Psychological Research (2022) 86:2352–2364
https://doi.org/10.1007/s00426-022-01707-6

REVIEW

A neglected pioneer of psychology: Otto Selz's contribution to the psychology of thinking and the dispute with Gestalt psychologists in *Psychological Research/Psychologische Forschung*

Robert W. Proctor[1] · **K. Richard Ridderinkhof**[2]

Received: 3 February 2022 / Accepted: 23 June 2022 / Published online: 14 July 2022

Abstract
In the early decades of the twentieth century, *Psychologische Forschung* was primarily an outlet for researchers from the school of Gestalt psychology. Otto Selz, whose views were closer to those adopted in the cognitive/information-processing revolution in psychology that began in the 1950s, never published in *Psychologische Forschung*. However, his work was the subject of a negative evaluation in the journal in a book review by Wilhelm Benary, which was followed by critical assessments published elsewhere by Selz and Karl Bühler of a chapter of Kurt Koffka's. A lengthy rebuttal from Koffka then appeared in *Psychologische Forschung*. In the present paper, we describe Selz's system and Benary's assessment of it. We then explain the relevant aspects of Koffka's book chapter (in: Dessoir M (ed) Die Philosophie in ihren Einzelgebieten. Ullstein, Berlin, 1925) and the strong critiques of it by Bühler and Selz in 1926, followed by details of Koffka's (Psychol Forsch 9:163–183, 1927) response. This part of the history of psychology is of significance to contemporary psychology on several levels. We have embedded this episode against the historical backdrop of Selz's life and tragic end.

> *From the standpoint of the history of cognitive psychology, we must fix our attention on… the twenty-year period from about 1905 to 1925… By the latter date, Selz had completed his principal work on problem solving, and some of the main contributions to Gestalt psychology of Kohler, Koffka, Duncker and Wertheimer had been published.*
>
> – Herbert Simon, 1981

Introduction

In the first quarter of the twentieth century, German psychologists made significant advances that impact psychology to the present. The contributions of the Gestalt school of psychology are well known, and many of their principles regarding perception and thinking have been incorporated into the field as a whole (Vallée-Tourangeau, 2018; Wagemans et al., 2012). Less widely appreciated, but equally important for psychology, are the contributions of the Würzburg school of Oswald Külpe and Karl Marbe, and Külpe's students Henry Watt, August Messer, and Narziβ Ach in the first decade of the twentieth century to performance of directed tasks. In books published in 1913, 1922, and 1924, Otto Selz extended the work of the Würzburgers from reproductive, or analytic, thinking to productive, or creative, thinking and problem-solving in complex tasks. As conveyed in the epigraph from Herbert Simon—who, along with Allen Newell, gave birth to contemporary views on problem-solving in the 1950s and 1960s (Newell & Simon, 1972)—major advances in the understanding of problem-solving had occurred.

Although the psychologists from the Gestalt and Würzburg traditions agreed on many aspects of problem-solving and creativity, they differed in the specific types of theories they offered as explanations. In this paper, we recount a little-known dispute from the 1920s between Kurt Koffka and Otto Selz, and their respective adherents, Wilhelm Benary and Karl Bühler. This dispute centered around similarities and differences between their views and the issue of to whom intellectual priority should be attributed.

✉ Robert W. Proctor
rproctor@purdue.edu

K. Richard Ridderinkhof
k.r.ridderinkhof@uva.nl

[1] Department of Psychological Sciences, Purdue University, West Lafayette, IN 47907, USA

[2] Department of Psychology, University of Amsterdam, Postbox 15916, 1001 NK Amsterdam, The Netherlands

We put emphasis on Otto Selz because he is often credited as having the forerunning views of cognitive psychology most similar to those of contemporary human information processing. In a memorium on Selz written in 1971, Reinert (1981, p. 14) noted,

> He is a very important psychologist of thinking who, as he himself put it, routed association psychology from this field of research and who with his operationally conceived *Denkpsychologie* [psychology of thinking] made the first comprehensive experimental contribution to the psychology of productive thinking.

Reinert went on to say,

> We, from our present-day vantage point, can properly appreciate Otto Selz's modernity and assess how far ahead of his time he was. Modern too are the concepts he coined or chose to employ such as 'operation', 'transformation', 'hierarchical structure', 'anticipation', 'schema', 'heuristics', and 'process'. (p. 16)

Furthermore, Simon (1981) emphasized, "In replacing associations by directed associations, Selz achieved a fundamental insight into the requirements of memory for an information-processing system that would be capable of thinking" (p. 151).

Although a search of articles published in *Psychologische Forschung* shows none by Selz, his views were the subject of a critical book review by Benary (1923), who worked under Wolfgang Köhler, and a critique/response by Koffka (1927). That Selz's work appeared in other outlets is not too surprising since *Psychologische Forschung* was primarily a journal for the Gestalt psychologists. However, in a review of the first 50 volumes of the journal, Eckart Scheerer (1988), then editor-in-chief, remarked,

> There is almost no contemporary awareness of the polemical battles fought in the pages of the journal, such as … Koffka's (1927) clarification of the Gestalt view on thinking, as opposed to the theory of Otto Selz. This is unfortunate, because the papers in question could be of considerable contemporary significance. (p. 74)

We agree with Scheerer's assessment that the works are of contemporary significance, and 35 years later, we discuss Selz's views on thinking, as well as Benary's and Koffka's critiques of them. We provide a brief description of some of the key points in Selz's views and how these differed from those of Koffka and Benary. We frame this discussion in the historical context of scientific approaches to goal-directed action and problem-solving. Moreover, we try to convey how the bitter dispute arose between Selz and his colleague, Karl Bühler, on the one hand, and Benary and Koffka on the other.

Nineteenth century views on goal-directed action

Higher mental functions often build on 'older' systems. Abstract goal-directed problem-solving exploits the principles of concrete goal-directed action, just like visual attention largely builds on neural oculomotor control systems. Towards the end of the nineteenth century, psychologists in Germany began to expand the problem of directedness from the field of action to the field of problem-solving. In either field, the notion of volition was central in challenging the view held by classical association theorists that thought and action were controlled by previous associative links. (Seebohm, 1981, p. 7, describes Selz as "an intrepid fighter who single-handedly took on virtually two thousand years of associationist thinking—and emerged victorious".)

We briefly review the nineteenth-century views on goal-directed action before expanding on the subsequent views of goal-directed problem-solving that are central to this article. 'Volition' refers to striving: the directedness of the individual organism towards, away, or against other givens, towards future states, and away from one's present state. Under the heading of 'conation' (a term popularized by Spinoza, 1677/1922), volition turned into one of the main topics of research (and dispute) in the field of action during the second half of the nineteenth century. For many of the early physiologists and psychologists, conation was the common label for the processes involved in motivation, desire, volition, and striving (for review see Ridderinkhof, 2014). The notions of conation and volition were largely deprived of mechanistic description.

Not all purposive behavior qualifies as goal-directed. Instinctive and habitual acts carry out apparent purposes without aims to do so. Such acts are adaptive, but not intentional; their consequence is a result, not an end. Volitional actions, by contrast, are a deliberate means to an ultimate or proximate end; an intentional operation instrumental to accomplishing that explicit aim. Such goal-directed action deals with the present situation by correlating it with any relevant facts and concerns, producing the action along the way that will be most likely to lead to its desired end. When means are devised by the individual on the basis of that person's own experience for accomplishing the ends to which it is impelled, the act may be deemed volitional.

