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TOWARDS NEW COGNITIVE FOUNDATIONS FOR SURVEY RESEARCH

Abstract. *This article will focus on the rapidly widening cognitive-science landscapes and their potential impact for fresh perspectives on survey research. More ambitiously, the article wants to explore new foundations for survey research which are based on current advances within the broad domains of the cognitive sciences. In essence, the article wants two establish four major claims. First, over the last decades survey research has reached its point of perfection and, given the quality standards of European data collections like the European Social Survey (ESS), can be improved further only marginally. Second, survey research in its current form is characterized by various forms of incompleteness which, however, cannot be re-solved within the contemporary boundaries of survey research. Third, the expanding field of the cognitive sciences should be considered as the most relevant background knowledge for survey research in all its aspects, starting from the design of questionnaires to the actual fieldwork-procedures and to the analysis of survey data. Fourth, shifting to a cognitive science background should have a highly significant aspect of re-shaping survey research and for alternative paths for survey designs which, so far, have hardly been explored.*

Keywords: *Long-term dynamics of science; cognitive science; survey research; genetic algorithms; over-learned and under-learned responses*

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This article wants to draw the reader's attention to new theory structures and models in the cognitive sciences[1] which, so far, were considered to lie outside the domain of contemporary survey research. However, the subsequent sections attempt to show that the cognitive sciences, broadly understood, should constitute the relevant theoretical background knowledge for survey research. Such a shift from the current folk psychology-traditions to the cognitive sciences should exert a considerable influence in re-shaping survey methodologies, survey analyses and, equally important, the theory constructions for survey-based research. Adapting and accommodating to this new background knowledge, survey research, in our assessment, should and will leave behind its established core routines and its standard procedures as special cases, very much as Newtonian physics has become a special niche within contemporary physics.

The Tipping Point for Survey Research

At the outset, a few general remarks will be undertaken on the current status of survey research. For the moment it seems that survey based research has become the most frequently used publication mode across the social sciences. The following table, compiled by Willem E. Saris and Irmtraud N. Gallhofer[2], shows a remarkable increase of survey-based research in wide segments of the social sciences, including, surprisingly, social psychology and economics as well.

Table 1: THE RISE OF SURVEY RESEARCH FROM 1950 TO 1995

	Economics	Sociology	Political Science	Social Psychology	Public Opinion
	(39.4%)	(59.6%)	(28.9%)	(48.7%)	(95.0%)
1949/50	5.7%	24.1%	2.6%	22.0%	43.0%
1964/65	32.9%	54.8%	19.4%	14.6%	55.7%
1979/80	28.7%	55.8%	35.4%	21.0%	90.6%
1994/95	42.3%	69.7%	41.9%	49.9%	90.3%

[1] *On current summaries of the neuro-cognitive architectures of these different faculties, see Gazzaniga, Bizzi and Black, 2004 or Calvert, Spence and Stein, 2004. Within the cognitive neuro-science arena, one finds meanwhile numerous sub-fields and disciplinary niches specializing on a particular senso-motoric, emotional or cognitive faculty. For a diverse set of literature, see Calvin, 1996, Calvin and Bickerton, 2000, Campbell, 1984, Damasio, 1994, 2003, Deacon, 1997, Edelman, 1987, 1990, 1992 or 2007, Hofstadter, 1982, Hofstadter and Dennett, 1982, Hofstadter 1985, 1995 or 1997, Holland, 1995, Lakoff and Nunez, 2000, Minsky, 1990, Norretanders, 1997, Pinker, 1997, Plotkin, 1997, Pollock, 1989, Ratey, 2001, Roth, 1999 or Sternberg and Wagner, 1994.*

[2] *See the summaries by Saris and Gallhofer, 2007:2p.*

Table 1 suggests that survey research is on a continuous victory march. However, it will be argued that survey research, despite its continued successes at the level of data production in the social sciences, has reached its tipping point already. Survey research, so the argument goes, will be challenged more and more especially on cognitive grounds, but also for epistemological and wider societal reasons. The next section will point to four fundamental forms of incompleteness in survey research which, in combination, significantly reduce the development capacities for survey research in its conventional form in the future.[3]

The Fundamental Incompleteness of Survey Research in at Least Four Dimensions

Initially, an argument will be provided that a phase transition in the overall science landscapes is currently under way which has been labeled as the transition from Science I to Science II. Science I was the dominant form of science from the beginning of modern science in the 16th century up to 1900/1950. Science II, consequently, emerged over the last decades and will turn out to be the new hegemonial regime, although Science II will not replace Science I completely. In a variety of domains and applications Science I-models and methods will still be used[4]. In view of the overall changes from Science I to Science II four significant deficiencies of survey research become apparent which, in combination, lead to the verdict of a fundamental incompleteness of current survey designs.

