

## THINKING OUTSIDE OF THE BOX:

### *On Karl Duncker, Functional Fixedness, and the Adaptive Value of Engaging in Purposely Deviant Acts*

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Not long ago, I assigned a problem to my graphic design students (at the University of Northern Iowa) in which I asked them to invent an information wheel. These are rotational, circular charts that display information in windows. Widely available in the U.S. in the 1940s and 50s, they were used in education and advertising to provide essential facts about such subjects as first aid, bird watching, enemy airplane spotting, star gazing, and weather forecasting (see HELFAND 2002).

When the students submitted their solutions, among the most unusual was a wheel chart that provided information on how to prepare a pizza. It was a surprising solution because the information was contained in a cardboard model of a “pizza cutter”, a circular blade with a handle. As the wheel is turned, various facts about pizzas appear.

I asked the student how he had come up with such a novel solution. He said it was difficult at first because he was impossibly busy with other classes in addition to part-time employment. He was so busy that, instead of eating appropriate meals, he only had time to eat pizzas. One night, as he ate hurriedly and worried about how to come up with a wheel chart for my class, it occurred to him that a pizza cutter is not only a knife - it is also a wheel, and at that point he started to think of it as a potential information wheel.

As the student described his thinking process, I recognized that he had used a problem solving strategy that was tested and described in the 1920s by Karl DUNCKER, a Gestalt psychologist who was a student at the time at the Psychological Institute at the University of Berlin. As I will explain in this essay, if DUNCKER were alive today, I suspect that he would tell us that this student had engaged in “productive thinking” and thus was able to avoid an impediment called “functional fixedness”. To use a now familiar phrase, the student’s ingenuity enabled him “to think outside of the box”, and to invent an alternative context (a redefined role, a new function) for the blade of the pizza cutter.

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Karl DUNCKER is an enigma in the history of psychology. An unusual number of scholars, from a variety of disciplines, have been drawn to his work, no doubt because it is widely assumed that he was uncommonly gifted. But I think he is also

of interest because, like Vincent VAN GOGH, Alan TURING, and Sylvia PLATH, he ended his life prematurely. After years of combating depression, he committed suicide in 1940, at age 37.

DUNCKER was born in Leipzig, Germany, in 1903, to parents who were active as Marxists. In 1923, he enrolled at the University of Berlin, where he became a student of two of the original Gestalt psychologists (Max WERTHEIMER and Wolfgang KÖHLER) at the Psychological Institute, which three years earlier had moved to the abandoned Imperial Palace.

Among his fellow students there were Rudolf ARNHEIM, Tamara DEMBO, Kurt GOTTSCHALDT, Herta KOPFERMANN, Wolfgang METZGER, Maria OVSIANKINA, Hans WALLACH and Bluma ZEIGARNIK. We know from a WERTHEIMER letter that he and KÖHLER regarded DUNCKER as their most promising student (quoted in KING, COX & WERTHEIMER 1998, 165). Years later, DUNCKER's classmate METZGER claimed that he was, as Simone SCHNALL has said, "the brightest and most versatile of the students" (SCHNALL 1999, 14); and, a few years ago, when I asked ARNHEIM about his memories of DUNCKER, he recalled that the students and faculty at the Institute thought that he was "the most gifted among us" (ARNHEIM 1998, 2).

It is not surprising then that when KÖHLER taught for one year at Clark University in Massachusetts in 1925-26, he arranged to also bring along his finest student. DUNCKER was offered a graduate fellowship, which enabled him to earn a Master of Arts degree from Clark in 1926. As shown by his thesis, titled "An Experimental and Theoretical Study of Productive Thinking (Solving of Comprehensible Problems)" (DUNCKER 1926), he was already intensely involved in an investigation of problem solving, the research for which he is famous today.

Returning to Berlin, DUNCKER completed his doctoral dissertation in 1929 on an aspect of apparent motion (which WERTHEIMER had earlier specialized in), and was then hired as KÖHLER's assistant, a position he held until 1935, at which time he was dismissed on trumped up political charges. In that same year, he also came out with a memorable book on the *Psychology of Productive Thinking* (later translated into English in DUNCKER, 1945), which refined and extended his earlier work on problem solving. This was also the year in which KÖHLER, after years of standing up to the policies of the National Socialists, decided at last to leave Germany and to accept a position at Swarthmore College in Pennsylvania. (Other major Gestaltists, including WERTHEIMER, Kurt KOFFKA and Kurt LEWIN, had already emigrated to the U.S.)