Continual adaptations to environmental conditions, varying at every instant, prevent actions from becoming invariant (Ribot, 1894), and necessitate the capacity to

anticipate and *prioritize*. The possibility of volitional action, in which the response is determined by the effect it will exert, arises with the power of anticipation, so that actions are directed by the relation between act and consequence. Hence, we do not respond uniformly to similar surroundings, as in habit or instinct, but we appraise the situation in relation to our current needs, concerns, preferences, and norms (Frijda, 2007), giving rise to a determinate *motive*. The volitional act is determined by reference to a desired end (Grafton & Hamilton, 2007; Sebanz et al., 2006).

The pivot upon which volitional action turns is the formation of a pragmatic idea of the desired action effect, which goes beyond what is directly present to our senses. Such an idea occasions action, in consequence of a past experience, to something not given in the present, providing the seed of what may be called a practical judgment (Hobhouse, 1915), and forming the basis of what is termed *ideomotor action* (Carpenter, 1852). Harleß (1861/2012) used the term '*Effektbild*' ('image of action effects') to denote the consequences of actions, not only in terms of sensory effects but also in terms of outcomes that one can learn to pursue or avoid.

Herbart (1825) was among the first to articulate the view that actions are initiated by anticipation of the desired sensory effects. He offered that when an action is executed, associations between the action and its sensory effects are created automatically. After being created, these associations can be used in intentional action to initiate the actions that produce the anticipated sensory effects. The common notion of ideomotor accounts was a tight linkage between internal images of actions and their effects on the one hand, and the actual actions on the other, such that any activation of the pragmatic idea of an action's effect will trigger the corresponding action. Noble (1858) reported that Professor [August] Beer of Bonn was able to dilate or contract the pupils of his eye at will by thinking of a very dark place or a very light place, respectively.

The view that thinking of the result of an action tends to set the action in motion was labeled *ideomotor* by Carpenter (1852, 1853) to differentiate it from sensorimotor action. This notion was voiced by Lotze (1852): "As soon as an idea of an accessible goal surfaces into memory, the unfolding action appears as directed to that goal, seeking to approach it; the suppressed action as repelled from it." (p. 298). Undoubtedly the most influential articulation of the ideomotor principle was that of William James, who observed, "Every representation of a movement awakens in some degree the actual movement which is its object; and awakens it in a maximum degree whenever it is not kept from so doing. […] The idea of the movement's sensory effects will have become an immediate antecedent condition to the production of the movement itself" (1890, vol. ii, p.526; p.586). In other words, "We think the act, and it is done" (James, 1890, vol. ii, p.522).

Ideomotor theory was, in part, a reaction to association theorists, who held that actions were driven by previously acquired links between events, responses, and outcomes. It is such association theories, which were dominant for many years, to which the earlier quotes about Selz "routing" association theory referred. Associationism dates back to Aristotle, and in philosophical psychology, it is linked to David Hartley, James Mill, and Alexander Bain (Mandler and Mandler, 1964/1981). Bain provided a solution to the problem of why one association is more likely than other possible ones, which had been of concern to associationists for many years. The solution to which he is credited, called *constellation theory*, is basically that that thought is directed by way of a task representation that yields a compound of multiple undirected associations. That is, rather than just the strongest association winning out, those associations that belong to the task form a constellation that of associative bonds among appropriate elements (Mandler, 2007; ter Hark, 2010). Constellation theory became the predominant form of associationism, being favored by the eminent psychologist George E. Müller, among others, and arguments against association theory in the writings of Selz and Koffka are often framed in terms of constellation theory.

Animal life possesses the capacity to *actively* strive for attaining goals, through skilled bodily movements adjusted to the environment and its dynamics (McDougall, 1928). When there is the idea of a desired end, the motive provides the impetus to act. We direct effort to what we desire, to what is in our *interest*. Interest infuses the action with a sense of tension, and of effort to relieve the tension by reducing the discrepancy between the current state and the desired end (Lewin, 1926). In this sense, this conception can be considered a forerunner of the notion of predictive processing (see Ridderinkhof, 2014, for a review).

Turn-of-the-century views on goal-directed problem-solving

Among the first psychologists to challenge classical association/constellation theorists, who held that thinking and problem-solving were governed by the strength of previously established associations were the psychologists of the Würzburg *Denkpsychologie* school. The first works were by Mayer and Orth (1901) and Marbe (1901), but those of Narziβ Ach are perhaps most well known. Ach's experiments required participants to perform an instructed task for which performance (the response provided and reaction time) was recorded, as well as an extensive retrospective report of their thought processes while performing the task. Based on such reports, he argued that determining tendencies (goal

representations for the task intentions) in addition to associative tendencies contribute to mental events. The determining tendencies are what give rise to the order of thought. According to Ach, the expenditure of effort involved in pursuing one's interest, and in relieving tension by reducing the discrepancy between the current state and the desired end, increases as a positive function of the perceived difficulty of implementing the imminent action (Ach, 1910, 1935). Put succinctly, Ach inferred that processes of thought have a fundamentally goal-directed character, and that the action executed in a task is a combination of determination strength from the instructed task goal and association strength from prior learning.

Ach's (1910) theoretical formulation was applicable to reproductive thinking but not to productive thinking. Selz further elaborated the notion that the thought processes involved in problem-solving are guided by a goal that drives solutions by showing how productive thinking could be explained in that manner. As Mandler and Mandler (1964/1981, p. 223) noted, "he is the first psychologist who is both willing and able to deal with the problem of productive thinking under the same rubric as reproductive thinking". Selz began his experimental work in Bonn, the new home of Külpe's research institute. He followed in Ach's footsteps by obtaining detailed retrospective reports (what would now be called verbal protocol analysis; e.g., Kuusela & Paul, 2000) of the way in which participants tried to solve complex problems (e.g., provide a definition of taxes; how come candles give light). Selz's results led him to formulate the concept of an *anticipatory schema* that governs the process of problem-solving (not unlike the *Effektbild* or pragmatic idea of action consequences in ideomotor theory). The anticipatory schema is "sufficiently determinate to impart […] an exclusive direction towards goal-relevant complexes" (Selz, 1924). Or, as his biographer Seebohm described it, "The pull of the goal determines the route which, as it unfolds according to the external conditions, takes its purposive course" (1981).

Without prior experience with the problem, the means ("operations") to achieve the anticipated goal must be abstracted from the pre-existing stock of solutions, combining and/or extending partially effective solutions, sometimes in creative ways, thus extending the repertoire of solutions. Problem-solving is mental work, in a concrete, action-related sense: "According to the nature of the task, cognitive operations or motor operations (movements) or operations of both kinds will take place. […] Any implementation of a set goal up to attainment of the goal […] presents itself as a chain of […] linked solving methods. […] In games of skill, it is more effective to concentrate on the result to be achieved than on the movements to be performed, because concentration on the movement outcome enhances the efficiency of the schematic anticipation of the movement in which the outcome is the only wholly determined component" (Selz, 1924; from Frijda & De Groot's, 1981a translation, p. 33)—notions rediscovered in sports science some ¾ of a century later (Wulf et al., 1998). In Selz's view, intelligence is the ability to acquire adequate methods of achieving goals and to transfer them to new problems. Duncker's famous work on 'out-of-the box problem solving' (Duncker & Lees, 1945), as original as it was, was largely an extension of Selz's thinking.