The first incompleteness is fundamental in nature and comes from the reliance on internal assessments and internal descriptions only.[5] Under the flag of Science I it was both necessary and sufficient for survey research to have a single internal descriptive account of a respondent as the basis for subsequent analyses. This single account was considered as necessary and sufficient for two different domains, namely for the internal preferences, goals, attitudes, evaluations, etc. of a respondent as reported by the respondent and for the actions and interactions of a respondent as a

[3] *It belongs to the well-known results of innovation research that old technologies are usually replaced at the height of their efficiency and their relative strength. Thus, analog cameras have been substituted by digital ones at the height of their performance-levels. On this point, see especially Utterbeck, 1989, 1996 or von Foerster, 2003: 284.*

[4] *On the distinction between Science I and Science II, see especially Hollingsworth and Müller, 2008 and on a wider discussion of this separation see Boyer, 2008; Mayntz, 2008; Nowotny, 2008 or Sornette, 2008.*

[5] *Here, the terms external description on the one hand and internal description on the other hand are to be used in the following way. External descriptions comprise any description by a competent observer of the overt manifestations and of the results of cognitive operations by an observable actor. In contrast, internal descriptions are tied to the self-description and self-evaluation of a competent actor alone.*

manifestation of these underlying preferences, goals, attitudes, evaluations, etc. This focus on individual respondents was supported by the view of individuals as carriers of stable internal preferences, goals, attitudes, evaluations which, due to their inscriptions in long-term memory, can be measured directly, albeit with a certain amount of measurement errors.

The second incompleteness of survey research stems from the restricted code in which survey items are presented. Currently a single survey item should be composed of an introduction, a motivation part, information regarding the content, instruction of the respondent, interviewer instruction, requests for answers and of answers with categories or response scales (Saris and Gallhofer, 2007: 121). However, the mode of fixed responses as well as asymmetric question and answer interactions become more and more marginalized in contemporary life worlds.

The third form of incompleteness has to do with the interactions between respondents and researchers which happen in a highly restricted and only in a media-mediated manner. Currently, no information mechanisms link the side of survey researchers with the respondents and no recursive interactions between researchers and respondents occur. Surveys are usually restricted to a single measurement affair only.

The fourth fundamental incompleteness of survey research is due to the absence of survey researchers from survey research. This does by no means mean that survey researchers should report on their profile of responses in the survey they have constructed. Rather, the emphasis lies on a detailed documentation of a survey in terms of its targets as seen by a single researcher or a research group, its actual composition, its selection procedures that led to the final version, its relations, similarities and dissimilarities to existing surveys and, above all, the intended novelty and the »cash value« (Wilfried Sellars) of producing a new survey data set.

Towards New Typologies for Survey Measurement Processes

Due to the fundamental incompleteness of survey research it is worth asking what types of measurements are performed within survey settings. It is interesting to note that in the formative years of survey and attitude research social scientists like Richard T. LaPiere have shown beyond reasonable doubt, but also with no lasting success, that survey research is faced with a deadly threat because attitudes and actions are separated by an unbridgeable gap. LaPiere's assessment from the year 1934 seems as valid and as controversial now as it was then.

The questionnaire is cheap, easy and mechanical. The study of human behavior is time-consuming, intellectually fatiguing and depends for its success on the ability of the investigator ... Yet it would seem far more worthwhile to make a shrewd guess regarding that which is essential than to accurately measure that which is likely to prove quite irrelevant. (La Piere, 1934: 237)

Following this counter-tradition to the dominant forms of comparative survey research Peter Converse's article on the nature of belief systems in mass publics in 1964 marks another hallmark in approaching survey measurements and survey data in a radically different way. His article on non-attitudes can be seen as another important reference point for an alternative view of the survey measurement processes. According to Converse, attitudes measured in normal survey research qualify as non-attitudes only and as such they are highly volatile and subject to frequent changes.

Subsequently, the issue of non-attitudes provoked a new account on the part of conventional survey research which emphasized the »real« measurement of »real« attitudes in surveys, but allowed for varying degrees of measurement errors. Thus, non-attitudes quickly changed into true attitudes again, albeit in a slightly blurred and fuzzy version.

Thus, it seems worthwhile to go deeper into the issue of measurement processes and of measurement types not only in survey research[6], but across different scientific domains. Table 2 presents an elementary division of measurement types for measurements across the natural and the social worlds. Here, two measurement dimensions are used, the first one on the repeatability of measurements (exhaustive/repetitive) and the second one on the degree of observer dependency.

- Exhaustive measurements lose, due to the measurement process, the possibility of a renewed measurement whereas repetitive measurements can be performed over and over again.
- Similarly, strong observer dependency means that the measurement process itself produces or generates the quantity to be measured whereas in weak observer-dependent contexts the quantities to be measured could be measured, in principle, before or after the actual measurement process as well.

