Chapter 8

Action Regulation Across the Lifespan

Winfried Hacker[1], **Pierre Sachse**[2] **and Christian Seubert**[2]
[1]*Arbeitsgruppe Wissen Denken Handeln, Technische Universität Dresden, Dresden, Germany,*
[2]*Institut für Psychologie, Leopold-Franzens-Universität Innsbruck, Innsbruck, Austria*

A comprehensive metatheory of work and aging, especially on action regulation across the lifespan, the ARAL theory, was presented in 2016 by Zacher, Hacker, and Frese. This metatheory integrates action regulation theory with lifespan developmental theories. Based on this integration, a series of propositions was offered, that "constitutes a preliminary scaffolding of ARAL theory ... open to further development" (Zacher et al., 2016, p. 292).

This chapter aims at a more restricted goal. The first part sets forth specific features of mental regulation of actions in paid work of employees. The second part reports empirical results and key features of mental action regulation in paid work across the work lifespan, i.e., depending on or interacting with employee's age.

From a lifespan perspective, some authors (Moghimi, Zacher, Scheibe, & Van Yperen, 2017) frame Selection-Optimization-Compensation (SOC) strategies (Baltes, 1997) as macro-strategies of action regulation at work across the lifespan. While selection implies prioritization of goals, optimization denotes the acquisition and the use of resources, and compensation involves the substitution of a decline in resources by available resources (Müller & Weigl, 2015).

In paid work of employees, macro-strategies, such as the prioritization of different goals, will depend on the degrees of freedom (autonomy) and skill variety of the work orders to be accomplished. Autonomy, skill variety, and possibilities to acquire and apply resources, such as knowledge and skills, should lead to increased satisfaction and engagement across the lifespan (Truxillo, Cadiz, Rineer, Zaniboni, & Fraccaroli, 2012). However, these

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macro-strategies must be grounded in a foundation of more detailed procedures that regulate individual actions. Here, action regulation theory becomes important.

MENTAL REGULATION OF PAID WORK: ACTION REGULATION THEORY

Action regulation at paid work is the topic of several versions of action regulation theory (Frese & Sabini, 1985; Frese & Stewart, 1984; Frese, Stewart, & Hannover, 1987; Frese & Zapf, 1994; Hacker, 1973; 1985a, 1985b, 1985c, 1985d, 1986a, 1986b, 2001, 2003; Rasmussen, 1983; Volpert, 1980, 1987, 2003). This theory comprises a fundamental approach in industrial psychology to describe how people try to carry out a given work order. In paid work, managers or clients usually assign orders to employees, who then "redefine" work orders into their goals (Hackman, 1970). The outcome of this redefinition process strongly depends on employees' motivation and competencies.

It is worth noting that action regulation is a basic aspect of job content. As such, and in contrast to job context, it reflects essential features of modern work life only indirectly at best. As an example, the serious consequences of increasing job insecurity and time pressure across the work lifespan are better grasped from a perspective of job context than its content (Sverke, Hellgren, & Näswall, 2002).

Roots of Action Regulation Theory

Action regulation theory is both rooted in Russian (Galperin, 1966; Leontjew, 1979; Rubinstein, 1958) and Polish psychology (Tomaszewski, 1981), as well as in information processing psychology (esp. Miller, Galanter, & Pribram, 1960). Early contributions were made by Lewin (1926, 1952). On this basis, it describes the covert mental (i.e., cognitive, motivational, and emotional) regulation of actions as core units of working activities (e.g., Zacher & Frese, 2018).

Surface Versus Deep Structure of Actions

Mental action regulation consists of the covert "deep" structure behind the overt "surface" structure of actions, that is, the arrangement of psychological steps beneath perceptible physical steps. For example, a sentence spoken out loud constitutes the surface structure of a communicative action, whereas the development of the idea to be transferred, as well as the selection and arrangement of words into a meaningful sentence, is its covert regulating deep structure. Fig. 8.1 shows another example, where straight lines illustrate a virtual logical decomposition of the entire task into (sub-) goals. In

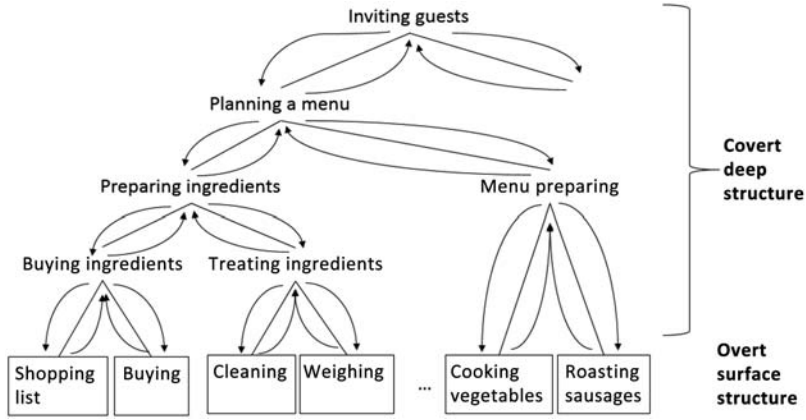

FIGURE 8.1 Mental action regulation describes the hierarchically organized covert deep structure of mental processes and representations (models) governing the overt sequential organization of physical steps.

contrast, bent lines show the actual paths of covert mental activity, which, after one step is finished, first returns to the superordinate task and, from there, on to the next step in the structure.

The entire work activity consists of a multitude of actions, each controlled by goals and sub-goals resulting from the worker's individual redefinition of the given work order. Therefore, the essential assumption of action regulation theory is: employees are active agents who develop, select, and pursue goals based on a mental model of the relevant sociotechnical working environment and of the necessary procedures and tools of goal achievement. Thus, the theory tries to answer the question of Miller et al. (1960, p. 13), "how actions are controlled by an organism's internal representation of its universe."

Components of Mental Action Regulation

Mental models encompass essential knowledge for action regulation; namely, goals and their sub-goals as well as mental representations of conditions and measures of goal achievement. As such, they enable actors mentally to test intended procedures (plans) before their physical execution. Cognitive, motivational, and emotional processes influence the development of mental models. Furthermore, long-term action-relevant personality traits, such as self-efficacy, may interact with these short-term mental processes and representations.

Related Cognitive Theories

There are similarities and overlaps of key concepts with other cognitive theories, especially with expectancy theory (Vroom, 1964), social cognitive

theory (Bandura, 2001), goal-setting theory (Locke & Latham, 1990), and self-determination theory (Ryan & Deci, 2000). However, important differences derive from some unique characteristics of paid work of employees.

