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Ter Hark, M

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Searching for the Searchlight Theory: From Karl Popper to Otto Selz

Michel ter Hark

The idea that we acquire knowledge by trial and error has been one of the truly great ideas of the twentieth century. As no reader of his philosophical and autobiographical work could have failed to notice, Karl Popper credits himself for having invented this idea. The theory of trial and error or, in Popper's words, the Searchlight theory of knowledge and mind, is not just a part of Popper's comprehensive philosophy but rather one of its key features. It is at the bottom of some of his most spectacular achievements in methodology, epistemology, the philosophy of biology, and even political philosophy. Indeed, it is put forward at once as a model for the growth of individual knowledge (both human and animal), the growth of life (Darwin's theory of evolution), and the growth of scientific knowledge (philosophy of science). As happens so often with innovative ideas, the Searchlight theory derives much of its glamour from the theory it rejects: the view of the mind being a *tabula rasa* and sense perception the origin of all (human) knowledge. Popper nicknames this empiricists' view as the Bucket theory since it conceives of the mind as nothing but the conduit for sense-impressions, an empty bucket to be filled by the accumulation and storage of information.¹ In his hands the Bucket theory collapses under the strain of philosophical arguments and scientific facts and is replaced by a theory which maintains that our knowledge of the physical world is drawn from our mind and constructed from the repertoire of knowledge dispositions we already possess. Acquiring dispositions proceeds according to the method of trial and error elimination. This method, Popper contends, consists essentially of three stages: forming a problem or expectation, trying out a number of solutions of the problem, and eliminating or discarding false solutions as erroneous.² A key feature of Popper's theory of trial and error elimination, and the

¹ Karl Popper, *Objective Knowledge: An Evolutionary Approach* (Oxford, 1972), 341-62.

² See especially Popper, *Objective Knowledge*, chapter 3 and Popper, *Unended Quest* (London, 1974), throughout, and Popper, *All Life is Problem Solving* (London, 1999), chap. 1.

reason for speaking of a Searchlight theory of knowledge and mind, is his insistence that problems or expectations take precedence over observations. Observations are always preceded by expectations, points of view, questions or problems which, as a searchlight, illuminate a certain area, thereby enabling the organism or the scientist to know what to observe in the first place.

The question arises how and when did Popper come to this theory of the growth of knowledge and mind which was to have such radical implications for the philosophy of science, epistemology, and the philosophy of psychology? My aim in this article is to trace the roots of his theory of the Searchlight.³ The earliest traces of the theory are to be found in his unpublished dissertation, *Zur Methodenfrage der Cognitive psychology* (1928). Here I will focus upon this “hasty last minute affair” written in the tradition of early German cognitive psychology and supervised by one of its most outstanding proponents, Karl Bühler. Scrutiny of this manuscript, however, reveals not so much the formative influence of Bühler as that of Otto Selz. Indeed, I will argue that Popper borrowed his crucially important Searchlight theory from Selz. Thus having found the origin of the key notion of his epistemology in psychology, the relation between psychology and philosophy in Popper’s work, always fraught with tension, is up for thorough reconsideration.

The Würzburger School of *Denkpsychologie*

It is only against the background of the prior history of psychology, with its development of sensualism and associationism by Wilhelm Max Wundt (1832-1920), Hermann Ebbinghaus (1850-1909), and G. E. Müller (1850-1934) that the achievements of *Denkpsychologie*, or cognitive psychology, can be properly understood. Wundt had defined psychology as the science of immediate experience. In analyzing experience into its ultimate elements and in formulating the laws in accordance with which these elements are combined, Wundt leaned heavily on sensationalism and associationism. Yet many of Wundt’s notions are transitional to the psychology of wholes (*Ganzheitspsychologie*) which takes different forms in the work of Christian Freiherr von Ehrenfels, Wolfgang Köhler, Felix Krüger, William Stern, and Selz. One such notion in Wundt’s work is his concept of apperception. His colleague Herbart, wholeheartedly in the tradition of atomism, still meant by apperception the mechanical coalescence of new and old mental images; but Wundt took the concept to refer to a voluntary activity that, as a sort of mental and unifying central force, gave order and direction to the course of mental images. His opponents ridiculed the concept of apperception as a return to the scholastic doctrine of mental powers, but one of Wundt’s most outstanding and successful students, Oswald

³ See Michel ter Hark, “Between Autobiography and Reality: Popper’s Inductive Years,” in *Studies in History and Philosophy of Science* (forthcoming).

Külpe (1862-1915), elaborated upon it further. He became Wundt's assistant and, in 1894, he was called to Würzburg as *ordinarius* for both philosophy and aesthetics. By 1896, he founded there a psychological laboratory which became, next to Leipzig, the outstanding institute of Germany. During this "Külpe period" publications of the greatest importance were issued by a number of psychologists that were to become famous far outside Germany.

Külpe's most significant departure from Wundt was his proposal to study in the laboratories those mental processes his teacher had deemed impossible to deal with experimentally: thoughts. Cognitive psychology has its beginning in 1901 with the publication of papers by A. Mayer and J. Orth on the qualitative nature of association, followed Karl Marbe's experimental study on judgment. As Külpe summarizes the first achievements of the School, these were largely negative: the traditional contents of consciousness, sensation, feeling and images, the very substance of Wundtian psychology, proved inadequate to account for the intellectual processes of thoughtful association and judgment. Yet subjects frequently reported that they experienced certain conscious processes which they could describe neither as definite images nor as acts of will. To these impalpable experiences, which could not be classified under any of the standard categories, Marbe gave the name *Bewusstseinslage*—states of consciousness. The next important publication came from H.J. Watt, who in 1905 conducted experiments in which he demonstrated the role of the *Aufgabe*, or task, as a directive, conscious influence in the problem he set for naming superordinates for sub-ordinates and parts for wholes. At the same time Narziss Ach, having graduated in Würzburg, finished his dissertation in Göttingen, where he conducted experiments on willing which turned out to be also an investigation on thinking. Ach dubbed the term "determining tendencies" for the directive influence of the task on the outcome of thinking.

Karl Bühler (1879-1963) joined the Würzburger School around 1906, where he would stay until 1909, the year he followed Külpe to Bonn. In Würzburg he wrote his most important contribution to cognitive psychology, his *Habilitation*, "Tatsachen und Probleme zur einer psychologie der Denkvorgänge" (1907). A sequel of this paper followed one year later. In Bühler's hands the methods of investigation of the School would take a decisive turn, deviating sharply from the canons of Wundt and provoking vigorous responses from the grand old man of psychology. His was an *Ausfragemethode*, a question-and-answer process, posing a problem to the subject and allowing him five or ten seconds or more to respond. Subjects had to answer questions for which there could be no cut-and-dried answer. A typical problem was "Was the Pythagorean theorem known to the Middle Ages?" On examining the protocols Bühler discovered that the reports of his subjects consisted in auditory and kinaesthetic images and feelings. Aside from these there were the peculiar stretches of consciousness that Marbe described as *Bewusstseinslage* and which Bühler called simply "thoughts."