Normally, the first measurement type in Table 2 is linked to the realms of quantum physics, where measurements are both exhaustive and strongly observer-dependent (e.g., Zeilinger, 2005), and the fourth type to the macro worlds across nature and society. Following the conventional wisdom (e.g., Hand, 2004 or Henshaw, 2006), measurements and observations in survey domains, if properly designed and conducted, can be treated like

[6] *On measurements in survey Andrews, 1984; Blalock, 1968 or 1990; Edwards and Bagozzi, 2000; Esposito and Rothgeb, 1997; Hox, 1997; Krosnick and Abelson, 1991; Lass, Saris and Kaase, 1997; Lord and Novick, 1968; Miethe, 1985 or Sniderman and Therbiault, 2004.*

measurements of velocities, length, temperature or distances in the macro-natural arenas. In short, measurements in survey research, if adequately adjusted for measurement errors, correspond to type IV (Saris and Gallhofer, 2007).[7]

Table 2: TYPES OF MEASUREMENT

	Strong Observer-Dependency	Weak Observer-Dependency
Exhaustive	Measurement Type I	Measurement Type II
Repetitive	Measurement Type III	Measurement Type IV

In sharp contrast to an established consensus on survey measurements, it will be argued subsequently that measurements in survey contexts, as performed according to the rules and guidelines of empirical social research[8], fall under the first measurement type and not under the fourth type.

With respect to the dimension exhaustive/repetitive, asking a survey question once destroys the possibility for asking it again immediately afterwards. Asking the same item two, three or more times in a row creates a new context for respondents. Likewise, asking the same survey questions in a repeated manner meets definite barriers and constraints on the side of respondents.[9] Thus, along the first dimension measurements in survey research are in no way similar to consecutive and repeated measurements for physical macro-objects and their properties like velocity or temperature.

For the dimension of weak/strong observer dependencies two broad alternatives are feasible in survey interactions. According to the conventional wisdom in survey research, responses are based on stable assessments which are well embedded in the cognitive-behavioral repertoire and inside the neuro-cognitive organization of respondents. Thus, Jon A.

7 Measurement type II is reserved for those cases where the measurement process destroys the conditions of the possibilities for renewed measurements. For example, measuring the breaking point for materials makes a renewed measurement impossible. Measurement type III applies whenever the measurement process creates a measurable quantity via the measurement process itself. Like in the case of a roulette, a croupier as a strong observer produces a sequence of numbers from 0 to 36 in a just in time-manner.

8 See, for example, the handbook of survey methodology by de Leeuw/Hox/Dillman, 2008.

9 Respondents could be asked, however, if they are willing to participate in a weekly or even in a daily survey. But such a demand must be stated clearly in advance and must be fully accepted by respondents. Again, in a daily questionnaire it will become exceedingly difficult to ask the same question twice. Additionally, daily surveys will be accepted by respondents only if they deal with daily changing processes. This condition is usually fulfilled in the field of consumption, media utilization within the last 24 hours or in the area of social contacts. But it should become exceedingly difficult to ask respondents on their trust in institutions in daily intervals.

Krosnick, Charles M. Judd and Bernd Wittenbrink adhere to the storehouse or file drawer image of attitudes and see a

> *great theoretical and practical value ... to hypothesize that a single attitude exists in a person's mind: the net evaluation associated with the object. (Krosnick, Judd and Wittenbrink, 2006: 26)*

In this conventional view, survey measurements are founded on respondents' introspective reports of their stable long-term attitudes and beliefs which are well-stored in the long-term memory of respondents. On this account, survey measurements can be subject to measurement errors which, however, can be corrected and adjusted.

In the alternative perspective, survey responses are created just in time within the context of a survey itself, without prior fixed quantities or specific values in the cognitive repertoire and organization of respondents. Rather, due to the fixed menu of admissible survey responses, respondents can be assumed to match this unusual format with their ordinary language routines and, albeit in a spontaneous manner, with some of their past experiences. In this perspective, survey responses are creative reactions on unusual requests which in most instances are produced and delivered in a spontaneous manner.

By necessity, the second alternative in conjunction with the exhaustive character of survey measurements, leads to the first measurement type in Table 2. It will become the main task in the next sections to build up additional support from the cognitive sciences to justify the assumption that survey responses are exhaustive in nature and are the results of strong observer dependencies.

Consequently, the next sections will introduce two basic models from the field of the cognitive neuro-sciences, the first one a meanwhile classical model for non-trivial systems and the second one a cognitive model for learning under the name of genetic algorithms[10]. Both models, in combination, provide new insights into the central actors in survey research, namely into the cognitive states of respondents.

Survey Respondents as Non-Trivial Actors

In the discussion of different measurement types one could already see that proponents of conventional measurement theory refer to the internal cognitive organization of respondents, although this reference is usually made in an ad-hoc manner.

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[10] *On genetic algorithms, see, for example, Goldberg, 1989; Holland, 1986; Holland et al., 1989; Holland, 1989; Koza, 1992; Michalewicz, 1992; Mitchell, 1996 or Rawlins, 1991.*

As a first step, a very general model will be introduced which points to a central feature of respondents which, however, is constantly neglected in survey measurement theory. In a series of publications[11] Heinz von Foerster uses the distinction between trivial and non-trivial ensembles. For him, this separation was vital in order to be able to differentiate between trivial physical systems on the one hand and non-trivial biological systems on the other hand. Thus, Heinz von Foerster's two models should be relevant both for the study of human actors and for models of learning or other cognitive abilities as well. In general, these two models or machines exhibit the following characteristics.