Selz published his experimental work and theoretical conjectures in a book titled *Über die Gesetze des geordneten Denkverlaufs* (On the laws of ordered thinking) (1913), but then was sidetracked by the outbreak of World War I. During the war, by studying detailed accident protocols, he found that aircraft staff never developed any anticipatory schema for emergency situations. Consequently, Selz (1919) proposed that to optimize safety, the staff's training protocols should include practice with emergency situations so that they could draw from an extensive repertoire of effective actions (automatized where possible).

After the war, Selz returned to Bonn, where he completed the second volume of his theoretical work: *Über die Gesetze des geordneten Denkverlaufs II: Zur Psychology des produktiven Denkens und des Irrtums* (On the laws of orderly thinking II: the psychology of productive thinking and of error) (1922). Soon afterwards he was appointed professor of Philosophy, Psychology and Pedagogy at the *Handelshochschule* (Business School) at Mannheim in 1923, where he continued his work for the next 10 years as director of the Institute for Psychology. During this period, Selz's views became increasingly distinct from those of the Gestalt psychologists. Indeed, his 1922 volume, which revolved around the directed operations of the mind, met with considerable opposition from the Gestalt psychologists, whose holistic approach represented the *Zeitgeist* by focusing on organismic rather than mechanistic principles.

Selz and the Gestalt psychologists

The background of proximate events in the dispute between Selz and the Gestalt psychologists is as follows. In 1922, Selz published the aforementioned book in which he laid out his theoretical system and the evidence for it. That same year, Benary took a position under Wolfgang Köhler at the Psychology Institute in Berlin, and from then through 1924 he contributed regularly to *Psychologische Forschung*. Many of these contributions were book reviews, of which he published 7 in 1923 (Janssen, 2003). Among those was a highly critical review of Selz's book, which was interpreted as taking a view counter to that of the Gestalt psychologists. This was followed in 1925 by an introductory chapter on psychology by Koffka in which he gave little credit to Selz. Bühler

and Selz took offense with Koffka's depiction, arguing in separate 1926 articles that Koffka had not acknowledged Selz's contributions sufficiently and that Koffka's account of thinking was similar to that of Selz. Koffka then wrote a detailed critique of Selz's system and defense of his own views in response.

Benary's (1923) review of Selz's (1922) book

Benary's (1923) review was divided into four numbered sections. Section 1 took up about half of the review and was essentially a synopsis of the book, which we will not recount here. In the remaining three parts, Benary was quite disparaging of Selz's views.

In Section 2, Benary criticized Selz for emphasizing that his approach is an experimental one. Benary remarked that, regardless of what one thinks of Selz's theses, they cannot be deduced by the kind of experiments he conducted. Benary noted that in Selz's theoretical evaluation of his experiments, propositions are introduced that are not derived from the experiments but from Selz's metaphysics. Essentially, Selz was criticized for providing ad hoc interpretations of the results of his experiments: "The subject's statements are examined to see if any of the previously mentioned ideas can be made "probable" (p. 422).

Benary then asked, what is the character of Selz's theory? His answer was, "The theory is a machine theory, and not essentially different from the association theory" (p. 423). The "not essentially different" assertion is relatively damning because a major goal of Selz and the Gestalt psychologists was to dispense with association theory. With regard to Selz's theory, Benary asserted that it generates specific behavior when the organism is organized for a certain purpose. This predetermined organization has only one degree of freedom, is causally determined, and can proceed only in one direction. Benary stated that in Selz's characterization, all thinking is based in reflexes. On this basis, Benary concluded that truly productive and creative thinking is not possible in Selz's theory. This conclusion is the nub of the disagreement between Selz and the Gestalt psychologists. Selz claimed that his theory could account for productive thinking and creativity, whereas Benary and others saw it as applicable only to reproductive thinking.

In Section 3, Benary addressed "one of the oddities of Selz's book", which is that Köhler's (1920) experiments on insight in his research with apes is taken as confirmation of Selz's theory. Benary's reasoning was that there is no room for insight in Selz's theory. He quotes Selz to the effect that Köhler places too much emphasis on the structural phenomena belonging to the psychology of choice, whereas Selz's theory acknowledges established views in the psychology of memory and physiology of movements and thus has "a complementary and embracing relation to the older association psychology" (Selz, 1922, p. 610). That is, Selz saw his theory as intermediate to the structural emphasis of the Gestaltists and the association approach to which they were opposed. Benary (p. 424) concluded:

> So when Selz speaks of a confirmation, it is meant that Köhler did not interpret his own experiments correctly, that they were only interpreted correctly by Selz. Of course, Selz seems to agree with Köhler that anthropoids show insightful behavior; but this agreement is only apparent, because for both authors insightful means something completely different.

In other words, Selz provided a memory-based reasoning account for behavior that Köhler attributed to insight.

Benary noted that Selz seemed to want to apply his theory to all aspects of creativity, through what Selz called "organized production". Selz highlighted "valuable successes" that occur by chance and then are noted by the organism. Benary's assessment was "there is no mention of the factually decisive factors of thinking and creating… In short, Selz's theory has no answer to the question of meaningful thinking" (p. 424). Benary went on to declare, "To whom, then, the psychology of thought is primarily concerned with this question, Selz's theory has nothing to offer. But even for those who see the problem in the more technical intellectual operations, no satisfactory solution is given by it" (p. 425).

Despite Benary's assertions in Section 3, ter Hark (2010) notes to the contrary that there are many similarities between Selz's views and those of Köhler because Köhler relied on Selz's (1913) theory of relational facts in developing his own theory. For example, Selz noted that Köhler's "inner relations" were the same as his "relational facts" (Selz, 1926, p. 193–194) and that "insight" was the same concept as "knowledge" as "newly acquired consciousness of a relational fact" (Selz, 1926, p. 193), as used in his 1913 book (ter Hark, 2010).

Section 4 of Benary's review was a short wrap-up in which he itemized shortcomings of Selz's theory of thinking "because he approaches nature with the machine attitude" (p. 425). Benary pointed out what he sees as a danger in applying Selz's theory to intelligence testing: "It leads straight back to testing…, and to the diagnosis of mechanical disorders" (p. 425).

Koffka's, 1925 "New Psychology" chapter and the responses of Bühler and Selz

Although Benary's (1923) book review started a smoldering feud between Selz and the Gestalt psychologists, it was a chapter by Koffka in a handbook in 1925 that ignited the animosity between the two camps. Koffka was one of the four most well-known Gestalt psychologists, including Köhler, Wertheimer, and Duncker. According to Devonis (2012),

> The essence of Gestalt theory as conveyed by Koffka was its focus on the perception of objects as meaningful within a context, its emphasis on the constructive and creative character of the mind, actively taking a role in organizing its understanding of the environment, and its holism and molar point of view.

Koffka (1925) wrote the chapter "Psychology" for the second volume of the edited book, *Die Philosophie in Ihren Einzelgebieten* [*The Philosophy in its Individual Fields*]. In the chapter, Koffka presented what he called the new psychology, which was that of the Gestaltists, and distinguished it from the old psychology of all other approaches. Although Koffka acknowledged that the contributions of other individual psychologists deviated in some ways from the old psychology, he indicated that his depiction of psychology typified the field as a whole, as well as its principles, up to the advent of the new psychology of the Gestalt psychologists.

