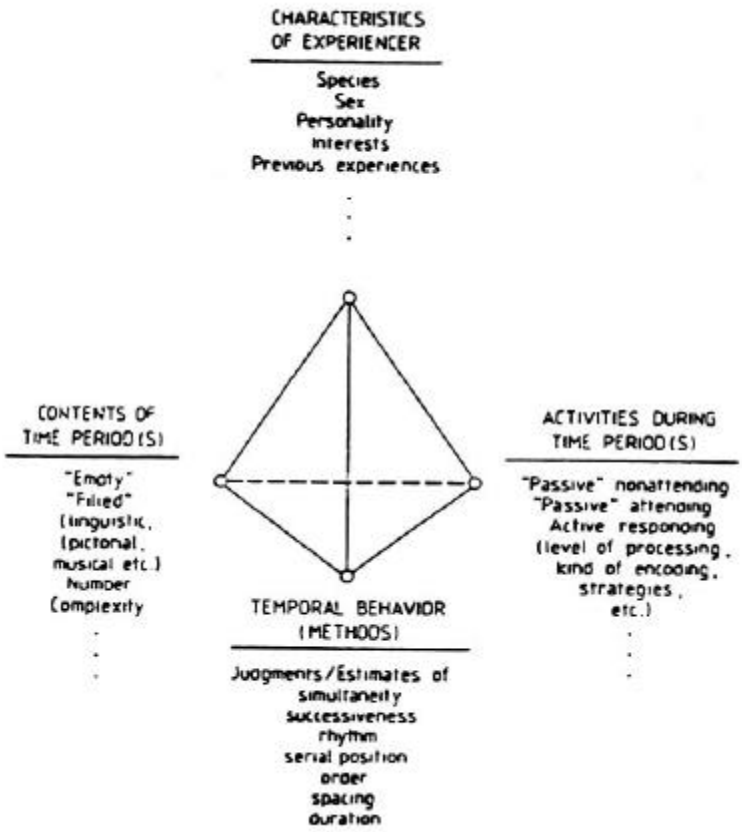
Several studies have been concerned with "filled" and empty" time — the degree to which a time interval is filled with sensory stimuli or events (see e.g. Poynter, 1989; Coren, Porac and Ward, 1984) and the degree of contextual change each event produced (e.g. Campbell, 1986).

Effects are claimed, too, for prospective vs retrospective judgements of duration. Briefly, if a person knows a duration estimate will be required, markers are created to segment time and these are available

for retrieval. Because time is not encoded automatically, retrospective judgements depend much more on the cognitive demands of the contents of the interval (see Poynter, 1989).

Block (1985), from reviews of numerous studies and on the basis of many of his own experiments, argues strongly for a contextualist representation of temporal experience, illustrated in Figure 2. Each of the four factor-clusters represents characteristics of time experiences, contents of time periods, activities during periods or cognitive processes; the six edges of the tetrahedron, the four planes and the solid tetrahedron itself represent two-, three- and four-way interactions found in the studies. It is not surprising, then, that remembered duration is not consistent with elapsed clock time; nor is it systematically biased in a way that permits error-correction by a simple mathematical function.

Figure 2



Source: (Block, 1985, p. 176)

Some general statements can be made, though, in nearly all cases, they refer to effects relating to one, or sometimes two of the four characteristic-clusters in Figure 2. The following are examples.

A fairly robust finding is that short intervals are overestimated and long intervals underestimated (e.g. Schiffman and Bobko, 1974; Ward, 1975; Nakajima, 1988); "filled" time duration is longer than "empty" time (Poynter, 1989); duration estimation increases with attention to time itself (Zakay, Nitzan and Glicksohn, 1983); prospective judgments are longer (and more accurate) than retrospective judgments (Brown and Stubbs, 1988); remembered duration is longer when changes occur in cognitive processes of estimation or contextual changes in the period itself (Block and Reed, 1978).

Time measurement itself has been carried out in a large number of experiments, using very short time periods and standard psychophysical methods (Macar, 1985; Zakay, 1990). Under controlled laboratory conditions, there has been considerable support for a psychophysical law for perceptual duration described by a power function. The exponents vary across subjects and experiments and usually they are less than but close to unity (e.g. Eisler, 1975, average .84; Eisler 1976, average .90). Some experiments have yielded exponents greater than 1.00 (see Allan, 1979). Using duration discrimination tasks, however, other studies have given results that indicate linear models (e.g. Allan, Kristofferson and Wiens, 1971). Allan (1979, 1983), on the basis of claimed analytical shortcomings in earlier experiments and the results of several of her own studies, has concluded that a linear function probably exists between perceived and subjective time.

It must be borne in mind, however, that these findings related to very short-term sensory perception under sterile laboratory conditions. They do not negate the empirically-derived assumptions of Block's model and Allan reported strong effects of non-temporal information (Allan, 1979).