0.1 Trivial machines: (i) synthetically determined; (ii) independent of the past; (iii) analytically determinable; (iv) predictable.

02. Non-trivial machines: (i) synthetically un-determined; (ii) dependent on the past; (iii) analytically non-determinable; (iv) unpredictable (Foerster, 1993: 74 pp.)

Trivial machines like input-output machines can be determined from their input and output data only. The basic distinction between trivial and non-trivial systems lies in the internal organization and structures of the latter.

Non-trivial machines have 'inner' states. In each operation, this inner state changes, so that when the next operation takes place, the previous operation is not repeated, but rather another operation can take place. (Foerster, 1993: 76)

Due to their state-determination, non-trivial systems with even a small number of input and output activities and inner states, move beyond the realm of synthetic or analytic determination.

03. Let n be the number of inputs and outputs ..., then the number N_T of passible trivial machines, and the number N_{NT} of non-trivial machines is: $N_T(n) = n^n$, $N_{NT}(n) = n^{nz}$, where z signifies the number of internal states of the NT machine, but z cannot be greater than the number of possible trivial machines, so that $z_{max} = n^n$ (Foerster, 1993: 77)[12]

The relevance of the distinction between trivial and non-trivial systems for survey research should be obvious. If one assumes that respondents in surveys are state-determined non-trivial actors, then the identification problem of internal states becomes of utmost importance. Conventional measurement theory operates, however, on a model of trivial actors where the problem of internal states can be safely neglected. Obviously, the conventional measurement theory for surveys has been operationalized for

[11] *See, for example, Foerster, 1984, 1993 or 2003.*

[12] *As a simple example, a trivial machine with n = 4, the result is $N_T(4 = 4^4 = 256$ However $N_{NT}(4) = 4^{4z}$ with $Z = 4^4$ which, after some calculations, becomes 2^{2048} or approximately 10^{620}.*

trivial systems, but not for non-trivial systems. To conclude, Table 3 highlights the differences between trivial and non-trivial models for respondents.

Table 3: TRIVIAL AND NON-TRIVIAL MODELS OF SURVEY RESPONDENTS[13]

Trivial Models-	Non-Trivial Models
Models	
Input/Function/Output	Functors (Operators)
Independent Variable/Function/	Operating on Functions
Dependent Variable	State-Determined Systems
Cause/Law/Effect	with Non-Linear Dynamics
Stimulus/Nervous System/Response	(Discontinuous, Qualitative
Goal/System/Action	Changes, Chaotic
Environment/Organism/Behavior	Behavior, etc.)
Motivation/Character/Actions, etc.	
Model Characteristics	
Predictable	Unpredictable
Independent of Pre-History	History-Dependent
Synthetically determined	Synthetically un-determined
Functions Identifiable	Functions not identifiable
Analytically computable	Analytically not computable
Value of functions effectively	Value of functions not
computable)	effectively computable)
Reductionist	Relational, systemic

GA-Systems as Cognitive Models of Survey Interactions

In this section a brief sketch of new groups of cognitive models from the domain of evolutionary computation[14] will be introduced because they provide the necessary ingredients for modeling the cognitive competencies and the social interactions inherent in the questioning and answering of surveys.

Using genetic algorithms (GA) as a specific framework, it will be assumed that both an interviewer and a respondent in a survey are organized as GA-ensembles. In the context of survey interactions, a GA-system is situated in an environment that produces a flow of verbal inputs for the GA-system which enter into the domain of internal processing. In turn, a GA-system

[13] *The subsequent differentiations in Table 3 have been put forward essentially by Heinz von Foerster, like in Foerster, 1984: 8ff.*

[14] *Evolutionary computation is an emerging field with different areas like genetic programming, genetic algorithms, evolutionary strategies or evolutionary programming. For an overview, see de Jong, 2006.*

generates verbal outputs for its environment which, once again, lead to a new round of verbal inputs for the GA-system.

The basic ingredients of a GA-system have been captured in Figure 1. Internally, a GA-system consists of an internal message list, a set of encoded classifiers $\{C_1, C_2, ..., C_n\}$ as if then rules and an output interface which generates a flow of verbal responses for the environment.

John Holland, one of the inventors of GA-systems, provides the following short summary of the GA's processing cycle.

The basic execution cycle of this system proceeds as follows:

1. Place all messages from the input interface on the current message list.
2. Compare all messages on the current message list to all conditions of all classifiers and record all matches.
3. For each set of matches satisfying the condition part of some classifier, post the message specified by its action part to a new message list.
4. Replace the current message list with the new message list.
5. Process the message list through the output interface to produce the system's current output.
6. Return to step 1. (Holland *et al*., 1989: 106)

A GA-system is basically a rule system and is equipped with three types of rules. Empirical rules are composed of different sets like categorical rules (If type T_1 has property P_1, then also P_2), associative rules (If type T_1 has property P_1, then activate category C_1), predictive rules (If type T_1 meets type T_2, T_1 will produce Action A_1) or diachronic rules (If Event E_1 occurs, then react with $Action_1$).