Soon after, DUNCKER also left. He moved to England, where he worked briefly (on a study of pain) with Sir Frederick BARTLETT at the University of Cambridge. At about this time, a condition that was diagnosed as endogenous depression, with which he had been coping for at least a decade, began to intensify. In his own words, this dysfunction cast a "veil of unreality over everything, especially the future" (quoted in KING, COX & WERTHEIMER 1998, 168), and left him so impaired that he spent two months in a psychiatric clinic in Switzerland. Meanwhile,

his friends and former teachers in the U.S. continued their efforts to find him an academic appointment.

In the fall of 1938, through KÖHLER's efforts, DUNCKER was finally hired to teach undergraduate students at Swarthmore. In the period that followed, in what would be his final years, he was not unproductive. He wrote an innovative paper on ethics, another on perception in relation to past experience, and co-authored a third on problem solving. At the same time, his mental condition deteriorated, so much so that the KÖHLERs urged that he move into their home, so that they could take care of him.

In a letter to WERTHEIMER, KÖHLER reported the awful event that took place in the winter of 1940, just a few weeks after DUNCKER's 37th birthday: In Baltimore, KÖHLER wrote, "he bought himself a weapon and was found Friday morning dead in his car. If he had stayed here I believe we could have rescued him. What would his future have been then? He was a superb person and a moving child" (quoted in KING, COX & WERTHEIMER 1998, 168-169).

What would his future have been? Given his extraordinary talent, if DUNCKER had not suffered from depression and had not taken his own life, what other work might he have done? There is no definitive answer of course, but that in itself is contributive to the persistence of our curiosity. It is sad and yet perfectly fitting - Is it not? - that the incompleteness of the life of a Gestalt psychologist should provide an example of closure.

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Productive thinking. Induced motion. Pain. Peer pressure in relation to children's food preferences. Ethical relativity. The influence of past experience on perception. Pleasure, emotion and striving. The phenomenology and epistemology of consciousness of objects. These are the primary topics addressed in DUNCKER's published research between 1926 and 1940. Yet today, when his research is cited, it is almost always for his work in problem solving.

The simple yet elegant problems he used in his experiments - the gimlet problem, the box problem, the pliers problem, the weight problem, and the paperclip problem - are often mentioned in psychology textbooks (along with the famous radiation problem), and in academic papers on creativity and problem solving (for his own description of these problems, see DUNCKER 1945, 86-87). Many people are well acquainted with at least some of those experiments, but, to guard against any confusion about the meaning of functional fixedness, let me look closer at just one .

In what is often said to be "the candle problem" (but which DUNCKER himself called "the box problem") there were two groups of subjects. On a table in the testing room, DUNCKER had placed three candles, a few thumbtacks, and three small pasteboard boxes ("about the size of an ordinary matchbox, differing somewhat in form and color and put in different places"), all of which he intermixed "among many other objects". In each group, the subjects were brought into the setting, one

at a time, and asked to mount the candles on a door at eye-level. The solution that DUNCKER predicted is to use the thumbtacks to attach the boxes to the door, using each as a shelf or a platform for a candle. In the first group (which had greater difficulty in reaching that solution), the boxes were already functioning as containers for the thumbtacks, matches, and candles. In the second group (which had less difficulty), the boxes were unused and empty. Based on this and other comparable experiments, DUNCKER concluded that our preconceptions of a thing's function (our "functional fixedness") so clouds and restricts our attention that it may require twice as long to solve the problem.

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Earlier, I described a student solution in which the circular blade of a pizza cutter was perceived outside its normal role and provided the form for a circular chart. After the fact, this may seem like an obvious answer, but escaping from functional fixedness is anything but easy. It requires a switch of attention (DUNCKER called it "recentering") in which the customary use of a thing (in this case, the blade's cutting function) is overridden by what researchers of creativity call an "unusual use" (in this case, its function as a wheel chart).