Research on measurement of long-term past-time is almost non-existent. In a crude but simple experiment, Cohen (1964) asked subjects to mark off on a linear scale, from birth to the present, a set of elapsed times ranging from recent events such as `yesterday's lunch' through to the remote personal past. In relative terms, estimates up to about six months prior contracted with remoteness in approximate accordance with a logarithmic function. Beyond that point, **relative** estimates were approximately veridical.

A few studies using periods of several months in their design were not directly concerned with time measurement but throw light on the problem. Friedman (1989) manipulated pairs of months six months apart to test the effect of selective task interference in the ordering of days and months. With controlled task interference, correct answers ranged from .90 to .76 of responses. Seymour (1980a, 1980b) carried out related studies in ordering months. They showed that the correct use of marker dates for estimating a given time period was problematic. Similarly, Brown, Rips and Shevell (1985) demonstrated that the use of events as markers in time is not error-free.

A concept probably related to time estimation, especially future time, is time perspective, which has been the subject of many studies. It is, presumably, an area of importance in time-trade-off measures that require estimation of future yearly periods and valuation thereof. One would expect people with weak future orientation and short or incoherent time perspective to have more difficulty coping with responses. The literature here, however, is a messy area from which to draw conclusions: partly because many of the studies are not well-designed and partly because they are nested in fields not directly related to our concerns; e.g. developmental psychology (Friedman, 1989; Levin and Wilkening, 1989) and psychological disturbances (Skybutt, 1968; Mo, 1990).

It seems likely that people have different time perspectives for different areas of their lives (see Svenson, 1983); that there are substantial individual differences in time perspective (e.g. Wallace and Robin, 1960; Block, Saggau and Nickol, 1983-84); socio-economic and cultural variables are probably important (Svenson, 1983; Block, 1990); and time orientation and length of planning horizons are related to age (Hultsch and Bortner, 1974; Acredolo, 1989).

A particular area that should be important in health status measurement is the relationship between temporal distance and emotional reaction to events. Two related studies are of interest. Following a study by Bratfisch et al in 1970 of this relationship over an extended past period, Ekman and Lundberg (1971) carried out three experiments concerned with both past and future time and emotional reaction. The first two experiments varied with respect to the time horizons; the first extending several generations into the past and future, the second set within a span of years incorporating the life-times of great grandparents and great grandchildren. The third period was undefined on calendar time and was defined verbally in terms of generations of experiment two.

Main findings were:

(a) the relationship between subjective and calendar time was described by a simple power function with exponents less than unity and the negatively accelerated growth rate more pronounced for future time (.72 v .89); and

(b) for past-time, subjective temporal distance gave a better prediction of emotional involvement than objective time and was described by a simple power function. For future events, the picture was unclear with results similar for subjective and objective time.

Of special interest was "children" as a stimulus where emotional involvement was considerably greater than for other stimuli in the third experiment. This is not surprising but, given the common procedures

of using patients, health professionals, care-givers or the general public in health status/quality of life measures, it would be interesting to see the results of such experiments using health-related stimuli for self-health, family-health and others-health.

DISCUSSION

Time, in all its guises, permeates the process of eliciting information for the development of health status/quality-of-life measures; yet it is a grossly-underresearched topic. In closely related fields such as survey methodology and behavioural decision theory it has received some attention; but even in those fields, only some areas of available knowledge have been incorporated in the general knowledge structure of the disciplines. By and large, health status/quality-of-life measurement has taken only a small part of this knowledge. The generation of valid base data for health status measurement is not the only problem to be dealt with of course; nevertheless it is a problem of fundamental importance.

The aim of this paper was not to solve problems. Guidance on procedures to minimise some of the error and biases in eliciting required information is available in survey textbooks and the literature on survey methodology and human judgment and decision making. We should know, for example, that it is very difficult to obtain absolute frequencies and sequences of events; or durations of particular feelings, attitudes or events; or time-dates of events. We should know, too, that there is a general bias of overconfidence in our knowledge, or remembrance, of the past and this is difficult to eradicate. We should expect different answers to questions depending on the structure of questionnaires and whether or not surveys are conducted by guided interviews, or by free recall, or by mail.

There are areas, too, where we know little about what to expect because research is virtually non-existent. Important among these are most aspects of future time-subjective measurement, duration and the relationship between temporal distance, salience of events and emotional involvement which, presumably, affects value or utility.

Another major concern is the comparative lack of cognitive research on the type of information sought in developing health status/quality-of-life measures. It is well-accepted that time-related behaviour is context-specific and it would be surprising if this particular "health" context did not have significant effects on some of the general findings on cognitive aspects of survey methodology.

It is hoped, then, that the paper will direct investigators to the available cognitive literature that will help in the design and execution of research in health status measurement and, perhaps, promote collaborative research to fill gaps that are too large and too important to remain empirically empty.

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