Specific Features of Paid Work

The specific features of paid work of employees are:

- Employees carry out given work orders that are internalized (Galperin, 1966) and redefined (Hackman, 1970) into the person's goals.
- Satisfaction of psychological needs (motives) in paid work is mediated twice, first by the resulting outcome, and second by the wages and their purchasing power, a specific form of instrumentality (Vroom, 1964).
- While most needs cannot be satisfied through paid work on a regular basis, goals take the role of "quasi-needs" (Lewin, 1926, 1952) and stimulate goal achievement similar to actual needs, for example, for food.
- Since the internalization of given work orders into self-set goals may succeed only partly and obstacles are the rule, will power is essential in the execution of paid work of employees. Miller et al. (1960, p. 71) stressed the role of mental self-talk to evoke will power during action regulation (Senay, Albarracín, & Noguchi, 2010).

Consequently, the application of concepts and models concerning self-selected leisure-time tasks in cognitive psychology (e.g., Gollwitzer, 1999; Prinz, 2000) on paid work of employees needs some caution and reservation.

Moreover, paid work in organizations—as contrasted with domestic work or experimentation with students—requires considering technological and organizational determinants of mental regulation. These determinants encompass:

- the physical, economic, social, or biological functioning of technologies, tools, and materials, of which employees need to be aware;
- the allocation of functions among robots, machines, or software systems and employees (automatization, digitalization); and
- the division of labor among employees in organizations, possibly resulting in partialized tasks.

These determinants influence task identity, learning requirements at work as well as the degrees of freedom of employees to exercise control over their activity and, thus, their objective possibilities of personal development across the work lifespan (Martin & Zimprich, 2005).

It follows that action regulation across the work lifespan depends on the characteristics of job design, more precisely, on the design of the jobs that employees choose and hold across their work lifespan. International standards, especially ISO 6385 (International Organization for Standardization

[ISO], 2016), describe the characteristics of well-designed jobs that support mental development and health of employees.

Redefinition of Work Orders into Goals

As mentioned above, given work orders are internalized (Galperin, 1966) and, thus, redefined into tasks with their respective goals that may guide action regulation. The process of redefinition comprises (Hackman, 1970):

- recognition of the order;
- readiness actually to interpret and implement the order as it is meant;
- personal assessment of the work order as to
  - employee's level of aspiration (Lewin, Dembo, Festinger, & Sears, 1944); and
  - employee's needs and values.

Consequently, with changing needs, values, or competencies across the work lifespan, the redefinition of work orders into action-regulating goals may vary, too.

Five Functions of Goals in Action Regulation at Work

Mental action regulation includes several components. Of main importance are representations of the intended result (the goal), representations of the procedures of goal attainment (the plans, according to Miller et al., 1960), and representations of the conditions (materials, tools, time slots, etc.) to be considered.

The key component are goals. Work goals comprise both the anticipation of the result and, simultaneously, the intention to implement this result. As such, goals bridge the assumed gap between cognition and motivation.

On the one hand, goals are anticipations of the required work outcome. This anticipation of the result is necessary to govern the implementation and process feedback, i.e., continuously to compare the actual with the intended result (Von Helmholtz, 1856). The more precisely this anticipation is elaborated, the better the result and the efficiency of the procedures. Anticipation enables feedforward processing, i.e., testing an intended procedure before its physical implementation. For dangerous tasks, precise anticipative tests are inevitable.

On the other hand, goals are intentions to implement the anticipated outcome. However, in order actually to implement the goal, it is to be complemented by an 'implementation intention' (Gollwitzer, 1999), as was conceptualized in the Rubicon model (Heckhausen, 1987; cf. Chapter 5 of this volume). The function of an implementation intention is to explicitly define the how, where, and when of the implementation of an anticipated result.

In most cases, goals are decomposed into a series of smaller sub-goals (cf. Fig. 8.1). Together with the necessary tools and measures of implementation, this goal/sub-goals hierarchy constitutes a plan of action.

Moreover, goals are starting points of action-regulating emotions. Goal accomplishment is frequently associated with "positive" emotions, such as the experience of success and pride. Failure to reach a goal, on the other hand, is associated with "negative" emotions, most frequently with more or less paralyzing disappointment (Zhu & Thagard, 2002).

Furthermore, action goals are the essential content of prospective memory and thereby govern implementation and enable feedback. Disremembered goals will interrupt action (Einstein & McDaniel, 1996). Last but not least, repeated goal achievement or failure to reach a goal may even affect personality traits, for example, self-efficacy.

Sequential-Hierarchical Organization of Action Regulation: Action Phases, Levels of Regulation

Mental action regulation is conceptualized to proceed in a "sequential-hierarchical way" (Volpert, 1987), that is, regulation may be described simultaneously as comprising a sequence of steps or phases as well as involving distinct levels (or modes) of regulating processes. The sequence of steps constitutes intermediate feedback loops with if-components (orientation, goal-setting, planning), then-components (execution of procedures, evaluation), and a final check of results. In reality, of course, actions do not consist of clear-cut sequential steps, but a continuous flow of information processing with the following phases (cf. Fig. 8.2):

1. Orientation. There is an external (environment-based) and an internal (memory-based) orientation on the work order and the conditions, means,

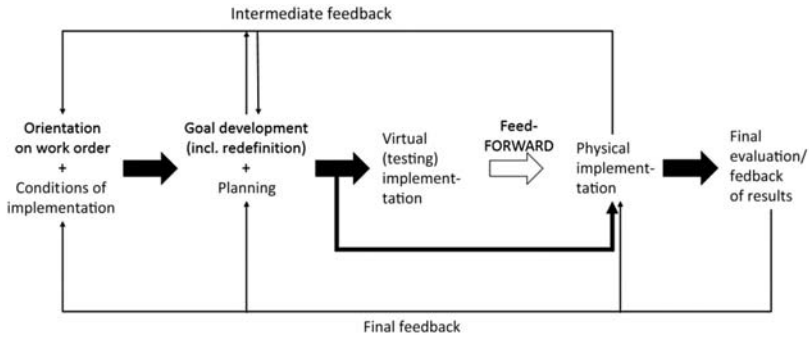

FIGURE 8.2 Mental action regulation is sequentially organized in feedback loops (final and intermediate) and possibly includes feedforward (*white arrow*).

and partners of its implementation. For example, employees check whether a completely new or a well-known work order is given.