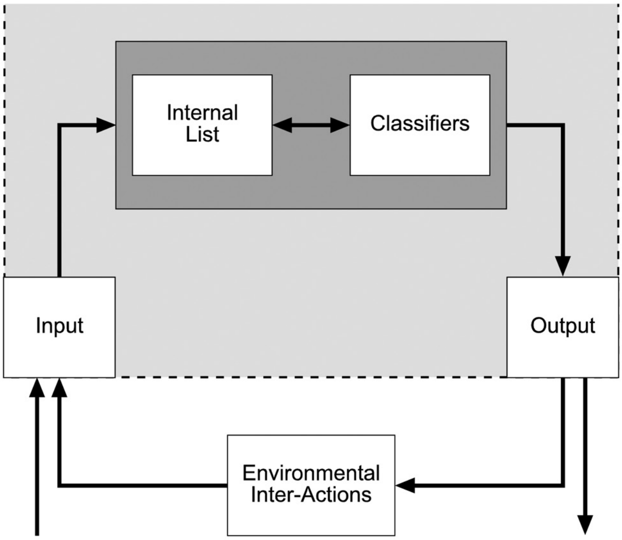
The second class of rules consists of inferential rules which are based on inductive generalization procedures like specialization rules, unusualness rules, law of large number heuristics or regulation schemes. The primary function of inferential rules is to produce better empirical rules. (Holland *et al.*, 1989: 43)

Finally, a set of unchangeable and in-built operative rules can be seen as the innate hardware of any GA-system:

Operating principles are neither learnable nor teachable. They are innate system manipulation procedures ... These include the procedures for calling up the relevant empirical rules for representing the environment; the bidding system by which such rules compete to construct the current representation of reality ... Other operating principles invoke some of the procedures of knowledge alteration ... (Ibid: 46)

The cognitive processing within a GA is based on a bidding process in which one of the GA-rules gets activated and executed. Given an internally encoded input from the environment, a suitable or viable GA-response is selected among a group of different available alternatives. This selection process is dependent on the strength of each of the classifiers which, in turn, is a function of their previous strength and their specificity, a drift towards higher internal complexity or a volatility of outputs.

Figure 1: A SCHEME FOR A GA-CLASSIFIER SYSTEM



Aside from the bidding process, a classifier system develops, in evolutionary time, a higher degree of internal complexity by a cross-over process and by the production of new classifiers as a recombination of previously successful ones.

The cognitive organization of a GA-system exhibits several remarkable properties which are necessary for their overall flexibility and for their absorption of environmental complexities like a potential multiplicity of internal rules for a given input, blatant overall inconsistency or an emphasis of specific over general rules.

This short overview of GA-systems should be sufficient to use GA-architectures for the interactions in survey contexts.

Towards a Logic of Over-Learned and Under-Learned Responses

Drawing on the two cognitive models of learning actors, a distinction will be introduced which should prove useful for the interpretation of the data generated under the auspices of conventional survey designs.

This basic distinction is frequently used in memory research[15] and, at least partially, in the research on embedded cognition[16]. Here, a separation can be made between over-learned and under-learned contexts. In memory research, the terms over-learned and under-learned refer essentially to the duration and to the frequency of learning processes or to the all or none character of learning.[17] In embedded cognition, an over-learned or an under-learned context is characterized by the stability or the instability of action sequences. In over-learned contexts one finds either identical, sequentially fixed or constant actions irrespective of varying contexts or different pre-histories. In over-learned configurations, a single fixed operation or a fixed series of operations is required, expected and, in the case of violations, sometimes even sanctioned. In under-learned contexts, one usually finds varying, un-stable, context-dependent and fluid actions which are genuinely innovative, are created on the spot and are highly volatile, depending on the degree of openness in a particular situation.

Turning to a special instance of over-learned and under-learned contexts, namely to responses, the following basic distinctions can be made.

An over-learned response is triggered by a question, a command and the like and is characterized by a fixed word, a number, a sentence, a sequence of numbers or a short narrative which essentially remain unchanged in the short run and which change only under exceptional circumstances in the long run.[18] Typical examples for over-learned responses include the name of a person, her or his date of birth, a person's education level, or the employment status. Over-learned responses can be differentiated into general and specific responses. The former contain numerous instances which belong to the cognitive repertoire of minimally competent persons like one's first name, the latter are dependent on the knowledge and performance levels of a concrete individual.[19]

In contrast, under-learned responses are highly volatile even in the very short run, they are subject to frequent changes in short time intervals and they are sensitive both to contexts and to pre-histories. They, too, like the specific over-learned responses, depend on the cognitive organization and repertoire of individuals. Another rather obvious feature of under-learned responses is that they are easily forgotten within a very short period of

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[15] On over-learned and under-learned facts in memory research, see, e.g., Bower, 1977 or Taylor, 2004.

[16] See, for example, Underwood, 1996.

[17] See, for example, Glass/Lian, 2008.

[18] It should be mentioned that the production of over-learned responses has been characteristic of traditional education systems.