A comparable switch of attention occurs in an old joke about a worker in a high security factory, in which the employees were carefully watched when they left at the end of their work day. On a particular day, this worker was stopped at the factory gate as he walked out with a wheelbarrow full of styrofoam packing peanuts. He explained that he had salvaged these from the trash, and was planning to use them in shipping gifts to his grandchildren. Searching through this packing material, the guards found nothing, and so they let the man go home. The following week the same thing happened, and the worker was again stopped. But he offered the very same story, and when the guards searched through the packing peanuts and found nothing, he was allowed to leave. But this continued, week after week, until the guards could no longer believe that one person would want or could make use of so much packing material. Finally, the man was held for interrogation, at which time he admitted that he had absolutely no use for packing peanuts - and that, all these weeks, he had been stealing wheelbarrows.

Hearing this joke, I am reminded of the phrase "part and parcel", which is a rough equivalent of "figure and ground". Throughout most of it, the packing peanuts occupy center stage as figure (part), while the wheelbarrows (which function merely as containers) are completely ignored as innocuous ground (parcel). At the end of the joke, there is an unexpected twist, a switch of emphasis, a recentering, when we learn that the parcel is really the part.

Likewise, in the first version of DUNCKER's box problem (in which the boxes are already in use as containers), the thumbtacks, matches and candles are actively focused on as figure (part or A), while the boxes are dismissed as ground (parcel or not-A). In the second version (in which the boxes are unused and empty), we are far

more likely to regard the boxes as figure, as potentially active ingredients in the process of solving the problem.

Throughout history, resourceful people of all kinds and varieties (whether artists, scientists, or devious criminals) have triumphed over functional fixedness, far in advance of the birth of the name. In the legend of the Trojan horse, for example, an object that at first was seen as merely a wooden effigy (that is, as a part, not a parcel) is revealed in the end to have functioned as a container for a small band of Greek soldiers.

In more recent history, the American architect Frank Lloyd WRIGHT worked “outside of the box” in the sense that he purposely weakened the wall between the inside (figure or part) of a residential dwelling and the outside (ground or parcel of land). WRIGHT admired the ambiguity of Japanese houses, in which, he said, it is often difficult to tell “where the [house] leaves off and the garden begins”. His early architectural aim, as he explained it, was to “eliminate the rooms as boxes and the house itself as another boxing of boxes”. He wanted to think of the wall of a house not simply as the “side of a box”. While a home should provide an “enclosure to afford protection against storm or heat when this is needed”, he said, it should also “bring the outside world into the house, and let the inside of the house go outside” (quoted in NUTE 1993, 40-41).

In art and design, a greatly admired example of this is a book that was invented in the Soviet Union in 1923. It was a small volume of propaganda poems, titled *For the Voice* (or, as sometimes translated, *For Reading Aloud*), written by Vladimir MAYAKOVSKY and designed by El LISSITZKY (see MAYAKOVSKY 2000). To illustrate the poems (each of which was printed on two facing pages), LISSITZKY did not use pictorial drawings and paintings (as was customary), but instead made new, surprising use of various “backstage” components of the printing process that, until that time, were never evident on the printed page (such as “printer’s furniture”, the scraps of wood that printers used to hold in place or “lock up” metal type), or, if shown, were intended to function as decorative spacing elements (called “printer’s ornaments” or “dingbats”). That same year, LISSITZKY left his homeland for an extended tour of Europe, including Germany, where he saw at Weimar an exhibition of art and design from the Bauhaus, and was also introduced to Walter GROPIUS, the founder of that famous school of art and design.

In 1925, the Bauhaus moved to Dessau, where it took on the ancillary title of Hochschule für Gestaltung (School of Design). Two years later, none other than Wolfgang KÖHLER was invited to lecture on Gestalt psychology to the faculty and students there. Unfortunately, he could not appear because of a scheduling conflict - so he sent to lecture in his place his most gifted graduate student, Karl DUNCKER.

In the audience at DUNCKER’s lecture was the famous Swiss-born painter Paul KLEE, who had already made purposeful use of unit-forming factors in his artwork as well as in teaching, apparently having been influenced by WERTHEIMER’s seminal paper about perceptual organizing principles (see TEUBER 1976). It would be interesting to know if the German painter Josef ALBERS was also present on that

day, because, like Karl DUNCKER, he too is now remembered for having devised innovative problems.