2. Goal development and planning. Next, the work order will be redefined into the employee's goal. In the employee mentally preparing for action, the goal is combined with a suitable strategy of goal implementation. For this reason, a goal/sub-goal chain is to be developed or retrieved with its operations, materials, means, and necessary cooperation partners. Across the work lifespan, the ratios of memory retrieval of well-tried action plans vs. time-consuming mental design and testing of new plans may change. This, however, depends also on the dynamics of available technologies that may relieve cognitive load.
3. Implementation. Step by step, the action plan is executed and adapted, narrowed, or redefined as necessary. Due to the resulting memory load and the increasing limitation of prospective memory capacity across work lifespan, sophisticated planning in advance will be avoided in favor of planning while doing. Coarse-grained planning in advance of necessary actions is applied roughly to control the future course of activity. In addition, detailed planning while doing may reduce feedback-based corrections at the very end due to changing conditions.
4. Evaluation and final feedback processing. The obtained outcome is compared with the anticipated outcome (i.e., the anticipation of the desired result, the goal). For this reason, the goal must be stored in prospective memory for the entire procedure. As a final step, the executed procedure (the plan) may be checked with regard to efficiency and effectiveness, thereby allowing for learning. Across the work lifespan, the utilization of this possibility might vary, depending on the novelty of the plan and motivation, among other factors.

In the next sections, the planning process of the second phase (goal-development and planning) will be explained in more detail.

Action Planning

Action planning comprises of the design, selection, or retrieval of a suitable strategy for goal implementation as well as the deduction of an effective sequence of sub-goals, their implementation operations and of effective means.

The planning process may be carried out cognitively, based on a mental model of different sequences of operations that are compared in order to identify one that is effective, or ,by utilizing external aids, such as paper and pencil or computers (Neubert, 1968; Skell, 1968, 1972).

The resulting plans, thus, are more than goals. They include procedures, more or less optimized sequences of operations, and means (Pascha, Schöppe, & Hacker, 2001). Depending on the complexity of the given work order and the existing degrees of freedom within the respective technology,

plans differ in their complexity, and, thus, in the mental effort necessary to develop them. A ranking of planning complexity (depending on the TBS [Tätigkeitsbewertungssystem/System of Task Assessment]; Hacker, Fritsche, Richter, & Iwanowa, 1995) comprises the following levels:

- Planning not possible or necessary.
- Planning of the sequence of operations only for sub-tasks of a work order.
- Planning of the style and sequence of sub-tasks of a work order.
- Planning of the entire strategy of implementation of a work order.

One of the gains of correct planning is the integration of preventive sub-tasks or operations which allow avoid failure avoidance and superfluous or time-consuming additional operations. An example is to shift the preparation of means or materials that might become necessary during task execution to the beginning of the task in order to avoid critical or time-consuming interruptions later on.

TOTE Units: Hierarchies of Recursive Loops

The sequential organization of mental action regulation in terms of feedback loops that may be broken down into smaller and smaller ones was generalized by Miller et al. (1960) as a hierarchy of recursive loops, the test−operate−test−exit units (TOTE). Superordinate units are hierarchically composed of smaller units, which are executed in the following manner: The goal is stored for means of comparison (test) and the results of its execution (operate) are compared with the stored goal (test); if the result of the operation/ execution fits with the goal, further goals or sub-goals are activated (exit).

Hierarchy of Levels (Modes) of Regulation

The concept of a hierarchical organization of mental action regulation is of high impact, especially in industrial psychology and ergonomics (Frese et al., 1987; Hacker, 1973; Rasmussen, 1983, 1986; Roe, 1999; Volpert, 1980, 1987, 2003). The concept of levels of mental information processing encompasses both the if-components (orientation; goal-setting) and the then-components (procedures to be executed; plans) of action regulation. The levels (or modes) of these if−then−units differ in the complexity of the involved mental processes and knowledge systems as well as in their degrees of automaticity. Metaphorically spoken, "higher," superordinate levels, control "lower" levels with their sub-goals and operations in order to achieve the superordinate goal.

More precisely, mental action regulation is not actually organized hierarchically, but heterarchically (Von Cranach, Kalbermatten, Indermühle, & Gugler, 1980) because of interactions between levels and of bottom-up

effects along with the top-down effects. Actions regulated on "lower" levels may lead to changes in the if- and then-components of the superordinate "higher" level. In addition, "low"-level processes may be initiated autonomously without the involvement of the superior level or mode.

The distinction between levels and, thus, the number of levels of the hierarchically organized mental action regulation at work mainly depends on authors' preferences of information processing theories. For example, Shiffrin and Geisler (1973) proposed a model of solely automated vs. controlled processes of action regulation. Fig. 8.3 illustrates another possible stepwise subdivision. In industrial psychology, models with few main modes but open to further differentiation proved helpful for practical reasons. For most problems of industrial psychology, the relevant levels are the automatic, the knowledge-based, and the thinking-based or intellectual level.

Figure 8.4 illustrates the discussed nesting of "lower" within "higher" levels of hierarchically organized mental action regulation.

Current research revealed that the criterion of consciousness offers only a small contribution to a clear-cut distinction between modes of mental action regulation: "...at least for adults, every fundamental, basic-level cognitive function that we can perform consciously, we can also perform non-consciously" (Hassin, 2014, p. 12). Stanovich and West (2000) and Kahneman (2011) elaborated upon this distinction, hypothesizing a fast, intuitive, and unconscious "system 1" and a slow, rational, and deliberate "system 2."

The dichotomy of deliberate rational and intuitive mental action regulation raises the question of long-term interrelations between these regulation modes across the work lifespan (e.g., flexibility of modes, permeability between modes) in contrast to short-term shifts between modes due to knowledge acquisition and mental automatization.