[19] A specialist on World War II and an expert on ants-research, for example, will share very large sets of general over-learned responses but will differ significantly with respect to their specific over-learned responses.

time. Table 4 offers several basic distinctions between under-learned and over-learned responses.[20]

Table 4: AN OVERVIEW OF OVER-LEARNED AND UNDER-LEARNED RESPONSES

Over-Learned Responses	Under-Learned Responses
Single Solution	Multiple Solutions Possible
Stable, Fixed	Highly Volatile, Unstable
Trivial	Non-Trivial
Repetitive	Creative
Key Input Only	Highly Selective of Inputs
Encoded in Long-Term Memory	Short-Term Memory only
Constant Reproduction across Time	Just in Time Productions
Context-Independent	Context-Sensitive
Path-Independent	Path-Dependent
State-Independent	State-Dependent
Global Consistency	Global Inconsistency
Observation Errors	Only Trivial Observational Errors
Identifiable	Possible

A final important distinction between over-learned and under-learned responses refers to the notion of observation and measurement errors. In over-learned responses measurement errors can be identified and, equally important, corrected. This correction can be accomplished due to the possibility for repeated measurements and due to the stable and fixed solutions in over-learned contexts. In fact, over-learned responses correspond to the fourth measurement type in Table 2. In sharp contrast, under-learned responses cannot be subject to measurement errors since an under-learned response misses an essential component, namely the reference values or the so-called true values. In under-learned responses one is confronted with a series of creative state-, input-, context- and history-dependent just in time responses where each of these responses, in the absence of neuro-physiological data from the cognitive neuro-sciences, must be treated as a »true value« under a set of specific, but highly varying circumstances.

With the distinction of overlearned and underlearned responses, it will be assumed hypothetically that the survey interactions between respondents and interviewers take place as a dialogue between two GA-systems.

[20] *The distinction between over-learned and under-learned responses has been introduced, quite obviously, also with respect to surveys and survey questioning. From the dichotomy in Table 4 a survey is usually a mixture between over-learned and under-learned responses. The former are highly concentrated in the socio-demographic section of a survey with questions on age, gender, occupation and the like whereas the latter are distributed over most of the remaining parts of surveys, especially over all the so-called attitudinal or evaluational segments.*

Here, the part of the interviewer will not be analyzed in greater length although this side could produce interesting new results, too. The center of the investigation is occupied with the GA-respondents, their cognitive architectures and the characteristic features of the interaction processes.[21]

As a starting point, it is fair to assume that for GA-organized respondents many of the survey questions, especially the ones related to attitudes or evaluations, will belong to the under-learned category. The available inputs in terms of questions, the restricted options for answers, the quantitative scales, etc. are not matched directly by the internal rule repertoire which could correspond to these specific inputs directly. Thus, answers to survey questions like trust in various institutions, life satisfaction in its various aspects, to name some prominent examples, require a creative response by a GA-respondent and qualify, thus, as under-learned. Turning to the GA-respondent side only, the following characteristic features of the interaction process can be specified.

One of the most important elements of the GA-based interactions lies in the sheer multiplicity of available responses by GA-respondents. The GA-organization allows a permanent recombination of new rules and, equally important, the co-existence of older and newer rules. The GA-organization acts rather graceful and very seldom removes older rules from its rule-set. This special feature of a multiplicity of answers has been noted by survey researchers as well. As pointed out especially by John R. Zaller (1992), respondents in surveys have a much richer repertoire of different responses at their disposal. Consequently, Zaller's response axiom states that

> *Individuals answer survey questions by averaging across the considerations that are immediately salient or accessible to them (Zaller, 1992: 49)*

What becomes of particular relevance here is that the high number of available responses is directly related to the under-learned situation and to the unusual requests for answering which require a creative response. In GA-language, due to the under-learned situation of a specific survey-question, a multiplicity of rules become activated since none of the available rule matches the input of a survey question.

The multiplicity of responses can be shown whenever a survey question does not require a selection of a single option, but asks for assessments of each of the options sequentially. Take, for example, the question of different

[21] *It goes without saying that a GA-architecture in its current form is under-critical and under-complex in view of the complex cognitive tasks inherent in survey responses. Thus, the present outline should be seen as a counter-factual sketch which is focused on GA-systems and which brings to light several characteristic features of the cognitive organization of respondents where the underlying GA-architecture can offer heuristic guidelines and a weak explanatory support.*

images of society which has been used in the Austrian Social Survey in 1993. Here, respondents were asked to which of the following four general views or images of society they could agree: to a meritocratic-conservative (a), to a »Marxist« (b), to a corporatist (c) or to a social relations-oriented view (d). As it turned out, even the contradictory pair of images, namely (a) and (b), was clearly treated in a non-contradictory manner. Only 54% of the respondents opted for one of the consistent options (a+/b-, a-/b+) and 46% agreed to inconsistent options. With respect to all four images of society, the largest single group agreed to all four images, followed by an agreement to three different images.