After his Ph.D. Otto Selz (1881-1943) went to Bonn where he participated in the seminars of Külpe and Karl Bühler. Above all he was engaged in experimental investigations in the laboratory of Külpe. These investigations resulted in his first major work, his *Habilitationsschrift, Über die Gesetze des geordneten Denkverlaufs. Eine experimentelle Untersuchung* (1913). Taking his cue from Bühler's theory of imageless thought, Selz, according to Külpe, made a significant step in psychology of thought.⁴ In fact the drift away from the program of the Würzburg School was more radical than Külpe would acknowledge. Already perceptible in 1910, the incipient rift among Selz and the Würzburg School became more obvious in the wake of a devastating review of Ach's book on willing.⁵

With his second major work in the psychology of thought, *Zur Psychologie des produktiven Denkens und des Irrtums* (1922), its publication being postponed owing to the First World War, Selz's intellectual prestige was uncontestedly on the rise, and in 1923 he was called for the chair of Philosophy, Psychology, and Pedagogy at the *Handelshochschule* in Mannheim. From this period, too, stem two of his short philosophical essays, *Oswald Spengler und die intuitive Methode in der Geschichtsforschung* (1922) and, *Kants Stellung in der Geisteswissenschaft* (1924), in which he attempts to bridge the gap between the natural sciences and the *Geisteswissenschaften* by means of his naturalistic and evolutionary epistemology.

In his scientific work Selz was increasingly marginalized owing to his unremitting criticism of colleagues but also to his overly complex style of writing. An evolutionist disguised as an introspective psychologist, Selz came into conflict with proponents of the *Geisteswissenschaften*, who blamed him for endorsing a mechanist view of man. Seeking to reconstruct psychological wholes on the basis of their elements, Gestalt psychologists considered him an atomist, whereas to the school of Krüger he was a one-sided rationalist. Closely allied to the Würzburg School, he did not shrink from launching frontal attacks on the ideas of some of its members. Aside from two pupils, Jules Bahle and Adriaan de Groot, he never founded a school, and after 1933 his name disappears almost completely from the German psychological literature.⁶ Yet there are excellent reasons for rescuing him from oblivion if only for his role (unbeknownst to him) in shaping the formation of another pupil, Karl Popper.

⁴ Quoted in H. Seebohm, *Otto Selz. Ein Beitrag zur Geschichte der Psychologie* (Heidelberg, 1970), 15.

⁵ Otto Selz, "Die experimentelle Untersuchung des Willensaktes," *Zeitschrift für Psychologie*, 57 (1910), 247-70.

⁶ Seebohm, *Otto Selz*, 278.

Selz's Revision of Psychology

A key feature of Selz's first great experimental work is his insistence on the distinction between the continuous coherence of ordered thinking as opposed to flights of ideas (*Ideenflucht*) and reverie. Requiring of any psychological theory that it provides an explanation for this distinction, Selz simultaneously argues that explanations appealing to the principle of association are woefully inadequate to this task. Although his experimental set-up was in the tradition of the Würzburgers, Selz's theoretical work deviates from the school in two respects. One is that Selz does not even adopt a modified version of associationism but rejects it completely; indeed one of the tasks he set himself was to demonstrate the inadequacy of the most sophisticated form of associationism, the constellation theory, as an explanation of ordered thinking. The second difference is that in Selz's work the explanandum of psychology is shifted from the content of thinking to the process of thinking. While the elder members of the Würzburger School, above all Külpe, set themselves the phenomenological task of describing and analyzing thought experiences as a mental category *sui generis*, Selz, without denying the importance of imageless thought, believes that the essence of thinking is to be found in a series of "operations" or "solving-methods." Selz, de Groot summarizes, "read protocols in a different way: he searched for the procedures (methods) by which the subject made progress...."⁷

Between 1902 and 1910 Selz devoted much time and energy to confronting association psychology and in particular the constellation theory. The argument leading to the demolition of the constellation theory takes its cue from Müller's proposed explanation for the solution of tasks requiring the subject to respond to a stimulus word, e.g., "farmer." Suppose, Selz says, a subject responds immediately with "occupation" to his reading the stimulus word. In Müller's account, Selz explains, the task "generic concept" operates as a directional representation preparing a wide range of names of generic concepts drawn from experience, among them the concept of "occupation." From among this wide variety of concepts only the association "farmer-occupation" would be selected owing to the favorable constellation induced by the task. However, Selz avers, this explanation would be successful only if associations irrelevant to the task would not be triggered. Yet this is far from being the case. Selz argues that association psychology eschews any reference to cognitive or meaningful relations between associations, such as "cause of" or "solution of" and that it instead admits only relations of temporal and spatial contiguity or similarity. Selz concludes, therefore, that by definition association psychology cannot exclude irrelevant associations from arising. Indeed, there is no more spa-

⁷ Adriaen de Groot, *Thought and Choice in Chess* (The Hague, 1965), 51.

tial and temporal contiguity between a specific problem and its specific solution than between that problem and countless other problems and solutions. Accordingly, completely pointless errors should occur rather frequently during problem solving. The fact that such errors do not frequently occur then is inexplicable from the point of view of the constellation theory.⁸

Whole completion on the basis of “schematic anticipations” is Selz’s alternative theory of problem solving. In many cases of memory retrieval, Selz opens his discussion of schemata, subjects already know that the information at hand is a piece of a larger whole. Indeed, they even often know what kind of whole the piece belongs to. Thus the candidate at the exam, Selz illustrates, knows not only that the first letter prompted by the examiner is part of a whole but also that this whole is a word, and that the word begins with this letter. This knowledge, Selz emphasizes, does not consist of two separate elements: the awareness of a word and the awareness of the prompted letter. Rather, the subject knows that the prompted letter is part of a word; that is, a relational whole is involved rather than an aggregate of elements. Being aware of this cognitive whole prompts the subject to anticipate schematically the answer to the question. Schematic anticipations establish a system of provisional relations between the new elements and the cognitive whole into which they fit, and are more than partial anticipations, for all of the elements of the result are somehow anticipated. At least one of those elements, the very one to be found by thinking, is more or less indeterminate. This indeterminacy, however, concerns only the sought for element itself, and not its relations with the other elements of the whole. Giving the example of a candidate in an oral examination trying to remember the *Melanchton*, and who is assisted by the examiner’s giving the first three letters *Mel*, Selz explains: “The awareness of the word sought is changed from the awareness of an indetermined word to the awareness of a word beginning with *Mel*.... We must think of it as though the empty scheme of a concrete word is partly filled out by the insertion at its beginning of the sounds spoken in anticipation....”⁹ Diagrams of schematic anticipations making clearly visible that the awareness of a problem relates to the cognitive whole to be realized as the scheme of a whole relates to the completed whole appeared in Selz (1922, 1924).