With regard specifically to Selz, the most relevant section is "Gedächtnis und Denken" ["Memory and Thought"]. In it, Koffka described that in association psychology, thinking is basically a memory function involving a succession of ideas generated according to the law of association. He acknowledged that Külpe and his students opposed this consequence but only supplemented it with the concept of determination. He noted that Selz pointed out that the theory of the Würzburg school is still a constellation theory based on the combined activations of determination and association strengths. Koffka stated that the necessary progress could be made only if constellation theory were abandoned altogether, and he credited Selz with making a meaningful modification of the method developed in Würzburg in an attempt to do so.

Immediately thereafter, though, Koffka (1925) discredited Selz's method, saying that the only new aspect of his experiments compared to the prior ones of the Würzburg school was that the tasks changed from experiment to experiment rather than remaining the same. Koffka also noted that because the problem-solving process had to be derived from participants' post-experiment verbal protocols and the problem solutions, the results were never unambiguous. He concluded, "One may use it [Selz's method] to get the theory of association into trouble, force it to always assume new auxiliary hypotheses, but one will never disprove it conclusively in this way" (p. 569). Koffka (1925) then went on to credit Kurt Lewin—a member of the Gestalt psychology school at the Berlin Psychological Institute who worked with Köhler and Wertheimer and published regularly in *Psychologische Forschung*—for proving that the presuppositions of association theory were insufficient in experiments that he conducted.

Eder and Dignath (2021) go into Lewin's (1922a, 1922b) experiments in detail, so we will not do so here. But, the methods were extensions of those of Ach (1910) and followed the general scheme of using incongruent conditions in which habit opposed or added to the "willed", or instructed, tendencies. In some conditions, Lewin obtained behavioral results suggesting an interaction of associative and determinative factors, for which a sufficiently strong association may overcome determination. However, in many others, with only minor changes in experimental conditions, he found no influence on responses that would be suggestive of habitual response tendencies countering or adding to the intentional, task-determined response tendency. Even for stimuli repeated hundreds of times over several days, there was no indication that their associations influenced performance. The results imply that association alone is not a sufficient condition for reproduction.

In his chapter, Koffka (1925) set a dismissive tone for psychologists in general and does not give Selz much credit. This prompted Bühler (1926) to respond on both counts. By calling Gestalt psychology the new psychology, Koffka's implication was that what preceded it is old and obsolete. Bühler satirized Koffka's claim for the new psychology, saying:

> Let us indulge sub specie aeterni in the Advent mood and see if salvation has come to us in the name of KOFFKA. The abundance of newly opened perspectives and promises is overwhelming: Mechanism and vitalism, causal and teleological thinking, understanding and explaining in psychology are reconciled, the psychophysical problem loses its barbs and a reform of the traditional logic and epistemology is imminent. All brought about by the cheap abandonment of a few untenable axioms on which the old psychology got stuck, and by the conversion to the way of thinking of Gestalt psychology. Gestalt - the way KOFFKA and his friends see things. (p. 146)

In the latter part of the article, Bühler (1926) chastised Koffka for not giving Selz appropriate credit. He stated with regard to then current research issues, "Nevertheless, the files are not yet closed, and it was not KOFFKA but SELZ who was the first to depart so far from the older doctrine" (p. 154). With regard to the psychology of thinking, Bühler cited Koffka as saying, "One (sic!) calls such a theory of the ordered course of thought a 'constellation theory', from the constellation, the sum of the reproduction tendencies just present, follows the product, the real course of imagination" (516), and then went on to retort, "Who is this anonymous 'man'? I think he is still among the living and his name is O. SELZ." (p. 158). He also noted that Selz's work "does not deviate by a hair's breadth from that of KOFFKA in the matter of the 'ordered course of thought' (this is also a SELZ expression)" (p. 158). Bühler then outlined similarities in the concepts used by Koffka to those used earlier by Selz, and asked, "How can KOFFKA

dare to develop in his textbook the whole doctrine as a result of "Gestalt psychology" without mentioning the name of SELZ, except for the purpose of dismissing him, mostly critically, on minor points?" (p. 159).

Selz (1926) also replied to Koffka (1925), vindicating his crucial and innovative contributions, and accusing Koffka of having plagiarized some of his ideas. Selz began by emphasizing that Koffka's critique of the associative explanation and constellation theory "closely follows in its basic ideas and terminology my investigations" (p. 160). He noted that he coined the term constellation theory in 1913 and contrasted such types of theory with complex theory that viewed complex wholes as being indissoluble. Selz went on to elaborate on the distinction between the types of theories and notes that he opposed any theory of diffuse reproductions with his own theory that emphasized specific reactions. He stressed that despite his having made many of the arguments against constellation theory described by Koffka in his section on the topic, his name was not mentioned, only coming up in a brief mention regarding the inadequacy of his methodology.

Selz decried Koffka's giving credit to Kurt Lewin as the true conquerer of the theory of association: "It will become clear to the reader that his [Lewin's] meritorious experiments are essentially a replica of Ach's experimental methodology, i.e., of a procedure developed in the circle of the Würzburg School" (pp. 161–162). He characterized Lewin's experiments as essentially a continuation of the criticism of Ach's experiments that Selz made in a 1910 article, "Die experimentelle Untersuchung des Willensaktes" (The Experimental Investigation of the Act of Will), which has generated other experimental studies. Selz stated that in 1910 and 1912 articles, well before Lewin's work, he had stressed that reproductive and productive processes are not sequences of ideas but cognitive and motor operations. Selz quoted from his prior work, "There it says (p. 259): Even if one admits the existence of a (reproduction-determining) inhibition, the question still remains whether this inhibition is really an associative (!) one, or whether not rather the inner reproductive activity (!) taking place during memorization perseveres even with senseless material."

Selz (1926) noted in multiple places that Koffka (1925) has taken on Benary's labeling of his theory as a machine theory. He disagreed with the characterization of his theory as a machine theory and that his theory is similar to Gestalt theoretical views in only minor points. Selz proceeded through Koffka's terminology and showed how many of the concepts can be mapped directly onto his.

Koffka's (1927) article

Koffka's article was a response to the charges of Bühler and Selz that he did not acknowledge Selz's contributions adequately and appropriately. In his words, "I would have no reason to respond to these essays if the two authors had not bluntly reproached me for having borrowed my theory of thought from Selz, let us say, with assiduous concealment of the source and with, admittedly, very unseemly obfuscation." Koffka focused solely on Selz's article, saying, "That I will leave Mr. Bühler's essay essentially untouched, will not surprise anyone who has read this essay" (p. 164), apparently because it was the more polemical of the two.

The purpose of Koffka's commentary was to show "that the theory of Selz is so different in nature from the one I have presented, that the accusation of an illegitimate borrowing is no longer applicable" (p. 164). One criticism of Selz's work is the type of tasks he uses: "He wants to investigate thinking, even productive thinking, with the help of tasks which are basically foreign to true lively productive thinking." In other words, Koffka is saying that Selz was using artificial laboratory tasks with the intent of understanding creative, insightful thinking outside of the lab. He describes the method as being essentially that employed by Watt and Messer, but enhanced by changing the task on successive attempts. However, Koffka emphasizes that all of the methods come from association-constellation theory, which means that a method that originates in that theory is being used to obtain evidence against it.

Summary

There are at least three elements to the dispute involving Selz's contribution versus those of the Gestaltists. First, Selz (1910, 1913) criticized the theory of Ach early on for still being a constellation theory because he allowed task performance to be influenced by undirected association tendencies as well as determining tendencies activated by the task goals. Selz indeed was the first to make this point. Second, he employed concepts similar to those of Lewin and Koffka to explain reproductive and productive thinking several years earlier, as emphasized by Bühler. Third, Selz's research method relied on analyzing retrospective verbal protocols in solving complex problems, whereas Koffka favored the behavioral methods applied to simpler tasks, as used by Lewin.