Second, this multiplicity of alternatives covers only the bright side of the coin. There is a dark side to this coin, too, because this multiplicity of alternatives contradicts an implicit assumption of survey designs and especially of survey designers. Usually, survey questionnaires are developed on the tacit assumption that respondents possess a consistent belief-system which can be captured through the items and dimensions of a multi-thematic survey. Wilson and Hodges (1992) describe this hidden assumption as the mental file view where respondents possess a well-ordered mental drawer, consisting of mental files on issues like legalized abortion, migration or trust in the police. Whenever a survey question is asked, they look for the appropriate file and report its content.

However, one of the most obvious characteristics of a GA-system lies in the global as well as in the local inconsistency of its rules which differ only in their relative strength. Surveys very seldom are designed to exhibit underlying inconsistencies in the attitude and belief system of respondents. The GA-architecture is structured in a way that the usual consistency relations do not apply. 80% of the respondents may be optimistic about their long-term future or about the future of the society as a whole. Any interpretation which would indicate that 100 – 80 = 20% of the population are quite concerned about the future would be extremely misleading. Normally, roughly 80% of the respondents will reply as well that they were very much concerned and worried with respect to the state of the environment and the sustainability of the mode of economic production and distribution. Global and local inconsistency is an essential element of a GA-architecture and this feature is reflected strongly in survey responses, too.

Apart from the global inconsistency of the GA-architecture, the third general characteristic deals with the logic of under-learned responses which does not comply with classical logic. Assume, in line with two valued logic, the availability of conceptual pairs like true/false, confirmed/rejected, allow/forbid, etc. As Hippler and Schwarz (1986), for example, demonstrated the conceptual pairs allow/forbid and not forbid/not allow are treated in surveys not as equivalent, but quite distinctively since allow and forbid are consistently seen as stronger statements than not allowing and not forbidding. Moreover, Hippler and Schwarz provide an un-intended support for the distinction between under-learned and over-learned responses because this observed asymmetry only holds for respondents with weakly developed attitudes (under-learned), not for persons with very strong attitudes (over-learned).

Another logical feature of under-learned responses is that the usual transitivity relations $a > b, b > c \rightarrow a > c$ do not hold.[22]

Furthermore, another seemingly illogical feature can be observed in the relation of generality and rule strength. One of the tacit assumptions especially in value-related survey research lies in the importance of general values as an essential determinant for preferences or specific routines. However, the GA-architecture reveals an interesting inversion between rule strength and generality. In brief, the most general rules turn out to be the weakest ones, the most specific rules, due to their context specificity, usually become the strongest ones.

Fourth, an underlying GA-architecture points to the important role of path dependencies, context effects and to the sensitivity to small input variations in survey-interactions. This special part has been studied in survey research extensively under labels like response effects, question order effects and the like.[23] The important point to be emphasized from a GA-perspective, however, lies in the simultaneity of a large variety of contexts, of a sensitivity to small input variations and of different pre-histories which cannot be isolated or de-composed in an un-ambiguous matter. Contexts may vary with interviewers and with specific events during a survey interaction, the wording of questions and, more importantly, the subsequent interpretation may vary with the pre-history of survey respondents prior to a survey interaction, etc. The simultaneity of these variations cannot be controlled sequentially which, in turn, raises another insurmountable problem for any comprehensive theory of measurement errors.

Aside from a multiplicity of potential replies, the overall inconsistency of these multiple alternatives, the non-classical logic underlying survey responses and context or history effects, volatility becomes a fifth essential feature of GA-based survey interactions. From a GA-based perspective, this volatility is composed of four different components. Initially, the volatility is partly due to the probabilistic bidding process which constitutes a necessary component of variation. Another part of the volatility comes from the necessity of producing creative responses which, by itself, must

[22] For a wonderful article on the topology of nervous nets and the non-transitivity of values, see McCulloch, 1980.

[23] See, for example, Bradburn and Mason, 1964; Cronbach, 1946; Krosnick and Alwin, 1987; Martin, 1964 or Schwarz and Hippler, 1991.

be considered as a non-trivial and inherently instable process. Additionally, the bidding process is, due to varying contexts of survey interactions, highly complex which, once again, adds to the volatility of responses. Finally, a fourth important aspect with respect to the volatility of under-learned responses lies in the scales which are available in many survey questions. When confronted with a scale between 0 and ten for example, respondents in under-learned situations usually are indifferent with respect to a broad range of values which adds another element in the overall volatility of responses.[24]

Numerous examples have been generated which point to the instability and the variation in responses. John R. Zaller gives an illuminating example in terms of changes in wordings.

A record instance of the effect of changes in question wording may be a New York Times poll in 1983 which found that public support for a 'freeze' on nuclear weapon production varied between 18 and 83 percent, depending on how the issue was framed. (Zaller, 1992: 29)

A particular striking example comes from the German Welfare Survey 1984 in which one of the most central questions, namely overall life satisfaction, was, by mistake, asked twice in an identical fashion. The correlation between both responses was only 0.60.[25]

Sixth, a highly fascinating feature in the creative nature of under-learned survey responses reveals itself by focusing on GA-architectures. Usually, the input side in survey interactions consists of a series of verbal items which, in conjunction, should be taken into account by a GA-system. But in a GA-architecture, it cannot be taken for granted that the entire input has been used in the process of producing an answer.