⁸ This criticism is taken over by Karl Duncker in *Zur Psychologie des produktiven Denkens* (Berlin, 1935).

⁹ Otto Selz, *Zur Psychologie des produktiven Denkens und des Irrtums* (Bonn, 1922), 114.

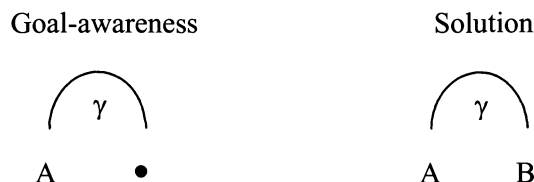


Fig. 1: A schematic anticipation of a cognitive whole

Selz's diagrams proved immensely fertile, inspiring both cognitive psychologists endorsing a view of intelligence as biological adaptation, like Piaget, and cognitive scientists, like Duncker, de Groot, Allen Newell, and Herbert Simon, taking logic and computer models as their point of departure.¹⁰

Schematic anticipations are not the only directive factors in problem solving; another factor is what Selz calls the total task (*Gesamtaufgabe*). It is especially here that Selz radically departs from the passive approach to thinking characteristic of associationism. According to Selz, task and stimulus word do not become separately active in the course of thinking but instead fuse into one another before the solving attempts start. This integration of task and stimulus word is the "unified total task" (*einheitliche Gesamtaufgabe*). Initially the task is a general one, and it is only by means of specific operations that it becomes more specific and circumscribed. This transition from a general understanding to a more specific one finally limits the possible number of solutions and, hence, is another directive factor in thinking.

Selz's approach to psychology became increasingly biological in the second volume as well as in the important synopsis of his work, the *Kurzgefasste Darstellung* (1924). Another important summary in this respect is "The Revision of the Fundamental Conception of Intellectual Processes" (1927), which appeared in *Kantstudien* and for a long time was the only accessible piece of writing of Selz owing to its translation in J. M. and G. Mandler's *Thinking: From Association to Gestalt* (1964). The term "revision" is aptly chosen by him for his undertaking in these writings is essentially to achieve an epistemological revision, a paradigm-shift if one likes, of fundamental psychological notions and explanations. Thinking, according to Selz, is no longer to be considered a pattern of mental images and thoughts but rather a "system of specific reactions or operations." Human personality, as he puts it later, is to be conceived as an "organized system of functional, cognitive modes of behaviour,"

¹⁰ See Duncker, *Zur Psychologie des produktiven Denkens*, quoted in J. M. Mandler and G. Mandler, *Thinking: From Association to Gestalt* (New York, 1964), 264 and Jean Piaget, *Psychologie der Intelligenz*, 42, and Hebart A. Simon, "Otto Selz and Information-Processing Psychology," in *Otto Selz: His Contribution to Psychology*, ed. N. H. Frijda and A. D. de Groot (The Hague, 1980), 155.

analogous to the organization of functional bodily movements. Resorting to the biological study of reflexes as a model for the functionality of cognitive operations, Selz points out that reflexes constitute a system of specific responses in the sense that when a specified event in the environment (a stimulus) occurs, the organism automatically responds with a particular way of behaving. Far from resurrecting association psychology from its ashes, the analogy between intellectual operations and reflexes is appealed to by Selz because of the non-associational and functional nature of reflexes:

In diametrical opposition to the play of associations which varies according to the constellation present, and which the theory of diffuse associations has in mind, we find here everywhere fixed, irreplaceable co-ordinations, which assure a biologically useful, life-maintaining response, and turn out to be a constant regulative factor in the process of life.¹¹

What Selz seeks to achieve with this analogy between motor operations and cognitive operations is nothing less than a biological or evolutionary revision of the then dominant theory of cognitive development which assigns an irreducible place to the intellect. According to this model, espoused above all by Bühler, intelligence gradually arises from the increasing multiplicity of acquired habits or associations. Following this tradition of developmental psychology, Selz distinguishes between instinctive learning, automatic learning (habit-formation) and insightful learning; yet he argues that even the simplest form of habit cannot be explained in terms of associative learning. On the contrary, he argues, “acquired reflexes” are guided by schematic anticipations. Thus conceived, the study of the genesis of habits becomes relevant for the study of the development of intelligence for, rather than being a qualitatively different and older stage, cognitive operations are, “a developmental integration of intellectual actions into an existing, more primitive system of specific responses.”¹²

It is here that Selz introduces his important notion of trying-out behavior (*probierenden Verhaltens*). The learning process which, soon after the first days of human life, transforms innate reflexes into acquired reflexes, Selz contends, is a process of trying-out (behavioral) schematic anticipations. His main argument for the selecting role of schematic anticipations upon automatic learning, however, comes not from animal biology but from his study of the acquisition of skills in sport and aircraft.¹³ A beginner at ninepins, Selz explains, seeking to

¹¹ Otto Selz, *Kurzgefasste Darstellung* (Bonn, 1924), 33.

¹² Otto Selz, “Die Umgestaltung der Grundanschauungen vom intellektuellen Geschehen,” in *Kanstudien*, 32 (1927), 229.

¹³ During the First World War Selz was invited to study the psychological causes of flight-accidents, a study which also contributed to his insights into the nature of skills. Otto Selz, “Über

hit a particular pin, will initially try out deliveries of varying force, trajectory, and spin within a range circumscribed by previous bowling experiences.¹⁴ Among these "trying-out movements," Selz contends, a small group will lead to a positive result (*R*), while the others will produce negative results (*N1*, *N2*, *N3* ...). In later attempts the subject cannot anticipate the exact movement which has led to *R* as a means to achieving his goal. Yet, Selz emphasizes, anticipating *R* prompts only those memory traces of earlier attempts which actually have led to *R*. Indeed, he recalls, it turns out to be more efficient to concentrate on the goal of the movement than on the movement itself, awareness of the goal heightening the selective effect of the anticipation of the correct movement. Finally successful movements will be made with great precision owing to the process of skilled application of means. This selective role of schematic anticipations is depicted in figure 2.

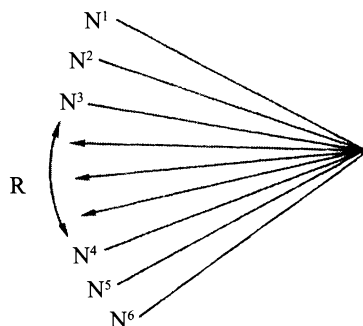


Fig. 2 Trying-out Behavior

The most important difference, then, between blind trial and error and trying-out behavior is that in the latter case attempts are based on a partial insight into the situation. Always showing a clear sense of direction, the organism tries out within a pre-set, goal-determined, and limited domain of solution possibilities. In Selzian terms, schematic anticipations co-determine the where and what of search and trying.