As mentioned before, the automatic, the knowledge-based, and the intellectual mode of action regulation (cf. Fig. 8.3) are of main practical interest here. Intellectual regulation includes, makes use of, and governs explicit and

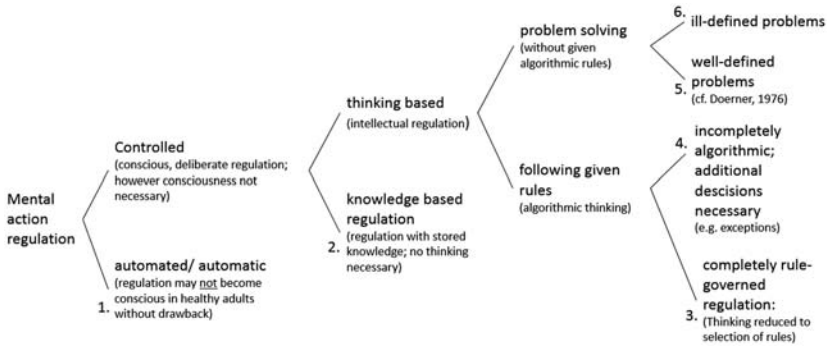

FIGURE 8.3 Hierarchically organized "levels" (modes) of mental action regulation: 'Higher' levels include, control, and apply "subordinate" levels.

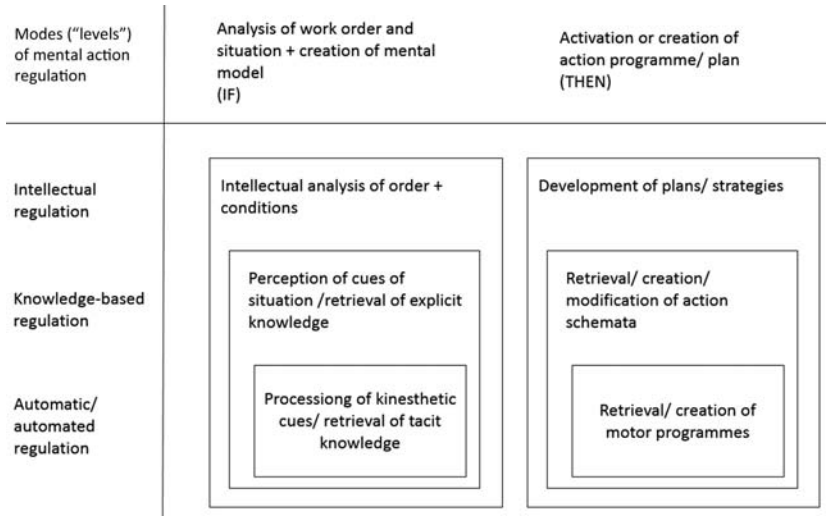

FIGURE 8.4 Hierarchical (heterarchical) organization of mental action regulation: The more comprehensive ("higher") levels (modes) incorporate the less comprehensive ones and may make use of them (Hacker & Sachse, 2014).

implicit knowledge-based regulation as well as automatic and automated procedures. While executing a task, people may shift from one mode to another. "Well-known parts are typically handled at a lower level, while new or unexpected parts (e.g., interruptions) call for regulation at a higher level" (Roe, 1999, p. 242).

This generic model of sequential–hierarchical organization of mental action regulation at work is adaptable to specific types of jobs, especially for innovative design problem solving of engineers or for interactive jobs, for example, of teachers or salespersons (see below).

Complete Versus Fragmented Work Orders and Tasks

Work orders and the resulting tasks and actions differ in the completeness of their sequential phases and hierarchical levels: Complete work orders require "whole pieces of work" (ISO 6385; ISO, 2016) and comprise all phases and levels, while fragmented work orders contain only some of them (Volpert, 1980).

Sequentially complete tasks comprise, in addition to mere execution, preparation (goal-setting and planning) and feedback processing, thus enabling self-directed correction and learning. Moreover, such sequentially complete tasks require mental regulation on different and alternating hierarchical levels. In contrast, fragmented tasks require regulation on fewer levels and, if automatized by routinization, may reduce mental regulation to the "lowest" level.

Complete Work Orders: A Normative Concept With Consequences Across the Lifespan

Based on empirical research, international standards on work design (e.g., ISO 6385; ISO, 2016) demand complete work orders and tasks. Complete tasks should require the worker to apply problem solving, decision making, self-control, and assume responsibility for results. Such tasks, thereby, stimulate intrinsic work motivation and learning, often provide social support due to cooperation requirements, and improve self-reported well-being and mental health (Hackman & Oldham, 1980; Rau & Triemer, 2004; Volpert, 1980; Wieland, Klemens, Scherer, & Timm, 2004).

As regards action regulation across the work lifespan, the approach of complete vs. fragmented work orders is of special interest. From its beginnings in the last century, research into long-term effects of work on personality and health nowadays not only considers job context (e.g., the long-term exposition to carbon monoxide in some branches; Ries & Sauer, 1991) but also job content (e.g., mental work requirements). As mental requirements are more comprehensive for complete than fragmented work orders, this gives rise to the distinction between human made and biological aging (Ries & Sauer, 1991; Warr, 1993); after all, work orders are designed by humans. Several studies report significant relationships between mentally enriched environments at work across the work lifespan and both dementia of retired persons (Then et al., 2013, 2014b, 2017) and better cognitive functioning in old age (Then et al., 2014a, 2015). Conversely, Baltes and Kindermann (1985) reported increasing mental deficits through situations that decelerate intelligence. Already in 1973, Schleicher measured the differing decline of fluid intelligence with age for employees with high-, medium-, and low-demanding work orders and the appropriate occupational education. As expected, the decline with age is highest with lowest mental requirements on the job and the lowest occupational education. Again, job design or redesign—ideally in a participatory change process—as well as job crafting turn out to be of central importance on employees' action regulation across the work lifespan.

The essential psychological line of argument here is that employees' job design or crafting activities not only change the objective mental regulation requirements of their immediate tasks, but in the long run will simultaneously alter aspects of their personalities, for example, by their learning to cope with new requirements. The social aspect of engaging and participating in job design, or the lack of this aspect in case of renunciation to do so, will affect personal development, too. Only mentally demanding learning on the job maintains learning capacity across the work lifespan (Park et al., 2014).

Employees' job crafting is a mechanism to change and adapt the requirements of action regulation across the work lifespan. Job crafting (Tims & Bakker, 2010) is a model of individual job redesign, according to which

employees change their job demands and resources and, thus, their conditions of self-development at work. In this context, SOC strategies (Baltes & Rudolph, 2012) may be seen as an example of job crafting.

Specific Types of Mental Action Regulation at Work I: Innovative Tasks

At least two types of common work orders exhibit specific characteristics of mental action regulation: interactive work in the service sector and innovative design problem solving.