Selz's methods were adequate to generate his theory, which has many of the characteristics favored from the information-processing revolution in the 1950s onward, but we tend to agree with Koffka that the retrospective report methods would not provide definitive evidence against constellation theory.

One of Selz's major points was that the anticipatory schema of the final goal in addition to the task determining tendency allowed an account that did not require a role for undirected associations. Benary and Koffka seem to have

overlooked this critical aspect in classifying Selz's theory as a mechanistic theory and in concluding that the theory could not account for productive thinking. Whereas Selz correctly saw the shift to directed associations organized by an anticipatory schema as a critical one in theorizing, the Gestaltists saw it as a minor variation on prior work.

In their book on thinking, Mandler and Mandler (1964/1981) reached a conclusion that is applicable today as it was then. They concluded that the main difference is that Koffka accentuated the emergence of new qualities, for which Selz's theory left little room. They pointed out that although "modern thought has tended to prefer Selz's 'machine' position against the implied Nativisim of the Gestaltists" (p. 235), the joint contribution of both lines of research was the abandonment of the constellation theory for a structural psychology of thinking.

Selz in the Netherlands

The description of the life of Otto Selz that follows is based largely on Beckmann's (2001), Seebohm's (1981), and Van Strien and Faas' (2005) depictions. The outlook of the Mannheim *Handelshochschule*, that was turned into a university in 1929, was primarily on applied science. This perspective led Selz to apply his theory on goal-directed thinking to educational problems, aiming to increase the level of intellectual achievement in school children. His "paradigm of practice" consisted of an analysis of the problem-solving operations that school children used (following Selz's approach of verbal protocols), followed by informing the pupils about their own problem-solving methods as well as alternative approaches, and having the more advanced pupils explain and teach their problem-solving styles to less advanced children. In well-controlled experimental studies in schools in and around Mannheim, the program proved effective in remedying children's learning difficulties.

This "paradigm of practice" brought Selz some acclaim, at least among pedagogues, and he entertained hopes of gaining a position at the University of Heidelberg. His career ended abruptly, however, when the Nazi's rose to power in 1933. The National Socialist party enacted racial laws that excluded Jews from professional civil service positions, including academic ones. On April 4, at the age of 52, Selz was dismissed from service by a decree of the Minister of Culture and Education, under the pretext of "maintaining security and order". He was denied access to his institute and its laboratory. In October the *Handelshochschule* was dissolved, and the next day the rector informed him that "You will probably not be transferred to Heidelberg. The reason for this can only be your descent, since non-Aryans cannot be appointed to a German university" (Beckmann, 2001). Selz was officially retired in March 1934. His expulsion left him to continue working in seclusion, cut off from scientific contact with his former scientific community.

Selz remained free to travel, and indeed visited Switzerland on occasion, but decided not to emigrate, apparently out of consideration for his mother and sister, whom he supported materially (Beckmann, 2001). This changed after the events connected to the *Reichspogromnacht* (formerly known as *Kristallnacht)* of November 1938. He was arrested and detained in *Konzentrationslager* Dachau. He was released 5 weeks later on condition that he leave the country, and he immediately filed an application for emigration to the Netherlands. Not that the climate for refugees was far optimal in the Netherlands, considering the economic burden refugees presented when livelihood opportunities were already under pressure for its own people. The Dutch state left aid for destitute refugees to private and religious organizations.

It turned out to be especially difficult to help academics among the refugees, since various administrative regulations had restricted the enrollment of foreign scientists at Dutch universities. However, at the University of Amsterdam, the renowned pedagogue Philip Kohnstamm, who had visited him in Mannheim, invited Selz to come to Amsterdam, with the support of Geza Révész, the director and founder of the Psychological Laboratory. Selz arrived in May 1939, and would live on 60 guilders a month, provided by Jewish charities. Selz befriended Herman Frijda, a renowned professor of economics, in whose house he was a frequent guest.

Kohnstamm brought Selz to the "Nuts-seminarium for Pedagogics", a teacher training institute of the University of Amsterdam, where he lectured on the importance of fostering the intellectual development of children. In a seminar in April 1940 on the "psychology of productive and reproductive intellectual activity", in Amsterdam's Rembrandt House, Selz told his audience that the successive drafts of Rembrandt's etchings show how the artist, relentlessly corrected the defects of his original conception (redistributing, for instance, main and secondary figures) before achieving the intended effect (Beckmann, 2001).

Révész involved Selz in the work of the psychological laboratory, and provided him with opportunities for publication of his work in *Acta Psychologica*, a journal established in 1935 by Révész, in part with the express purpose of serving the publication needs of emigrated psychologists. Selz's last paper published in his lifetime, on the "construction principles of the phenomenal world", was published in the *Nederlands Tijdschrift voor Psychologie* (Selz, 1941).

Sometime after the German invasion in May 1940, Jews were no longer allowed to profess in public institutions, and Kohnstamm, Révész, and Frijda were forced to suspend their professorships. The next month, Selz wrote "a particularly urgent request" to his former adversary Kurt Koffka in the U.S., where he had held a professorship since 1927. Selz

explained, "It is extremely important to me to be considered for future invitations from America to foreign psychologists, even if it can only be for a very modest position, and I ask you to offer me your kind help in this matter." (Beckmann, 2001).

Koffka informed Wertheimer, a German Jew who had been emigrated to the U.S. in 1933 after the Nazi's rose to power, and who was a member of the "Committee on Displaced Foreign Psychologists" that made efforts to find immigration opportunities for persecuted colleagues in Europe. In October, Selz wrote to Wertheimer that "I received the attentive letter from our colleague Mr. Koffka of 28.8.40. To my great delight, I learn from his messages that you want to make an effort for me in the most collegial way." Despite his efforts, however, Wertheimer was unsuccessful in securing a position for Selz. He also tried to enroll Selz for a brief scholarship program, but the program required good prospects for employment at an American university after the scholarship expired. Although Selz was well known in his field by European psychologists, he was completely unknown in the U.S. Moreover, Selz was beyond the formal age limit for the scholarship program. Under these conditions, Wertheimer failed in his attempts, and Selz remained in exile in Amsterdam, at increasing risk for his personal safety.

Step by step, the rights of the Jews were further restricted, and many lost their employment. From early 1942 onward, unemployed Jewish men and boys were drafted for "labor" in Westerbork, not far from the German border. Westerbork had been established in 1938 after the *Reichspogromnacht* as a reception camp for refugees from Germany; cynically, the German occupiers transformed it into a temporary transit camp for Jews and other prisoners to be deported. Soon, entire families were sent to Westerbork; from there, many were deported sent by train to other "labor camps" in Germany and occupied Poland.

Many Jews in the Netherlands, including Selz's friend Frijda, went underground to escape the raids. Kohnstamm was spared because his wife was non-Jewish and offered to find Selz a hiding place, but Selz declined. He felt that the Iron Cross he received for his service in World War I would protect him, and continued his work. In 1942, he expressed his conviction of "how fruitful the work of the psychologically trained practical pedagogue can become". (Indeed, his didactic approach would later be successfully taken up and practiced in American management trainings.)