A philosopher primarily interested in epistemology, Selz sought to use his cognitive psychology as a (naturalistic) foundation for epistemological theories aimed at understanding the nature and growth of scientific knowledge and even of culture.¹⁵ Thus invoking his recent scientific findings in cognitive psychology in explaining creative thinking, including discoveries in science and art, Selz significantly broadened the objectives of experimental psychology by

den Anteil individueller Eigenschaften der Flugzeugführer und Beobachter an Fliegerunfällen," *Zeitschrift für angewandte Psychologie*, 15 (1919), 254-300.

¹⁴ Selz, *Kurzgefasste Darstellung*, 48ff.

¹⁵ Otto Selz, *Zur Psychologie des produktiven Denkens und des Irrtums* (Bonn, 1922), and Selz, *Kurzgefasste Darstellung*.

encompassing an area deemed hitherto the exclusive province of hermeneutic psychology. Indeed the very part of the human mind which is the breeding-ground for products of culture, both Dilthey and Spranger contend, is not subject to the laws of nature.

Rather than being a mysterious *Geist* withdrawn from the laws of nature the human personality, Selz contends, is functionally interwoven with its biology. As he puts it both in the preface of his work on productive thinking (1922) and in his synopsis of his results in cognitive psychology two years later,

The view defended here is diametrically opposed to the teaching of Bergson and of a philosopher who is close to him, Spengler. They conceive of life as a process, as a continuous stream in which nothing occurs twice, but in which continually new forms arise in a mysterious, causally inexplicable way.... By contrast, we have shown here that it is precisely *the constant, systematic linkages of cognitive operations and the recurrence of the same conditions of elicitation which constitute the preconditions for progressive development, for the growth of new operations and the generation of new products of the mind....* Perhaps our era is witnessing the beginnings of a “biology of the inner.” Psychology thus enters the ranks of the biological sciences.¹⁶

Popper's *Zur Methodenfrage der Denkpsychologie*

Writing his dissertation in psychology under Bühler, the young Popper was familiar with the most important works in cognitive psychology, including Selz's recent work on creative thinking and evolutionary epistemology. *Zur Methodenfrage der Denkpsychologie* is difficult to read and still far removed from the elegant prose familiar from Popper's later writings. Neither is it a very original piece of writing, for rather than elaborating views of its own, the author walks well-behaved at the hand of Karl Bühler and sails blindly on the latter's methodological views in his recently published *Die Krise der Psychologie* (1927). In this most important but much neglected book, based upon his famous course in General Psychology at the University of Vienna, where he had become professor in 1922, Bühler argues that psychology is the science of the triad experience-behavior-culture.

Popper's first goal is to defend Bühler's pluralistic methodology against the objections of contemporary physicalism. More relevant here is his second goal, which is to demonstrate the indispensability of Bühler's pluralistic methodology for cognitive psychology, and in this context is the biological or evolutionary theory of cognitive development. For in the course of his discussion

¹⁶ Selz, *Zur Psychologie*, xii. See also Selz, *Kurzgefasste Darstellung*.

of cognitive psychology it becomes clear that Popper is no less interested in the evolutionary theory of cognitive development than in the topic, which not only (formally) deserves, but also receives the most extensive treatment, viz.: the importance of Bühler's pluralism of aspects for cognitive psychology.¹⁷

His preoccupation with a biological theory of cognitive development is also reflected in the sequence with which he deals with Bühler's three aspects, for rather than starting to discuss the aspect most relevant to cognitive psychology—the aspect of experience—it is in fact one which is furthest removed from the study of thought—but firmly rooted in the biological sciences—which receives credit for being the first in line: the behavioral aspect. However, it is not so much American behaviorism which is covered by the behavioral aspect as Bühler's notion of “meaningful behavior” (*sinnvollen Benehmen*). Another sign of Popper's engagement with a biological theory of the intellect is his proposal to substitute the expression “functional behavior” (*zweckmässigen Verhalten*) for “meaningful behavior,” by virtue of its being more entrenched in biology.¹⁸

More than the notion of efficient behavior it is the related notion of *zweckhaften Verhaltens* which is at the center of Popper's reflections on the behavioral aspect. Popper's explanation of this distinction is as follows. Functional behavior is behavior which is highly adapted to a specific situation. Were an animal to show maladjusted behavior, for instance a dog barking at a locomotive, it does not immediately follow that it is completely pointless; if it can be shown that the animal's behavior would have been functional in another situation it is, although not objectively efficient, subjectively functional (*zweckhaft*). Subjectively functional behavior, Popper avers, plays an important role in “behaviouristic cognitive psychology.”¹⁹

Initially he explains this role by means of a passage of Ernst Mach in his article *Der Begriff*, published in *Die Principien der Wärmelehre* (1896), in which he discusses the genesis of concepts especially among animals and young children. Mach observes that under different circumstances, which have nonetheless something in common, animals react in the same way. A young animal, for instance, typically grasps at a physical object which seems to it like food, licks at it and puts it in its mouth. These activities, according to Mach, “produce new *decisive* sensual properties (smell, taste)....” which in their turn pro-

¹⁷ Malachi H. Hacohen, *Karl Popper: The Formative Years 1902-1945* (Cambridge, 2000). The importance of this subgoal has been overlooked by Hacohen in his brief discussion of Popper's dissertation. Moreover Hacohen fails to relate both the Bucket theory and the Searchlight theory to Popper's endorsement of Selz in respectively in Popper, “Die Gedächtnispflege unter dem Gesichtspunkt der Selbsttätigkeit,” *Die Quelle*, 81 (1931), 607-19, and Popper, *Zur Methodenfrage der Denkpsychologie* (unpublished manuscript).

¹⁸ Karl Popper, *Über die Vorstellungen der Tiere* (Leipzig und Bern, unpublished manuscript, 1928), 49.

¹⁹ *Ibid.*

duce further behavior like throwing the object away. He concludes: "I consider these *similar* activities as well as these *similar sensual* properties produced thereby, *both* of which somehow become conscious, as the *physiological* foundation of the concept"; and then follows the passage quoted by Popper: "That which is reacted upon in the *same* way falls under *one and the same* concept."²⁰ According to Popper, Mach would have explained maladapted yet subjectively goal-directed behavior in the following way: the situation in which the animal behaves inefficiently means the same to the animal ("falls under the same concept"), as that in which the same reaction would have been functional. The animal has made a "mistake," it has "confused" the one for the other.