As recalled by Howard DEARSTYNE, an American designer who enrolled at the Dessau Bauhaus in 1928, the students in ALBERS' beginning course, while seated at long tables, were presented with such unlikely art materials as "wire, wire mesh, paper, corrugated cardboard, sheet metal, matchboxes, newspapers, or what not. We were supposed to do something with these - just *basteln*, or play around with them, to see if we could make something out of them or discover something about them" (DEARSTYNE 1986, 90-91).

The purpose of these exercises, ALBERS later explained, was "unprejudiced experimentation" - by which he apparently meant the antithesis of functional fixedness - with the goal that the student would "search by oneself and learn how to discover by oneself". At the beginning of each problem, said ALBERS, the most common ways of using these materials (their usual or typical functions) are identified and discussed, "and, since they can no longer be discovered, they are banned". Paper, for example, is nearly always used by manufacturers not as an edge but as a flat sheet that is glued. "That is a reason for us to use paper standing up", he continued, "uneven, plastically mobile, two-sided and with the edges emphasized. Instead of gluing it, we tie it, pin it, sew it, rivet it, that is fasten it in other ways and we also investigate its capacity to withstand tension and pressure [...]" (quoted in DEARSTYNE 1986, 92).

Albers was fifteen years older than DUNCKER. He died in 1976, at age 88, after having served for years as head of the program of art and design at Yale University. DUNCKER, as mentioned earlier, died at less than half that age in 1940. Looking back, it is ironic that both are remembered for only a portion of their accomplishments - because of functional fixedness, or what actors and others would commonly call "typecasting", "pigeonholing" or "stereotyping".

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More than sixty years after his death, does the work of Karl DUNCKER have any immediate relevance - especially at the onset of a strange new century, in a climate of hatred and violence and change? Or is all this lofty talk about productive thinking and functional fixedness so much academic rot, with little if any importance in life outside of the university?

One answer became clear to me more than a year ago, as I was driving to school one morning, on a day when I had planned to give a new problem to my graphic design students. It was September 11, 2001, and when I turned on the radio, I heard the news reports about the attacks on the World Trade Center and the Pentagon. In the days that followed, we were told that the attackers, in order to pass undetected, had not used typical weapons, but had carried instead the ubiquitous blades (called "box cutters") with which grocery boys dismantle empty cardboard crates. Unable to carry bombs onto the airplanes, they had realized that any airplane, when its fuel tanks are full, is itself a bomb. Later we were also told that they had planned to use

crop dusting airplanes to discharge airborne poisons. Whatever the details, it was apparent that the attackers had used the same problem solving strategies that Karl DUNCKER had researched at the Psychological Institute in Berlin in the 1920s - and that they had made sinister, ruinous use of our susceptibility to functional fixedness.

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### *Zusammenfassung*

Karl DUNCKER (1903-1940), ein in Deutschland geborener Gestalt-Psychologe, gibt eines der Rätsel der Psychologie-Geschichte auf. Von seinen Lehrern am Berliner Psychologischen Institut als ihr vielversprechendster Schüler hochgeachtet entwickelte DUNCKER innovative Experimente zur "funktionalen Gebundenheit" und damit zusammenhängenden Aspekten des Problemlösens, setzte dann aber seinem Leben vorzeitig selbst ein Ende. Dieser Artikel arbeitet Ähnlichkeiten zwischen seinen Experimenten und den Problemlösungs-Methoden heraus, die auf dem Gebiet der Künste von Erneuerern wie Frank Lloyd WRIGHT, El LISSITZKY und Josef ALBERS entwickelt wurden.

### *Summary*

Karl DUNCKER (1903-1940), a German-born Gestalt psychologist, is an enigma in the history of psychology. Regarded by his teachers at the Berlin Psychological Institute as their finest student, he developed innovative experiments in "functional fixedness" and related aspects of problem solving, but then ended his life prematurely. This essay points out the resemblance between his experiments and the problem solving methods used by such artistic innovators as Frank Lloyd WRIGHT, El LISSITZKY, and Josef ALBERS.

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