On June 30, 1943, Révész applied to the Central Office for Jewish Emigrants for preferential treatment of Otto Selz, but this was to no avail. Selz was arrested in July and sent to Westerbork, from where he sent a postcard to his friends, announcing that he planned a series of lectures there on behalf of the other inmates. It was to be his last sign of life. On Tuesday, August 24, 1943, train No. DA 703 departed for Auschwitz. Otto Selz's death is recorded on August 27, in or near Auschwitz. He died in the gas chambers immediately after arriving, or perhaps from exhaustion or suffocation during transport, or he was killed during an attempted or staged escape.

In 1944, Herman Frijda and two sisters of Philip Kohnstamm also died in Auschwitz. More than 100,000 Dutch Jews, and some 15,000 Jewish refugees from Germany, were put on transport via Westerbork and murdered in the concentration camps.

Otto Selz's contributions in his later years

In his work published between 1929 and 1943, Selz tried to further clarify the differences and commonalities between associationist psychology and Gestalt Psychology. Robering (2020, p. 98) characterizes Selz's contributions during the period as follows: Selz

> developed a novel account of the structure of the phenomenal world, i.e., the world as it appears to us in perception. Selz calls this new general theoretical framework "synthetic psychology of wholes". . . This synthetic psychology of wholes is opposed to both associationism, which – building upon the ideas of the British Empiricists – had dominated psychology in the nineteenth century, and gestaltism as it has been developed in various schools in Austria and Germany since the beginning of the twentieth century.

Selz (1941) argued that associationism and Gestalt psychology share the assumption that gestalts are tied together dynamically by means of forces. However, they entertained opposing views of the direction of that force. In Robering's (2020, p. 98)) words:

> Whereas associationist[s], however, assume that the force of association composes unanalyzable psychic elements into more comprehensive wholes, gestaltists conversely assume such wholes to be primary and explain their articulation into parts as a self-organization of the perceptual field by its inner forces. Such explanations, if adequate, explain the emergence of wholes; they are alternative answers to the question why a whole of a certain kind develops. However, they cannot explain the specific way how this whole is structured; they cannot disclose its "constitutional or structural laws".

This is a weakness that Selz believed should be remedied, but that cannot be remedied by either associationists or Gestaltists, as both aim at a causal-genetic explanation of wholes. To find these structural laws, Selz argued, what is required is a phenomenological analysis. This, states

Robering (2020), may "reveal how structured wholes are composed out of simpler items and will thus open the way back—"for long considered impossible in psychology" (Selz, 1941, 176)—from analysis to synthesis."

Otto Selz's legacy

"Selz probably found the most recognition, and at least some personal friendship and warmth, in the Netherlands. This thought can be a comfort to us when we think of the tragic end of his life." These were the words that concluded the obituary for Otto Selz written in 1946 by Selz's most important Dutch student, Adriaan de Groot.

More than the application of Selz's theory in education, it was de Groot's experimental research on thinking and problem-solving in chess that proved influential in spreading Selz's views. De Groot's main work, which benefited from Selz's advice and used his self-reporting method, was published directly after the war, in 1946, in Dutch (*Het denken van den schaker)*. Its English translation of 1965 (*Thought and Choice in Chess*) still is by far the most cited work on chess thinking, with nearly 5,000 citations at present (de Groot, 1946). But Selz's work was not introduced to the English-speaking scientific community until 1951 with the publication of *Thinking*, a review of the psychology of thinking by George Humphrey (1951). Humphrey devoted a full chapter to Selz and the importance of his work.

The chapter on Selz in Humphrey's book triggered the later Nobel prize winner Herbert Simon to read de Groot's study (he actually learned Dutch in order to be able to read it), which in turn introduced him to Selz's work. "Our own work […] owe[s] large debts to Selz", Simon and Newell acknowledge in their highly influential *Human Problem Solving* (Newell & Simon, 1972). As argued by van Strien and Faas (2005), "it was principally Simon's inclination to place his own work in a historical perspective, and to procure himself of a scientific pedigree, that rescued Selz from oblivion and assured him a place in the history of cognitive psychology".

Mandler and Mandler (1964/1981) also recognized, "Probably the major turning point in the history of thinking came with the work of Otto Selz". Simultaneous with the waning of the domination by behaviorism, interest in thinking processes and mental operations waxed. The introduction of the first computers was one of several critical factors in establishing the information-processing approach in psychology (Xiong & Proctor, 2018), and helped ignite the ensuing cognitive revolution. It stimulated psychologists to develop software that simulates human problem-solving, to which end Selz's conjecture proved immediately applicable. His mechanistic "machine theory", previously met with disdain, now became extremely relevant (Dörner, 1996; Newell et al., 1958/1963, 1963). Wettersten (2019) noted,

> A fundamental starting point for Simon's cognitive psychology was Selz's. […] Selz described how directed thought processes were guided by problems, by the search for solutions which, with reference to problems, had to meet certain standards. And, he went further in that he described how such thought processes proceeded when unanticipated difficulties and or mistakes were discovered (Selz, 1913a, 1913b, 1922, 1924). Selz studied, as did Miller, Galanter, and Pribram much later, feedback loops. (p. 404)

In September 1970, the German Psychological Society posthumously awarded Otto Selz its highest distinction, the *Wilhelm Wundt Plakette* for his eminent achievements in psychology (see Fig. 1). On that occasion, Günther Reinert, representing the Society said,

> We did this because we take seriously the man who was in danger of not being taken seriously by his fellows and because we want to put on the record that we take him seriously… Above all we take him seriously as the theoretically profound and original thinker and publicist who was in many respects ahead of his colleagues. (1981, p. 14)

Ten years later, on the occasion of Selz's 100th birthday, a volume with works by and on Selz was published by Adriaan de Groot and Nico Frijda (Frijda & de Groot, 1981a). Nico, son of Herman Frijda, had as a teenager also gone underground but was captured and detained by the Germans in 1944. He survived because the Germans could not prove his identity (even though they had strong suspicions). Nico Frijda remembered Selz from the latter's frequent house visits, "mainly as a nervous but friendly refugee, whom one could

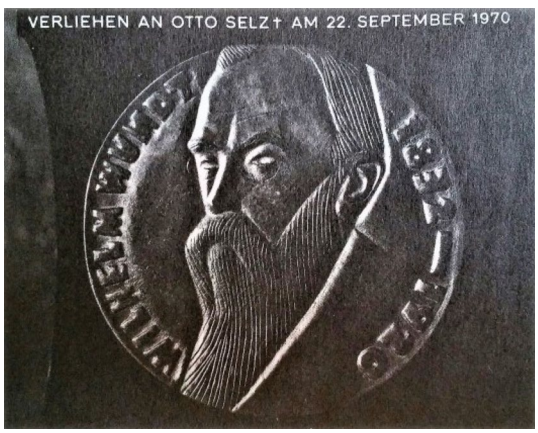

Fig. 1 Photo of the *Wilhelm Wundt Plakette* Awarded Posthumously to Otto Selz

ask for cigar bands—which children collected in those days" (Frijda was about 11 at the time) (Frijda & de Groot, 1981b).

The quote of Reinert cited in our opening section comes from the Frijda and de Groot volume. From that quote, it is apparent that Selz incorporated many concepts that play significant roles in contemporary theories of human information processing: mental operations, or procedures (e.g., Posner, 2005), mental transformations (Greenspon et al., 2020), hierarchical structure (Kleinsorge & Heuer, 1999), anticipation (Camu et al., 2018), schemas (Graziano, 2019), heuristics (Wiener et al., 2009), and cognitive process (Horne et al., 2019). This use of similar concepts provides evidence that Selz's theory was a forerunner of contemporary views. However, the issue of whether "insight" is a product of ordinary thought processes, as Selz claimed, or a distinct component process as Köhler and the other Gestalt psychologists claimed, remains a matter of debate to this day (Fleck et al., 2013; Weisberg, 2018).