Since Bühler was one of the chief proponents in German lands of the campaign against Mach's sensualism and associationism, Popper's appeal to him is surprising. It is noteworthy therefore that when resuming this theme in his sketch of a deductive psychology of knowledge, in 1933, the reference to Mach will be accompanied by critical comments on his sensualism and associationism. In 1928, Popper does not abandon Mach, yet the seeds of his later critical and dismissive remarks of sensualism and associationism are sown in the discussion of the behavioral aspect. Subsequent to the reference to Mach follows a discussion of the views of some authors one of which is explicitly against Mach: the animal psychologist Hans Volkelt. Popper's immediate reason for calling in the views of Volkelt is that there are two respects in which Mach's theory is inadequate. The first is that Mach does not explain further what is meant psychologically by the phrase "means the same to the animal"; the second is that the connection between Mach's theory and the behavioral aspect of psychology is far from evident.

In his much neglected *Über die Vorstellungen der Tiere*, Volkelt seeks to understand animal consciousness, how the animal sees and conceives its environment, in a way which differs from both behaviorism and unrestrained anthropomorphism. One of the most striking features of animal behavior, he observes, is its being adapted to a very limited scope of situations, and that it is more or less maladjusted to facts outside of this circle. A pupil of Krüger, Volkelt argues that it is the total situation (*Gesamtsituation*) rather than its constituting elements which determines the animal's behavior, animal consciousness somehow effecting a synthesis of the sensory material. Animal consciousness, he avers, consists of complex-qualities. The coalescence of a multiplicity of situations into complex-qualities is not the only cause of the finely tuned conduct of animals. It is only on the further assumption that complex-qualities are tied (*Zuordnung*) to specific ways of behaving, thereby becoming effective, that a full-fledged explanation of the adaptation of animal behavior is accomplished.²¹

²⁰ Ernst Mach, *Die Principien der Wärmelehre* (Leipzig, 1896), 416, and Popper, *Zur Methodenfrage der Denkpsychologie* (unpublished manuscript, 1928), 51.

²¹ Hans Volkelt, *Über die Vorstellungen der Tiere* (Leipzig und Bern, 1914), 106.

The question what it can mean psychologically that different situations have the same meaning for the animal, left unanswered by Mach, can now be answered, according to Popper, by Volkelt's theory that the animal's visual impressions of both situations are embedded in the same complex-qualities.²² Moreover, Popper avers, it is only Volkelt who provides a biological explanation of such exchanges. According to Volkelt, the extent to which complex-quality and reaction are effectively co-ordinated is proportional to the vital importance of the current situation.²³ The animal organism is highly adapted to vitally important situations, and it is only in "vitally indifferent situations," situations to which it is not adjusted, that the animal can make "mistakes."²⁴ Thus Popper's conclusion: "To the objective observer this reaction is a failure, but not to the animal: the animal acts subjectively functional."²⁵

By putting forward his theory of complex-qualities Volkelt not only takes issue with Mach's sensualism but also with association psychology. Although Volkelt's book appeared a year after Selz's first book, there is no evidence for Volkelt having read Selz, yet the similarity between their views is striking. It is therefore interesting to see that Popper, after having discussed Volkelt, turns to Selz's interpretation of animal behavior as well as Bühler's theory of stages. As Popper observes:

[Selz] finds a connection only with certain outstanding intelligent achievements of chimpanzees. This has to do with the fact that he builds his fully introspection-based theory from the higher end of the developmental row. Although Selz is clearly strongly biologically oriented, his theory of the operations of thinking does not yet establish a connection with the most primitive ways of behaving. This gap is bridged by Bühler's "theory of three stages": instinct-training-intellect.²⁶

Especially the reference to Bühler will be welcomed by those who believe that Popper's later work is much indebted to his theory of stages, yet it seems to have been made more out of respect for his teacher than on purely intellectual grounds. For it must be remembered that Bühler's stage of training is straightforwardly associationistic, and in that respect closer to Morgan than to the views of those with whom Popper seems to sympathize most: Volkelt and Selz. Popper's familiarity with Selz's non-associationistic theory of trial-and-error is

²² Popper, *Zur Methodenfrage der Denkpsychologie*, 52. Since complex-qualities are always imbued with feelings the animal has, one might also say that different visual impressions "are embedded in the same feelings."

²³ Volkelt, *Über die Vorstellungen der Tiere*, 98.

²⁴ *Ibid.*, 36-37.

²⁵ Popper, *Zur Methodenfrage der Denkpsychologie*, 54.

²⁶ Popper, *Über die Vorstellungen der Tiere*, 57-58.

beyond dispute, for in the very chapter of Selz (1922) to which he refers, the one about chimpanzees, his notion of trying-out behavior is centrally important. Moreover, as we will see soon, Popper even explicitly refers to Selz's idea of trying-out behavior. As one who had at least an inkling of the overall scheme of Selz's cognitive psychology, Popper, at this juncture, could have derived Selz's criticism of Bühler, which was discussed in section 2.

The discussion of the aspect of experience is the least original part of Popper's dissertation. Yet in the final part of this section, resuming the thread of an evolutionary theory of cognitive development, he makes some comments which simultaneously show the formative influence of Selz and the still rudimentary phase of his thoughts in this area. Emphasizing the theoretical importance of a biological approach to the study of experience on the grounds that it would enable investigators to connect the most subjective aspect of psychology with the two more objective aspects, viz.: behavior and culture, Popper mentions especially Selz: "Both the attempts and the results of Otto Selz agree perfectly with this program. He attempts with success to interpret biologically the observed operations of thought [*Denkoperationen*]. At the end of his *Kurzgefasste Darstellung*, he formulates his views on this point with the following words."²⁷ Then follows the passage already quoted at the end of section 2 in which Selz announces the "biology of the inner man." Indicative of the still rudimentary character of Popper's evolutionary theory is that it is precisely in this passage that Selz at the same time dismisses "the senseless play of associations" as an adequate explanation of cognitive development and proposes his integrative theory of stages which not only supplies important correctives to Bühler's theory but also accords no place whatsoever to the *Geisteswissenschaften*. The section on the objective products of the mind, or culture, shows the same pattern as the preceding ones: a rather cumbersome theoretical discussion arguing for the need of the aspect of culture for cognitive psychology suddenly shifted towards the evolutionary theory of cognitive, and especially, scientific development.

Having earlier dismissed a parallelism of structure between, on the one hand, subjective experiences and, on the other hand, objective intellectual structures (his later world 3), Popper now turns to the method of scientific research (*Forschungsseite*). In this area, he contends, cognitive psychology is on much firmer grounds. It is here that the earliest traces of his later method of trial and error, his theory of the Searchlight, is to be found:

Perhaps there are important parallels in the methods and operations of the scientific and the "pre-scientific" induction? To give just one example: The Selzian concept of trying-out behavior (*probierenden*

²⁷ Popper, *Über die Vorstellungen der Tiere*, 77.