The special features of innovative tasks arise from the features of design problem solving (Caroll, Miller, Thomas, & Friedman, 1980; Hacker, 2002; Sachse & Specker, 1999) in designing artefacts like machines, software programs, or technologies. In these cases, the work order only prescribes a broad frame that circumscribes a desideratum to be filled by the innovation in question, rather than a well-defined goal. For example, if a drug against a special type of cancer is desired, both the features of the drug are largely unknown as well as the process of its identification and design.

In such situations, applying a goal-directed, stepwise sequential-hierarchical procedure is impossible: since the result is unknown or only a vague hypothesis, a tangible goal cannot be anticipated and decomposed into sub-goals.

Therefore, a hybrid procedure of alternating opportunistic and systematic episodes (Visser, 1994) arises. This is neither a trial-and-error procedure or muddling through, nor a systematic decomposition of the work order into parts and sub-goals. Instead, people apply a strategy based on hypotheses and assumptions (Hillier, Musgrove, & O'Sullivan, 1984), thereby exploring relevant conditions and corresponding partial goals.

This procedure is organized in feedback loops composed of generation–evaluation units, forming an iterative sequence of generating and adjusting steps, i.e., a process of continuous error correction (Smith & Browne, 1993). By 'mental wandering,' people become aware of ill-defined associations based on their knowledge of former solutions of other problems, which they perceive as an opportunity to test their fit on the current problem. This is knowledge-based reasoning. The steps of application and testing of knowledge-based opportunities alternate with episodes of systematic decomposition of partial goals, once these are identified. The partial results finally accumulate in an entire solution (Task-Episode-Accumulation [TEA] model; Ullman, Dietterich, & Stauffer, 1988). Some of these steps may be intuitive contributions of "system 1" (Kahneman, 2011).

Fig. 8.5 contrasts the strict sequential-hierarchical mode of rule-based work orders (above) with the opportunistic mode of innovative design problem solving (below).

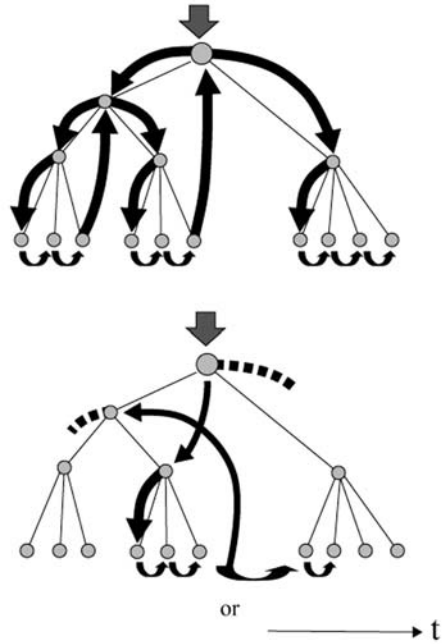

FIGURE 8.5 Versions of sequential-hierarchical organization of mental work regulation: Decomposition of a well-defined goal of rule-governed work orders (upper graph) versus an "opportunistic procedure with systematic episodes" (Visser, 1994) if the specific characteristics of the goal are unknown (lower graph).

As this mode of mental action regulation depends on opportunities, that is, on rich experience in a problem area, its efficiency across the work lifespan might correspond with prerequisites to apply professional experience across work life. Apart from personal experience, reflecting on their procedures proved helpful for employees in design problem solving jobs to improve outcome quality (Wetzstein & Hacker, 2004a, 2004b).

For employees in creative design problem solving jobs, the normative approach of complete tasks may require a certain degree of rule-based or even automated sub-tasks with sensorimotor regulation in order to balance mental requirements in favor of employees' long-term well-being and health.

Specific Types of Mental Action Regulation at Work II: Interactive Tasks

Interactive tasks imply tasks with clients, for example students or patients. A generic aspect of interactive work orders is to exert influence on clients' mental regulation of their behavior, that is, their goals and mental action regulation. Thus, an abstract model of mental regulation here consists of two

interacting TOTE units, where the goal of the service provider is to influence clients' intentions.

The main instruments of interactive work, especially in human services, are speech and—to a lesser extent—emotions. A more-or-less conscious goal of the service provider is to develop helpful emotions in the client (e.g., trust) and, for this reason, to produce, or at least to show, helpful emotions and expressions (e.g., friendliness) on his part. The well-known slogan 'service with a smile' may serve as an illustrative example (cf. Chapter 23 of this volume).

The specific challenge here is to find a sustainable balance of empathic devotion and professional detachment (Lampert & Glaser, 2016) across the work lifespan in order to avoid negative consequences, such as emotional exhaustion, the core component of burnout (Bakker & Demerouti, 2007).

Another distinctive feature of interactive work in human services is grounded in the rather unpredictable dialogic structure of mental action regulation, which limits planning in advance in favor of planning while doing or intuitive heuristics, gut feelings, and gut decisions (Gigerenzer, 2007). Therefore, mental action regulation of interactive tasks requires a system of goals, including the expression of emotions as an instrument. Since strict sequential-hierarchical processing will be impossible, mental action regulation will develop in the course of the interaction with the client, that is, while doing. Generic plans must be adapted continuously to clients' reactions.

The normative approach of complete tasks should be adapted for interactive work as well. Interactive tasks may require a certain degree of monological sub-tasks, for example, preparation of teachers' lessons or administrative assignments for clinicians. In so doing, complete interactive tasks balance object-oriented or monologic as well as person-oriented or dialogic sub-tasks.

Concerning the lifespan perspective, research suggests that emotion regulation skills improve with age (Charles & Carstensen, 2010; Doerwald, Scheibe, Zacher, & Van Yperen, 2016; cf. Chapter 6 of this volume). However, studies have also shown that age may be associated with greater vulnerability to emotionally distressing situations (Charles & Luong, 2013). Therefore, because of the inherent and possibly distressing emotional components of interactive work, it may be reasonable to offer supervision as an integral component of complete tasks in order to ensure workability across the lifespan.

Participative Job Design

All in all, considered from a macro-perspective, action regulation at paid work across the work lifespan amounts to a dichotomy:

Either employees proactively participate in job design or redesign and/or engage in job crafting in order to design the conditions of their mental

development (with respect to their biological aging, among other things)—or they refrain from designing the conditions of their personal development, thereby possibly accepting human-made aging. As Goethe (1966) formulated, people are to decide whether they intend to be hammer or anvil. Rudolph and Baltes (2017) stressed the role of such activities for age and health. Participation in work design is integrated in both national legislation and international standards. For example, ISO 6385 calls for an "effective and efficient integration of employees into work design" (ISO, 2016, p. 10; translation by the authors). Convincing arguments for the positive effects of enriched work environments were offered, for instance, by Then et al. (2013, 2014b).