Another 10 years later, a volume of Selz's "Selected Writings" was published (Metraux & Herrmann, 1991). The editors noted that his "teachings are as good as forgotten today". Indeed, "most publications on the history of psychology do not mention his name" (van Strien, 1997), and his name remains largely unknown.

The present second author (KRR) started his undergraduate studies at the *Psychologisch Laboratorium* of University of Amsterdam in 1982, and has a vague recollection of the *Wilhelm Wundt Plakette,* which was on display in the central hallway. The department of Psychology moved to another building in 1990, and moved again, in 2011, and then once more, in 2015; and at some point in the process, the *Plakette* got lost. A few years before his death, Frijda mentioned that he had no idea what happened to it. Subsequent to Nico's death, KRR initiated a search to recover the *Plakette*. It turned out that during the 2015 move, some unknown person decided to dispose of it, out of ignorance, and dumped it in a garbage container. It was only by accident that a passing professor noted the event, and decided to check out the heavy object and rescue it from destruction. It was made of bronze, and about 20 cm in size (see Fig. 1). We are pleased to say that on April 21, 2022, the Selz memorial Plakette was officially reinstated in the central hallway of the *Psychologisch Laboratorium* of University of Amsterdam.

In the fall of 2001, the king of the Netherlands opened the National Holocaust Names Memorial in Amsterdam. Among the names are those of Herman Frijda and Otto Selz. It is our hope that, together with the present paper in the *Psychologische Forschung* centennial, the reinstating of his *Plakette* will permanently re-establish our knowledge and appreciation for the work of Otto Selz, pioneer of the cognitive revolution, the only German professor of psychology whose life fell victim to the Nazi camps.

Funding This study was not funded by a grant.

Data availability statement No new data are reported in this review article. The articles, chapters, and books cited in the text are available online and in libraries.

Declarations

Conflict of interest Robert Proctor declares that he has no conflict of interest. Richard Ridderinkhof declares that he has no conflict of interest.

Ethical approval This article does not contain any studies with human participants or animals performed by any of the authors.

References

Ach, N. (1910). *Über den Willensakt und das Temperament*. Quelle & Meyer.

Ach, N. (1935). Analyse des Willens. In E. Abderhalden (Ed.), *Handbuch der biologischen Arbeitsmethoden*. Urban and Schwarzenberg.

Beckmann, H. (2001). Selz in Amsterdam. Der Denkpsychologe Otto Selz (1881–1943) im niederländischen Exil. *Psychologie Und Geschichte, 9*, 3–27.

Benary, W. (1923). Referat Otto Selz: Über die Gesetze des geordneten Denkverlaufs. II. *Psychologische Forschung, 3*, 417–425.

Bühler, K. (1926). Die "neue" Psychologie Koffkas [The 'new' psychology of Koffka]. *Zeitschrift Für Psychologie, 99*, 145–159.

Camu, T., Hommel, B., Brunel, L., & Brouillet, T. (2018). From anticipation to integration: The role of integrated action-effects in building sensorimotor contingencies. *Psychonomic Bulletin and Review, 25*(3), 1059–1065.

Carpenter, W. B. (1852). On the influence of suggestion in modifying and directing muscular movement, independently of volition. *Proceedings of the Royal Institute, 1*, 147–154.

Carpenter, W. B. (1853). *Principles of human physiology with their chief applications to psychology, pathology, therapeutics, hygiène, andfForensic medicine*. Blanchard and Lea.

de Groot, A. D. (1946). *Het denken van den schaker*. Amsterdam: Noord-Hollandse Uitgevers Maatschappij. English translation: Thought and choice in chess. (reprinted Den Haag: Mouton, 1965).

de Spinoza, B. (1922). *Ethics (Transl. Meijer, W.)*. S.L. van Looy.

Devonis, D. C. (2012). Koffka, Kurt. In R. W. Rieber (Ed.), *Encyclopedia of the history of psychological theories* (pp. 607–608). Cham: Springer.

Dörner, D. (1996). *The logic of failure: Recognizing and avoiding error in complex situations*. Perseus Books.

Duncker, K., & Lees, L. S. (1945). On problem-solving. *Psychological Monographs, 58*(5), i.

Eder, A. B., & Dignath, D. (2021). Associations do not energize behavior: on the forgotten legacy of Kurt Lewin. *Psychological Research Psychologische Forschung*. https://doi.org/10.1007/s00426-021-01631-1

Fleck, J. I., Beeman, M., & Kounios, J. (2013). Insight. In D. Reisberg (Ed.), *The Oxford handbook of cognitive psychology* (pp. 779–794). Oxford University Press.

Frijda, N. H. (2007). *The laws of emotion*. Erlbaum.

Frijda, N. H., & de Groot, A. D. (Eds.). (1981a). *Otto Selz: His contribution to psychology*. Mouton.

Frijda, N. H., & de Groot, A. D. (1981b). Preface. In N. H. Frijda & A. D. de Groot (Eds.), *Otto Selz: His contribution to psychology* (pp. vii–xi). Mouton.

Grafton, S. T., & Hamilton, A. F. (2007). Evidence for a distributed hierarchy of action representation in the brain. *Human Movement Science, 26*, 590–616.

Graziano, M. S. (2019). Attributing awareness to others: The attention schema theory and its relationship to behavioural prediction. *Journal of Consciousness Studies, 26*(3–4), 17–37.

Greenspon, E. B., Pfordresher, P. Q., & Halpern, A. R. (2020). The role of long-term memory in mental transformations of pitch. *Auditory Perception and Cognition, 3*(1–2), 76–93.

Harleß, E. (1861). Der Apparat des Willens. Zeitschr. *Philosophie Philosophische Kritik, 38*, 50–73. Transl. Pfister, R., Janczyk, M. 2012. Psychological Research, 76, 561–565.

Herbart, J. F. (1825). *Psychologie als Wissenschaft neugegründet auf Erfahrung, Metaphysik undMathematik. Erster, synthetischer Teil [Psychology as a Science Newly based on Experience, Metaphysics and Mathematics]*. August Wilhelm Unzer.

Hobhouse, L. T. (1915). *Mind in evolution*. MacMillan & Co.

Horne, Z., Muradoglu, M., & Cimpian, A. (2019). Explanation as a cognitive process. *Trends in Cognitive Sciences, 23*(3), 187–199.

Humphrey, G. (1951). *Thinking: An introduction to its experimental psychology*. Methuen.

James, W. (1890). *The principles of psychology, in two volumes*. Henry Holt & Co.

Janssen, J.-P. (2003). Teil IV. Bibliographie Wilhelm Benary. *Psychology Science, 45*(IV), 75–78.

Kleinsorge, T., & Heuer, H. (1999). Hierarchical switching in a multidimensional task space. *Psychological Research Psychologische Forschung, 62*, 300–312.

Koffka, K. (1925). Psychologie. In M. Dessoir (Ed.), *Die Philosophie in ihren Einzelgebieten* (pp. 497–603). Ullstein.

Koffka, K. (1927). Bemerkungen zur Denk-Psychologie. *Psychologische Forschung, 9*, 163–183.

Köhler, W. (1920). *Die physischen Gestalten in Ruhe und im stationären Zustand: Eine naturphilosophische Untersuchung*. Vieweg.