Verhaltens) seems to me to have important parallels in objective scientific research. Science tries out its methods, its “models” (as Bühler puts it), and in such a way as to correspond completely with the Selzian scheme (*dem Selzschen Schema*). As is well known the actual ways of scientific research in no way correspond with the logical principles of the representation; as little as the operations (*Operationen*) described by Selz correspond with the objective logical operations. Despite this science is in the end clearly driven by tasks (*aufgabegesteuert*), the determining tendencies (*determinierenden Tendenzen*) come clearly to the fore.

Selz himself has several times made use of the example of scientific research; although not in the sense in which we here propose. His analysis encompasses not the objective intellectual structures, nor objective scientific research, but certain scientific discoveries under the aspect of experience.²⁸

This passage unmistakably shows that Popper has borrowed his later theory of trial and error, with its characteristic emphasis on the guiding role of problems both in individual and scientific knowledge acquisition, from Selz, yet it also shows his thoughts to be still rudimentary at this juncture. For one of the most surprising features of this passage is his speaking of induction as a matter of course. Embracing induction not only conflicts with his well-known deductivist methodology and epistemology—as well as with his own portrayal of the genesis of his philosophy—but also with the epistemological implications of Selz’s psychology. As I have made clear in the preceding section, Selz’s detailed and frontal assault on association psychology, and his defense of a theory of complex-completion, in fact boiled down to a view of the animal or human organism as an active cognitive subject constantly putting forward tentative proposals or hypotheses rather than as a passive recipient, patiently waiting for the accumulation of information to be inductively safe. Fully embracing what he calls the “Selzian scheme” of problem-solving therefore means that the material for building a deductive, and problem-driven, methodology and epistemology is already available to him in 1928, yet the inductive paradigm has such a strong hold on Popper that it prevents him from drawing the revolutionary implications of Selz’s work. In the next section we will see how Popper makes a move nearer in the direction of a deductive theory of knowledge and science by first discarding, again within the framework of Selz’s cognitive psychology, the Bucket theory of knowledge and science.

²⁸ Popper, *Über die Vorstellungen der Tiere*, 69-70.

The “Bucket Theory” and Mnemonic Exercise

The ensuing development of Popper’s thoughts on psychology brings us to a short publication in the monthly journal of pedagogical reform, *Quelle*, edited by Eduard Burger. Scrutiny of this much-neglected article titled, “*Die Gedächtnispflege unter dem Gesichtspunkt der Selbsttätigkeit*,” shows that the elaboration of a Selzian evolutionary epistemology takes only gradually shape. After having toyed with the idea of applying Selz’s notion of trying-out behavior in the philosophy of science we find Popper now appealing to Selz’s theory of complex-completion in a pedagogical debate between, on the one hand, the *Lernschule*, and, on the other, the *Arbeitsschule* of Eduard Burger concerning the role of memorization in education.²⁹ The labor schools attempted to steer education away from a drill school approach, typical of the *Lernschule*, towards seeking children’s active engagement through self-discovery.

Having a huge amount of knowledge at one’s disposal is the ruling principle of the *Lernschule* (*Stoffprinzip*). This principle demands a lot of memorization. Mnemonic exercise is achieved, according to the school, by accumulation of knowledge and frequent repetition of this material. While approving of the pedagogical importance that the *Lernschule* attaches to memorization, Popper sees the weak point of the school’s program in the way it believes that mnemonic exercise is achieved. That is, the problem with the *Lernschule* is not pedagogical but psychological.

The ensuing description of the psychology underlying the pedagogical program of the *Lernschule* shows Popper using for the first time a metaphor which will figure prominently in his later writings: “To the *Lernschule* memory is nothing but a container of material, a sort of bucket of knowledge.” The essence of memory, on this view, is to let in and store knowledge. Indeed, the only properties of the bucket are its more or less reliable storage of knowledge, and its having a certain space. The consequences for pedagogy are that mnemonic exercise can only be achieved by repeating the process of storing and retrieving of information as much as possible, and by an accumulation of dictated knowledge which will enlarge memory space.

Popper’s next use of the metaphor of the bucket will be in 1948, in his article, “The Bucket and the Searchlight Theory: Two Theories of Knowledge,” which was not published in English until 1972, in *Objective Knowledge*. One of the striking differences between these two articles is that while Popper in 1931 introduces the Bucket theory as a purely psychological theory, the em-

²⁹ Michel ter Hark, “Between Autobiography and Reality: Popper’s Inductive Years,” *Studies in History and Philosophy of Science* (forthcoming). To the extent that the article is about pedagogy, and especially about certain psychological presuppositions of pedagogy, it is a continuation not of the dissertation on cognitive psychology but of the thesis on dogmatic thinking of 1927. Indeed, some of the pedagogical questions left unanswered by Popper in his thesis now receive a clear and definitive answer.

phasis in 1948 is on epistemology throughout. Furthermore, there he not only hides the psychological roots of his evolutionary or genetic epistemology from view, but the pedagogical context in which his criticism of association psychology initially arose, is totally absent.³⁰ A third difference is that, in 1931, the Bucket theory is not yet overturned by, or even contrasted with, what Popper regards as one of his great achievements: the development of a Searchlight theory of the mind.

The theory that does replace the Bucket theory in 1931, however, is the theory of Otto Selz. As Popper goes on,

This view of the psychology of memory is more or less the same as the outlook of association psychology. Unfortunately, association psychology, even though its very complete breakdown has been the main result of psychological research at the turn of the century, is still widespread. This decisive turn in the psychology of thought (and of memory) was initiated by Kant and carried through, according to strict experimental methods, by the school of Külpe, especially Bühler and Selz.³¹

The fundamental mistake of association psychology, Popper argues, is its attempt to derive the whole of human memory, even the whole of intellectual capacities, from a single and simple form of associative memory (what he calls the bucket). Popper's alternative account of the genesis of the different functions of memory follows Selz's cognitive psychology in detail. The role of associative memory is restricted to the processing of nonsense syllables in the laboratory, but even in such rather artificial situations, Popper argues, subjects often establish meaningful connections between stimuli. With this understanding of meaning, Popper concludes, thinking enters memory: "The laws of the mechanisms of association are replaced by the 'laws of ordered thinking' (Selz)."³² And a few lines further: "Selz has coined the name 'intellectual operations' for the functions of thinking."³³ That Popper's alternative account of memory and memorization wholly depends for its conception on ideas he takes over from Selz is corroborated by a passage in which the latter's theory of complex completion is put forward as providing the *Arbeitsschule* with the required notion of psychological activity:

Selz has shown that "reproductive thinking" is an extremely active process, a production process (*Arbeitsvorgang*). The important method,

³⁰ Popper does not refer to his 1931 article in his later discussions of the Bucket theory.