Paid work, thus, turns out to be a means for designing the conditions of employees' personality (self) development. The disastrous effects of long-term unemployment on health and personality stresses the significance of this approach (Frese & Mohr, 1978; Jahoda, Lazarsfeld, & Zeisel, 1975).

Participation in work (re-) design or job crafting, i.e., engaging in proactive behaviors, should aim at ergonomically optimized procedures and especially at job enrichment to produce mentally demanding tasks with sustainable potential for learning by doing and with peers (Kooij, 2015). These aims are well within reach of the "design for all" approach, that is, to design tasks that are suitable for younger as well as older employees by offering degrees of freedom as to personal modes of functioning (e.g., use of SOC strategies). Extending this approach, work design models increasingly consider trends toward individualization (interindividual perspective; Schaufeli & Taris, 2014) and also for the changing needs of individuals across their lifespan (intraindividual perspective; Schlick, Frieling, & Wegge, 2013).

MENTAL ACTION REGULATION OF PAID WORK ACROSS THE WORK LIFESPAN

The span of paid work life roughly includes a period from 20 to 65 years of age. Significant differences in mental action regulation may be expected during the beginning and the end of the work lifespan, i.e., between younger (about 20−35) and older employees (about 50−65).

Obviously, these groups of jobholders differ not only in age, but also in aspects unique to a specific birth cohort, their tenure and work biography, job-related experiences, as well as the topicality of their education and professional training (including their familiarity with new information and communication technologies, that is, digital natives vs. immigrants).

In general, age relates negatively to fluid intelligence but positively to crystallized intelligence (cf. Chapter 2 of this volume). Speed of information reception and processing is slowing and there is a decline in controlled mental processing resources (loosely speaking, in "mental" or "working

memory" capacity). Moreover, the variability of mental processes and performance differences among people increases with age.

The decline in controlled mental processing resources along with slowing of information processing is due to an age-related decline in the efficiency of inhibitory processes. Thus, less irrelevant information is suppressed and affects processing. However, in real-life situations, older adults will compensate for this distraction by changes in cognitive style, relying more strongly on content-dependent resources, such as immediate environments, to assist mental action regulation (Hasher & Zacks, 1988; Horn, 1962; Schaie, 1980).

In spite of a factual cognitive decline, empirical research speaks against the assumption of a general association between age and performance but assumes a number of moderators instead (Hansson, Dekoekkoek, Neece, & Patterson, 1997; McEvoy & Cascio, 1989; Ng & Feldman, 2008; Waldman & Avolio, 1986). Park (1994) suggests four explanations for this nonfinding:

- Older adults are familiar with their jobs and thus require fewer cognitive resources to perform;
- Cognitive resources used in work by older adults are resistant to decline due to extensive practice;
- Complex knowledge structures (crystallized intelligence) increase with age and compensate for declines in controlled mental processing capacities (fluid intelligence);
- Experience provides enhanced access to environmental support (such as people, external aids to cognition) that compensates for losses in fluid intelligence.

Regarding the effect of practice on the preservation of cognitive resources, longitudinal evidence speaks in favor of the use-it-or-lose-it hypothesis (Wang & Shi, 2015). However, research points toward another, less favorable insight, as Finkel, Andel, Gatz, and Pedersen (2009) demonstrated in a study that examined the relationship between complexity at work and trajectories of cognitive aging along the pre- and postretirement phase. While participants facing high complexity in person-oriented work showed a greater improvement in verbal skills until retirement than participants facing low complexity in person-oriented work, they also showed a greater rate of decline on spatial ability after retirement. Furthermore, processing speed showed an accelerated decline after retirement compared to the time until retirement in both groups (high and low complexity in person-oriented work). No differences were found for high versus low complexity in data-oriented work. Beyond the explanation of a lack of continued practice, this detrimental effect may also relate to a decrease of expertise and the loss of environmental support after retirement to help compensate for cognitive decline.

Beside real-world environments at work or other life domains, engaging in simulated or virtual environments, enabled by current information and

communication technology (ICT), may exert beneficial effects on adults regardless of age. As concerns older adults, for example, digital gameplay has been found to enhance older participants' memory and reasoning performance (Basak, Boot, Voss, & Kramer, 2008) and well-being (Allaire et al., 2013), and partaking in digital social networking activities may help older adults overcome social isolation and associated poorer health outcomes (Charness & Boot, 2015).

Apart from physical and cognitive changes, age-related differences concern other domains, too, such as (Rietzschel, Zacher, & Stroebe, 2016; Truxillo, Cadiz, & Hammer, 2015; Zacher, 2015):

- personality (increase in conscientiousness and agreeableness, decrease in neuroticism and openness, increase in self-efficacy; cf. Chapter 3 of this volume),
- affect (improved emotion regulation, focus on positive emotional cues, greater vulnerability to emotionally distressing situations; cf. Chapter 6 of this volume),
- motivation (increase in intrinsic motives and generativity, decrease in extrinsic and growth motives; cf. Chapter 20 of this volume), and
- self-regulation (increase use of self-regulation strategies, particularly SOC; cf. Chapter 4 of this volume).

Thus, the question is whether or not these age-dependent changes in general mental processing and other domains will affect the outlined components of mental action regulation at paid work, too.

To answer this question, empirical studies are necessary that should meet some characteristics of design. Ideally, longitudinal studies with employees who carry out work orders that are identical in their mental regulation requirements would allow control of the manifold confounders in job content and job context as well as in employee's personal characteristics.

Otherwise, cross-sectional studies with comparable groups of younger and older employees who carry out identical work orders under comparable working conditions may provide valuable insights. Age groups should be comparable at least with regard to professional training, job tenure, general health, and, possibly, gender. Sample sizes should allow for comparisons of differences in features of mental action regulation among and within age groups, considering the assumed increasing processing variability with age. The necessity to compare work orders with identical mental requirements might reduce involved sectors.

However, while cross-sectional studies largely assume that age differences arise due to age-graded changes over time (Zacher, 2015), cohort effects are easily neglected, thus justifying a warning: "Cross-sectional age differences involve primarily generational rather than ontogenetic change components" (Schaie & Labouvie-Vief, 1974; p. 305).