Kuusela, H., & Paul, P. (2000). A comparison of concurrent and retrospective verbal protocol analysis. *American Journal of Psychology, 113*(3), 387–404.

Lewin, K. (1922a). Das Problem der Willensmessung und das Grundgesetz der Assoziation I. *Psychologische Forschung, 1*(1), 191–302.

Lewin, K. (1922b). Das Problem der Willensmessung und das Grundgesetz der Assoziation II. *Psychologische Forschung, 2*(1), 65–140.

Lewin, K. (1926). Vorsatz, Wille und Bedürfnis. *Psychologische Forschung, 7*, 330–385.

Lotze, R. H. (1852). *Medicinische Psychologie oder Physiologie der Seele*. Weidmann'sche Buchhandlung.

Mandler, G. (2007). *A history of modem experimental psychology: From James and Wundt to cognitive science*. MIT Press.

Mandler, J. M., & Mandler, G. (Eds.). (1964). *Thinking: From association to Gestalt*. Wiley/Greenwood Press.

Marbe, K. (1901). Experimentell-psychologische. *Untersuchungen über das Urteil—Eine Einleitung in die Logik*. Leipzig.

Mayer, A., & Orth, J. (1901). Zur qualitativen Untersuchung der Association. *Zeitschrift Für Psychologie Und Physiologie Der Sinnesorgane, 26*, 1–13.

McDougall, W. (1928). Emotion and feeling distinguished. In C. Murchison (Ed.), *Feelings and emotions: The Wittenberg Symposium* (pp. 200–205). Clark University Press.

Metraux, A., & Herrmann, Th. (Eds.). (1991). *Otto Selz: Wahrnehmungsaufbau und Denkprozeß (Ausgewählte Schriften)*. Huber.

Newell, A., Shaw, J. C., & Simon, H. A. (1958). Empirical explorations with the logic theory machine. In E. A. Feigenbaum & J. Feldman (Eds.), *Computers and thought* (pp. 109–122). McGraw-Hill.

Newell, A., Shaw, J. C., & Simon, H. A. (1963). Chess playing programs and the problems of complexity. In E. A. Feigenbaum & J. Feldman (Eds.), *Computers and thought* (pp. 39–70). McGraw Hill.

Newell, A., & Simon, H. A. (1972). *Human problem solving (vol 104, no. 9)*. Prentice-hall.

Noble, D. (1858). *The human mind in its relations with the brain and nervous system*. J. Churchill.

Posner, M. I. (2005). Timing the brain: Mental chronometry as a tool in neuroscience. *PLoS Biology, 3*(2), e51.

Reinert, G. (1981). In memoriam Otto Selz: Spoken upon the occasion of the posthumous award of the Wilhelm Wundt Plakette in 1971. In N. Frijda & A. D. De Groot (Eds.), *Otto Selz: His contribution to psychology* (pp. 13–19). Mouton.

Ribot, T. (1894). *The diseases of the will (Transl. Snell, M.M.)*. Open Court.

Ridderinkhof, K. R. (2014). Neurocognitive mechanisms of perception–action coordination: A review and theoretical integration. *Neuroscience and Biobehavioral Reviews, 46*, 3–29.

Robering, K. (2020). Otto Selz's phenomenology of natural space. *Phenomenology and the Cognitive Sciences, 19*(1), 97–121.

Scheerer, E. (1988). Fifty volumes of Psychological Research/Psychologische Forschung: The history and present status of the journal. *Psychological Research Psychologische Forschung, 50*, 71–82.

Sebanz, N., Bekkering, H., & Knoblich, G. (2006). Joint action: Bodies and minds moving together. *Trends in Cognitive Science, 10*, 70–76.

Seebohm, H.-B. (1981). The psychologist Otto Selz: His life and destiny. In N. H. Frijda & A. D. de Groot (Eds.), *Otto Selz: His contribution to psychology* (pp. 1–12). Mouton.

Selz, O. (1910). Die experimentelle Untersuchung des Willensaktes. *Zeitschrift Für Psychologie, 57*, 241–270.

Selz, O. (1912). *Experimentelle Untersuchungen über den Verlauf determinierter intellektueller Prozesse. Bericht über den V. Kongress für experimentelle Psychologie* (pp. 229–234). Leipzig: Barth.

Selz, O. (1913). In E. Teil (Ed.), *Über die Gesetze des geordneten Denkverlaufs. Eine experimentelle Untersuchung.* Spemann.

Selz, O. (1919). Uber den Anteil der individuellen Eigenschaften der Flugzeugführer und Beobachter an Flügunfallen. *Zeitschrift Für Angewandte Psychologie, 15*, 254–300.

Selz, O. (1922). *Über die Gesetze des geordneten Denkverlaufs,* Zweiter Teil: *Zur Psychologie des produktiven Denkens und des Irrtums. Eine experimentelle Untersuchung.* Bonn, Cohen.

Selz, O. (1924). *Die Gesetze der produktiven und reproduktiven Geistestätigkeit. Kurzgefasste Darstellung.* Bonn, Cohen.

Selz, O. (1926). Zur Psychologie der Gegenwart. *Zeitschrift Für Psychologie, 99*, 160–196.

Selz, O. (1941). Die phänomenalen Grundlagen des Zahlbegriffes. *Nederlands Tijdschrift Voor Psychologie, 9*, 147–192.

Simon, H. A. (1981). Otto Selz and information-processing psychology. In N. Frijda & A. D. De Groot (Eds.), *Otto Selz: His contribution to psychology* (pp. 147–163). Mouton.

ter Hark, M. (2010). The psychology of thinking before the cognitive revolution: Otto Selz on problems, schemas, and creativity. *History of Psychology, 13*(1), 2–24.

Vallée-Tourangeau, F. (2018). *Insight*. Routledge.

van Strien, P. J. (1997). Otto Selz über Kreativitat. *Psychologie Und Geschichte, 7*, 339–356.

van Strien, P. J., & Faas, E. (2005). How Otto Selz became a forerunner of the cognitive revolution. In T. C. Dalton & R. B. Evans (Eds.), *The life cycle of psychological ideas* (pp. 175–201). Springer.

Wagemans, J., Elder, J. H., Kubovy, M., Palmer, S. E., Peterson, M. A., Singh, M., & von der Heydt, R. (2012). A century of Gestalt psychology in visual perception: I. Perceptual grouping and figure–ground organization. *Psychological Bulletin, 138*(6), 1172–1217.

Weisberg, R. W. (2018). Insight, problem solving, and creativity: An integration of findings. In F. Vallée-Tourangeau (Ed.), *Insight* (pp. 779–794). Routledge.

Wettersten, J. (2019). The Würzburg School today: The three—now four—world theory and new psychological research. *Theory & Psychology, 29*(3), 396–416.

Wiener, J. M., Ehbauer, N. N., & Mallot, H. A. (2009). Planning paths to multiple targets: Memory involvement and planning heuristics in spatial problem solving. *Psychological Research Psychologische Forschung, 73*(5), 644–658.

Wulf, G., Hoβ, M., & Prinz, W. (1998). Instructions for motor learning: Differential effects of internal versus external focus of attention. *Journal of Motor Behavior, 30*, 169–179.

Xiong, A., & Proctor, R. W. (2018). The role of task space in action control: Evidence from research on instructions. In K. D. Federmeier (Ed.), *The psychology of learning and motivation* (Vol. 69; pp. 325–364). Academic Press