³¹ Karl Popper, "Die Gedächtnispflege unter dem Gesichtspunkt der Selbsttätigkeit," in *Die Quelle*, 81 (1931), 610.

³² *Ibid.*, 613.

³³ *Ibid.*

the important tool of this production process, is the scheme. In this scheme an unoccupied space (*Leerstelle*) takes the place of lacking thoughts, thoughts that have to be reproduced. The systematic completion of these unoccupied spaces of the scheme (the “determined change of complex”) leads to reproduction.³⁴

Rather than being a passive and mechanical process, Selz has taught, human memory turns out to be a systematic reconstructing of schematic anticipations and their gaps. It is this psychology of memory, Popper believes, that can help steer education away from the *Lernschule*, in which children are treated as empty buckets to be filled by the accumulation of knowledge, towards seeking children’s active engagement through thinking, without neglecting the role of memorization in favor of the intellect. Selz’s cognitive psychology, as Popper sees it, is a natural psychological foundation for Burger’s pedagogical idea that education is the systematic development and perfection of teaching methods (“learning to learn,” what is called the *Kraftprinzip* in contrast with the *Stoffprinzip*).

To fight the drill schools, Popper summons pedagogues to abandon not the exercise of memory but the appeal to associative memory. He professes even deep skepticism as to the question whether associative memory is capable of developing at all. Perhaps, he says, associative memory is a primitive and rather fixed disposition of the human mind. In any case, the bottom-up attempt of deriving the higher forms of thinking from the mechanisms of association, so characteristic of association psychology and the related constellation theory, Popper recalls, thereby clearly alluding to Selz, has completely failed. Even getting rows of numbers and words firmly into one’s head may profit from the new view of intellectual operations as developed by Selz: “Inculcating, then, becomes a process of thinking [*Denkarbeit*].”³⁵ Memorization guided by “the laws of ordered thinking,” Popper is anxious to point out, although equally mechanical, is yet completely different from associative memory; he dubs it “automatised insightful memory.” The difference turns out to be less an ontological one, as suggested by his categorizing of associative memory and automatized insightful memory in two different layers of the mind, respectively, training and intellect, than a matter of genesis. Indeed, automatized insightful memory is defined by opposition with the (failed) bottom-up approach of association psychology; its genesis proceeds the other way round:

This one consists in a reduction of certain processes, certain chains of ordered thinking, by way of a continual repetition of the course of reactions; indeed, it is even possible that the consciousness of the mid-

³⁴ Popper, *Die Quelle*, 616.

³⁵ *Ibid.*

dle parts of the chain completely fades away, and that finally only the part at the beginning and the one at the end of the chain appear immediately connected with one another.³⁶

The key distinction is that in a theory of ordered thinking the process of mechanization sets in later than it would in an associationist theory. Only after the pupil has become familiar with the relevant piece of memorial knowledge by means of the intellectual operations as described by Selz, can mechanization be initiated. The result in both cases seems to be the same, yet the difference is as big as that between a skillful piano player and a gramophone record.³⁷ As this analogy indicates, insightful memory becoming automatic is a process on a par with the development of skills, of know-how. Although he does not refer to Selz's specific theory of know-how, it is evident that it is this theory to which Popper's theory of mechanization is immensely indebted. Indeed, his specific wording that "chains of ordered thinking" are reduced by repetition to such an extent that "only the part at the beginning and the one at the end of the chain appear immediately connected with one another" echoes Selz's explanation of skills.

Despite the article's mainly practical objectives there are passages in it which point to Popper's later deductive epistemology. Having repeated that associative memory and automatized insightful memory are fundamentally different processes, he goes on to say that the latter consists merely in an abbreviation of reactions. That is, rather than creating something new (knowledge, belief?), mechanization only makes something disappear. His subsequent remark, "Where these reactions, these processes of reconstruction, are not shaped yet, there is nothing which can be abbreviated," is, in the context of the article, a pedagogical warning not to let the process of mechanization begin too soon, but at the same time can be seen as conveying the core idea of the later Searchlight theory that, since learning (mechanization of skills) can take place only on the basis of already shaped intellectual operations, these intellectual operations have to precede knowledge-acquisition.³⁸ The fully epistemological elaboration of this Selzian view, however, has to wait one or two years. In *Die beiden Grundprobleme der Erkenntnistheorie*, Popper will indeed come to defend the deductive view that anticipations precede reactions.

Popper's Deductive Turn

In the section "The possibility of a deductive psychology of knowledge" of *Die beiden Grundprobleme der Erkenntnistheorie*, Popper undertakes the task

³⁶ Popper, *Die Quelle*, 614.

³⁷ *Ibid.*, 613.

³⁸ *Ibid.*, 618.

of attacking what he calls an inductive prejudice: the idea that only an inductive psychology of knowledge would be feasible.³⁹ Unlike the philosophical theory of knowledge, which seeks to justify knowledge claims, psychology of knowledge is a theory of the acquisition and genesis of knowledge. These two approaches to knowledge, despite being clearly related, he emphasizes, are yet logically independent, and an inductive stance in epistemology can be associated with a deductive stance in psychology, and vice versa. Nevertheless, many of those who favor an inductive epistemology, like Mach and Carnap, subscribe to an inductive psychology of knowledge, which, moreover, is explicitly sensualistic. On this inductive sensualism, humans arrive at knowledge and experience by generalizing from individual experiences, in particular, perceptual experiences.

As to the genesis of this alternative theory Popper's account is ambiguous. On the one hand he says that it results from his applying the deductive theory of knowledge to the area of psychology, his so-called principle of transference, but on the other hand he refers to cognitive psychology. As he begins his sketch: "In the *psychology of knowledge* properly so called [or 'Denkpsychologie'] deductive lines of thinking are to be found primarily among *biologically* oriented psychologists."⁴⁰ While expecting here the names of Bühler and Selz, Popper instead mentions Mach, who is clearly not in the tradition of deductive cognitive psychology but in the opposite camp of "inductive sensualism." Quoting again Mach's contention ("What is reacted upon *similarly* falls under *one* concept") Popper now argues that it can be used for the construction of a deductive psychology of knowledge. Already surprising in the dissertation, here, in the context of designing a deductive theory, the appeal to Mach is scarcely convincing. For Popper and Mach nurture antithetically different conceptions of the genesis of knowledge, respectively, a deductive and cognitive theory, and an inductive and sensualistic view. So how can Popper contend that Mach's claim contains the building blocks for a deductive psychology of knowledge. It is one thing to say that in Mach's explanation a distinction is made between a reactive and a receptive side of the physiological system, but it is another thing to say, as Popper does, that the reactive side is of decisive importance. This latter claim, crucially important for a deductive theory, is precisely what is denied by Mach: the new sensations of smell and touch produced by activities are said to be decisive. It is only in the anti-sensualistic work of Volkelt and especially of Selz that the idea that our knowledge of the external world is drawn from our mind, from its anticipatory schemes, and, initially, from behavioral anticipatory schemes, reaches its clearest expression. Admittedly, Popper does drop the name of Selz later but in so parenthetical a way as to be

³⁹ This prejudice automatically leads to an inductivistic prejudice in the field of the theory of knowledge, according to Popper.