Thus, one is suddenly confronted with the possibility that other forms of understanding outside the intended domain of survey researchers were operative in generating a specific answer. For obvious reasons, the term »un-intended consequences« of a survey question points to the possibility that respondents did not reply to an intended question, but to a different one which was composed of selective elements of the original one.

Take, for example, a seemingly straightforward question like a self-assessment of one's overall position in society and a measurement method, using a scale from 1 to 10.[26] More than 80% of the unskilled workers positioned themselves above the societal average (6 and higher), in contrast to roughly 57% of the skilled workers. In GA-language it seems very likely that

[24] *While this indifference range may vary between respondents, it can be assumed that each respondent is indifferent with respect to at least two values on such a scale.*

[25] *See for more details Glatzer, 1984.*

[26] *This example comes from the Austrian Social Survey 1993 and is discussed at length in Müller, 1998.*

many respondents in the unskilled group produced an answer with respect to their subjective overall position from 0 to 10, and not to the intended societal positions from 0 to 10.

Another feature of unintended effects comes into play whenever under-learned items like work satisfaction, using a scale from 0 to 10, are asked in various, seemingly different dimensions. As has been shown in another publication[27], the answers to different dimensions of work satisfaction tended to be quite similar across Europe, despite very heterogeneous working and living conditions. In GA-language, the seemingly different dimension of work satisfaction became subject to a default operation which, among other results, would have produced very similar outcomes, had the list of dimensions been longer than the existing one.

The feature of defaults is of critical importance for a new perspective on comparative analyses because these defaults offer empirical support for similarity relations between non-identical questions within identical larger domains like work satisfaction.

The seventh feature of under-learned survey responses leads outside the GA-domain proper and to the domain of long-term and short-term memory. Under-learned responses, due to their under-learned nature, do not enter into long-term memory and are, thus, quickly erased from the memory screen in a very short period of time. [28] Within survey settings, twenty to thirty minutes are sufficient for having completely forgotten a specific under-learned response to a survey question.

These seven GA-based features conclude the presentation of the new cognitive background theory for survey interactions.

Towards New Designs for Comparative Survey Research in the Age of Science II

In our judgement, the next years and decades will experience a fundamental change in the core approaches to identify attitudes[29], to determine subjective as well as objective living conditions or to capture individual life styles. The paths for comparative survey research of the 20th century and its trajectories in the 21st century will be situated in significantly different cognitive territories. It would require several separate articles to present the consequences of the new cognitive foundations for survey research in more detail. But we would like to indicate the general direction for such a

27 See Reautschnig, 2009 and Müller and Reautschnig, 2010.

28 Following Saris and Gallhofer, 2007: 220, twenty minutes within a conventional survey interview are sufficient for practically forgetting an under-learned response to a survey question.

29 On classical approaches to attitudes, see, e.g., Ajzen, 1989; Ajzen and Fishbein, 1980; Eagly and Chaiken, 1993 or Fishbein and Ajzen, 1975.

reconfiguration of survey methodologies. This re-shaping requires, above all, recursive research designs where the step S_{t+1} operates on the results of step S_t. In this way, research designs should move towards cognitive equilibrium areas or attractors. Table 5 shows that a small number of research designs are already available which can be qualified as recursive.

Table 5: RECURSIVE DESIGNS IN SOCIAL SCIENCE RESEARCH

Methods	Applications	Similarity Relations	
		Recursive Operations	Eigenforms
Circular Questioning[30]	Social or Cognitive Perspectives	Recursive, towards a Homogenization of Perspectives	Stable Social or Cognitive Group View
Delphi-Methods[31]	Scenarios, Cognitive Assessments	Recursive, towards Consensus Formation	Group-Consensus
Generative Social Sciences[32]	Rule-based Dynamics	Recursive, toward Stable Configurations	Equilibrium, Limit Cycles, Strange Attractors, etc.
Meta-Analysis[33]	Results of Empirical Research	Recursive, towards Robust Knowledge	Robust Results of Empirical Tests
Triangulation[34]	Utilization of Different Research Methods	Recursive, towards Robust Knowledge	Stable Results

It will become the major task for subsequent publications to present an overview of new recursive designs in survey research which, moreover, correspond to the new cognitive foundations, outlined in the present article.

[30] *On circular questioning see, for example, Pfeffer, 2001.*

[31] *Delphi-Methods have been introduced already in the 1950s. See, for example, Rescher, 1998.*

[32] *Generative social science has become a generic term for rule and actor based designs. For a summary, see Epstein, 2006.*

[33] *Meta-Analysis has become a common procedure in the eighties and nineties of the 20th century in areas like clinical research and psychology. For a summary, see, for example, Hunter and Schmidt, 2004.*

[34] *Triangulation has become popular quite recently as a design to integrate a heterogeneous set of research methods across the quantitative and the qualitative spectrum. See, for example, Punch, 1998:242–246.*

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