We searched for relevant literature in the PsycINFO and PSYNDEX databases. Our basic search strategy comprised combining terms that indicate work-related research (e.g., job, work occupation) as well as terms that indicate age-related research (e.g., age, lifespan, junior, senior, young, old) with both the global term 'action regulation' as well as related constructs (e.g., action preparation, planning, goal-setting, routinization, feedback processing, cooperation). Truncations, wildcards, and boolean operators were applied accordingly. From an initial scanning of the results, a list of stop terms (i.e., terms indicating unrelated fields of research such as cancer or schizophrenia) was generated to sort out irrelevant studies. Furthermore, terms were added further to specify the search regarding topic (e.g., retirement) or study design (e.g., longitudinal). Despite an extensive literature search, empirical studies on the topic of action regulation relating to age were found to be generally scarce and rarely explicitly drew upon specific components of action regulation. Therefore, we broadened our search focus to studies that overlapped in topic but that were not necessarily guided by any version of action regulation theory.

Mental Action Regulation Across the Work Lifespan in its Entirety

A number of studies on mental regulation of work across the work lifespan do not analyze separate components of regulation (e.g., goal-setting, planning, or feedback processing), but the entire regulation of working tasks and jobs.

One of the rare longitudinal studies (Richter, Schmidt-Lerm, & Krenkel, 1996) analyzed the mental task demands of employees in manufacturing and administration ($n = 100$; 69 male, 31 female) five years before their statutory retirement age and just at this age (reduced $n = 72$). The participants were asked about perceived job demands and their plans for the period of retirement. Objective and self-reported job content (mental demands) significantly corresponded with the complexity of these plans. However, this effect completely disappeared after intelligence was accounted for.

Bergmann (1996) analyzed self-reported job demands that corresponded with possibilities of learning on the job. She applied items of the well-established System of Task Assessment (Tätigkeitsbewertungssystem, TBS; Hacker et al., 1995; a computerized version of TBS is known as REBA; Richter, Debitz, & Pohlandt, 2009). The job requirements (TBS items) considered were:

- Task completeness vs. fragmentation,
- Possibilities to develop action programs,
- Possibilities of (social) learning by exchange of experiences,

- Transparency of work order and of the conditions of its implementation,
- Control,
- Type of mental demands (algorithmic/ rule-governed vs. problem solving), and
- Possibility to apply acquired knowledge and skills.

Older employees (50 +) were asked for a retrospective description of their job demands in the first and the last half of their professional biography (independent variable) and their wishes regarding the job demands for the remaining professional period (dependent variable).

Complexity of reported demands on mental action regulation was increasing insignificantly across the work lifespan. However, there was a significant positive relationship between the complexity of mental demands in the professional biography so far and employees' wishes for demanding mental requirements in the remaining period—in spite of a decreasing future time perspective (Bal, De Lange, Zacher, & Van der Heijden, 2013). The author interprets the results in terms of maintaining mental competencies of older employees by continuous mental training at work.

Analogously, Richter (2010) found a significantly higher impact of job control (learning opportunities) on maintenance of employees' professional competencies across the work lifespan than of job demands (work intensity). The results of Schaie (2005) and Frieling, Müller, Bernard, and Bigalk (2006) confirm that task characteristics that promote learning (e.g., task completeness, task variety, control, feedback) significantly correspond with high competencies of the jobholders.

These results are in line with a systematic review of Then et al. (2014b) that found evidence for the protective effect of high job control and high work complexity against the risk of cognitive decline and dementia. Zacher (2015) reported studies with similar results.

The results of Bergmann (1996) stressed the point that high mental work demands are not suffered, but may even be desired by employees. Ulbricht and Sachse (2010) found comparable data for older people with respect to daily living beyond work life.

Modern studies in neurogenesis and learning may offer explanations (e.g., Weddel & Shors, 2008): Even healthy older people up to 65 may develop new neurons in relevant parts of the brain (e.g., hippocampus). However, only difficult and demanding learning directed toward new topics will keep these new neurons alive, whereas some training will not suffice. Unfortunately, there is empirical evidence that older workers are less willing to participate in formal training and career development activities (Ng & Feldman, 2008, 2014; cf. Chapters 10 and 13 of this volume). Social learning on the job might be a way out.

A meta-analysis of Ng & Feldman (2008, 2014) and a survey study of Zacher, Degner, Seevaldt, Frese, and Lüdde (2009), who found that older

employees contribute more than younger employees to organizational citizenship behavior, offers another argument for macro-changes occurring in mental regulation of paid work across the work lifespan. The finding may reflect age-related shifts in contents of self-set goals—job control provided (Zacher, Heusner, Schmitz, Zwierzanska, & Frese, 2010)—and in strategies (Weigl, Müller, Hornung, Zacher, & Angerer, 2013).

Similarly, some studies report on age-related differential effects of task characteristics, for example of task variety, on burnout and turnover intentions, depending on age-dependent differences in employees' preferred goals (knowledge-acquisition goals of younger employees vs. present-oriented goals of older employees; Kanfer, Beier, & Ackerman, 2013; Zaniboni, Truxillo, & Fraccaroli, 2013).

As mentioned earlier, SOC strategies may be seen as macro-strategies of action regulation at work across the lifespan. A number of studies reveal insights into the complex interplay of SOC with age. Moghimi et al. (2017) reviewed the literature concerning the association of age and SOC strategy use. In their meta-analysis, they found a weak positive correlation between age and SOC strategy use. Rudolph and Baltes (2017) report findings from two longitudinal studies on moderators of the relationship between flexible work arrangements (as a form of SOC strategy use) and work engagement and found younger age to enhance this relationship. Abraham and Hansson (1995) showed that specific SOC strategies were positively related to measures of performance maintenance and goal attainment, respectively, and that these associations increased with age. A study by Zacher and Frese (2011) reported that while age related negatively to perceived opportunities at work, this effect was mitigated for both employees in low-complexity jobs with high use of SOC strategies and employees in high-complexity jobs compared to employees in low-complexity jobs with low use of SOC strategies. Müller et al. (2013) reported a positive association of SOC strategy use and work ability, which was stronger for older compared to younger nurses. Weigl et al. (2013) found a negative relationship between age and work ability that was weakened under conditions of high job control and high SOC strategy use. Teshale and Lachman (2016) found the positive relationship between daily SOC usage and happiness to be strongest in middle-aged and older adults compared to younger adults. In summary, these studies highlight the beneficial impact of SOC strategies on a number of work-related outcomes, conditional on age and crucial task features, such as job control and job complexity.