⁴⁰ Karl Popper, *Die beiden Grundproblem der Erkenntnistheorie* (Tübingen, 1979), 23.

out of all proportion to his real indebtedness to him. Every commentator, however, has to concede that Popper's sketch shadows Selz's theory of specific responses and anticipations. For the evidence for this is unanswerable. The allusions and parallels are simply too numerous to be denied.

To begin with, his conception of cognitive processes exactly parallels Selz, who, as was recounted by Popper himself in 1931, coined the expression "intellectual reactions." As Popper now, but without mentioning Selz, says: "Our knowledge and thinking are not to be conceived as a combining or associatively ordering of sensory experiences, of *receptions*, rather our thoughts have to be characterised as *intellectual reactions*."⁴¹

That his reliance on Selz extends itself far beyond the terminological level, and in fact amounts to a complete assimilation of the "Selzian scheme," is further testified by Popper's emphasizing, and elaborating, the analogy between intellectual operations and motor operations, which was a key element in Selz and which was also to influence Piaget. Like Selz, Popper contends that: "*Physiological reactions* in general (not only intellectual ones), although naturally *elicited* by a stimulus (a reception), are as far as the specific form of the course of their reactions concerned exceedingly dependent upon the *subjective conditions of the reacting apparatus itself*."⁴² This raises the question how (intellectual) reactions, drawn from the mind rather than from the world, nonetheless prove themselves adaptive in objective circumstances.⁴³ It is in answering this question that he drops the name of Selz, but only after first crediting the biologist H. Jennings with the finding of a solution: "To this question the *theory of trial movements* of Jennings for instance can provide an answer."⁴⁴ Echoing his earlier pedagogical work and the work of Selz, but now referring to Jennings, he points out that exercise and repetition merely abbreviate the series of trials and reactions rather than creating something new. Yet this reliance on Jennings, rather than providing further support for a deductive psychology of knowledge, only erodes support for it because at the bottom of his theory of trial movements rules the principle of association.⁴⁵ Selz, on the other hand, not only outflanked and discredited association psychology but also provided an alternative theory for both trying-out behavior and "associative" memory which shifts the emphasis from the passive reception of sensory impressions to the active restructuring and completing of schematic anticipations. But this seems

⁴¹ Popper, *Die beiden Grundproblem der Erkenntnistheorie*, 24.

⁴² *Ibid.*

⁴³ *Ibid.*

⁴⁴ *Ibid.*, 24-25.

⁴⁵ H. S. Jennings, *Behavior of the Lower Organisms* (London, 1905). Indeed the cornerstone element of Jennings's theory is what he calls the law of the resolution of physiological states, saying that the resolution of one physiological state into another becomes easier and more rapid after it has taken place a number of times. This associative law accounts not only for trial-and-error behavior but even for associative memory.

not to be the reason why Popper finally mentions Selz. Rather Selz seems to be named as further supporting the view of Jennings as just outlined by Popper. Subjectively preformed reactions, as the remark in question goes, “could *adapt* themselves through ‘trying-out behaviour’ [*probierendes Verhalten*] [Selz], through failure and finally fitness, to the objective situation.”⁴⁶ It is only in outlining how this adaptation comes about that full justice is done to the deductive features of this process of knowledge acquisition, but in that phase of the sketch Selz is no longer mentioned, and it is clearly the author of the sketch who wishes to be credited for having elaborated the theory. But here it is also manifest that he is in effect advancing Selz’s position. Thus, his remark that the structure of intellectual reactions, like the belief in causality, can be modelled on the structure of physiological reactions echoes Selz’s integrative theory of stages.⁴⁷ Likewise, Popper’s use of the concept of co-ordination (*Zuordnung*) parallels Selz’s for it is the objective situation with which (intellectual) reactions are co-ordinated. Finally, his use of the centrally important concept of anticipation exactly parallels Selz’s contention that co-ordinations differ from associations in that the co-ordination “is not established by the experienced succession of stimulus and operation, but can precede it.”⁴⁸ Indeed, the following passage contains not a single new idea and is no more than a reworking of Selz:

If the co-ordination [*Zuordnung*] between intellectual reactions and objective situations is established via trying-out behaviour, then the co-ordinations always *precede* their adequacy [*Bewährung*] in time. The co-ordinations therefore are as regards their adequacy *anticipatory* (as long as the reaction has not proved itself adequate, it can be called an “unfounded prejudice”). The fulfillment will also often fail to occur: the anticipatory co-ordination between reaction and stimulus is *tentative*. Therefore I dub the subjectively pre-formed intellectual reactions shortly “*Anticipations*.”⁴⁹

This is almost an attempt to freeze Selz’s theory of schematic anticipations into oblivion by eschewing all mention of him; indeed Popper even takes credit for having invented the concept of anticipation. Having earlier, in 1931, while explicitly referring to Selz’s theory of memorial knowledge, discarded the idea of the mind being nothing but the conduit for sense-impressions, he now has

⁴⁶ Popper, *Die beiden Grundprobleme der Erkenntnistheorie*, 25. In a footnote he refers to Selz’s three books on the *Cognitive Psychology*.

⁴⁷ *Ibid.*

⁴⁸ Selz, *Zur Psychologie des produktiven Denkens und des Irrtums*, 570. Also quoted in chapter four.

⁴⁹ Popper, *Die beiden Grundprobleme der Erkenntnistheorie*, 25-26.

come to appropriate Selz's alternative evolutionary theory according to which our knowledge of the external world is drawn from our mind, or, as Popper puts it "from trying-out anticipations, which are co-ordinated tentatively to the 'material' of receptions."⁵⁰ Rephrasing this theory later, in 1948, as the Searchlight theory of mind and knowledge Popper has succeeded in erasing all the traces of Selz, yet it can be argued that even this brilliant metaphor is prompted by his reading, and especially his seeing, of Selz's diagrams (see figure 2). Indeed, this diagram not only looks like a searchlight but, as will be clear by now, also functions as one. Finally, if this search for the Searchlight theory is correct then Popper's epistemology is much more intertwined with psychology than is allowed by his own anti-psychologism.

Rijksuniversiteit Groningen.

⁵⁰ Popper, *Die beiden Grundprobleme der Erkenntnistheorie*, 26.