We did not find empirical studies that investigated other action-relevant, micro-genetic questions concerning the development of action goals by redefinition of given work orders, the role of goals as anticipations of desired results, the division of these anticipations into chains of sub-goals, or the function of goals as "quasi-needs."

Components of Mental Regulation Across the Work Lifespan

Action Preparation: Orientation, Goal-Setting, Planning

What are the specific questions about action preparation, especially goal-setting and planning, in paid work across the lifespan? First, in paid work, employees may not develop self-set goals as they like; instead, they are to internalize given work orders into goals in accordance with their employment contracts. Thus, the widely analyzed selection of goal content—an aspect of mental action regulation—across the lifespan is only of minor relevance in paid work. In lieu thereof, the varying manners of redefining work orders across the work lifespan as well as aspects of job crafting become main questions.

Furthermore, goal implementation, planning, and feedback in paid work are governed by laws (e.g., of economy, technology and, thus, physics or biology) and the logic of the applied means (e.g., the proper use of a word processor to write an article). To recognize, comprehend, and to take advantage of these laws and logics in mental action regulation represents a challenge for employees. This competence may vary across the work lifespan depending on age-related experience, education (cf. digital natives vs. immigrants), and mental processing capacity.

Moreover, the validity range of the planning fallacy (Kahneman & Tversky, 1979) is of interest in mental action regulation at work. "Planning fallacy" refers to the optimistic underestimation of the time for completion of a task. The effect is well-known for large projects and for experimentation with students. The question here is whether this effect will also show in employees' daily paid work, and whether there are changes across the work lifespan.

Additionally, changes across the work lifespan may occur in the proportions of retrieval of established strategies versus the development of new strategies through problem solving, as well as of the identification of conditions in the external work process vs. their retrieval from internal memory.

Analogously, the design of an optimal sequence of sub-goals and operations might differ between younger and older employees, depending on their differing physical and mental resources. Likewise, the perception of the gains of proactive planning might vary across the work lifespan, too. A case study that examined younger and older workers in an automobile manufacturing plant may serve to illustrate this (Gaudart, 2000). The author found that while younger workers alternated repeatedly between supply and assembly operations during a work cycle, older workers bundled supply operations at the beginning of the work cycle in order to minimize additional supply movements during assembly.

At last, in view of the changes regarding memory across the lifespan, the degree of externalization of information to be remembered during the work

process should vary across the work lifespan, too (cf. Galperin's externalizing/interiorization theory, 1966). In daily life, older people as well as experts more frequently produce external cues and aids to alleviate prospective memory and to guide their activity than younger people do. Most work tasks offer plenty of opportunities for externalizing and, thus, mental relief (Hacker & Herrmann, 1997; e.g., see Crawford, 2015).

The answers of research to these questions on mental action regulation of paid work across the work lifespan seem meagre so far: A number of studies analyzed action preparation, goal-setting, and planning, which are essential components of mental action regulation. However, only few of them dealt with the variability of these components at paid work across the work lifespan.

Several studies describe changes in the content of goals across the work lifespan. As expected, studies found out that younger employees tend to prefer growth-oriented goals, while older employees favor social, presence, and health-oriented goals at work (Huhtala, Feldt, Hyvönen, & Mauno, 2013; Nurmi, 1992; Penningroth & Scott, 2012; Tones, Pillay, & Kelly, 2010; Zacher et al., 2009). Latham and Locke (2007) suggested age as a moderator in the selection of performance vs. learning vs. behavioral goals. Grube and Hertel (2008), as well as Kliegel, Martin, McDaniel, and Phillips (2007), proposed—based on models of developmental psychology—that older employees restrict the number of their goals and focus their plans on familiar topics. Ebner, Freund, and Baltes (2006) presented a generic lifespan concept about goal orientation across adulthood, reporting "developmental changes in personal goal orientation from young to late adulthood: From striving for gains to maintenance and prevention of losses" (p. 664). Moreover, Kliegel et al. (2007) summarized empirical data, verifying that interindividual differences in planning performance exceed age-dependent differences. Similar findings were reported for prospective memory (Kliegel & Martin, 2003).

Some studies report on action styles as personality traits, referring to goal orientation and planfulness of goal implementation (Frese et al., 1987; Heisig, 1996). We interpret these styles as relatively stable personality traits that affect mental action regulation across work life. For example, the action style factor "intense persecution of aims" (Heisig, 1996) allows distinguishing among managers in small business with differing returns on investment (Kemter, Ben-Sassi, Klose, & McKenzie, 1998; McKenzie & Kemter, 1998, personal communication). However, successful training that follows the principle of continuous education may improve goal-setting and goal implementation across the work lifespan (Brandstätter, Heimbeck, Malzacher, & Frese, 2003; Landmann, Pöhnl, & Schmitz, 2005).

A study by Esposito, Gendolla, and Van der Linden (2014) examined the mediating effect of subjective task difficulty between self-efficacy beliefs and goal-directed behavior in healthy elderly people performing a memory task. The authors found that elderly people with low self-efficacy beliefs

assessed the task to be more difficult than people with high self-efficacy beliefs, which resulted in reduced goal-directed behavior in the first group. The authors explicitly aimed at assessing self-efficacy beliefs and not self-efficacy as a capacity. Consequently, they noted that older adults may be more likely to adopt negative self-efficacy beliefs due to negative stereotypes of aging in Western culture, which might explain withdrawal from goal-directed behavior as a form of stereotype threat. However, a possible compensatory use of external cues to alleviate memory load (i.e., taking notes) under real-world conditions was not considered in the study and may thus limit the generalizability of the results.

Apart from Gaudart's (2000) finding cited above, complemented by the observation that planning will depend on experience, which sometimes corresponds with increasing age (Skell, 1976), other changes in planning of daily work orders in paid work across the work lifespan are not reported to our knowledge.

All in all, the relevant empirical studies describe macro-phenomena beyond the implementation of work orders in paid work. Details concerning the process of goal-development and redefinition, or age-dependent preferences of planning while doing vs. planning in advance, the division of goals into sub-goals etc., are largely missing.

The crucial component of successful action regulation, the implementation intention (Gollwitzer, 1999; Inzlicht, Legault, & Teper, 2014) seems to be omitted in empirical research on action regulation at paid work across the work lifespan regarding its specific functions. Nevertheless, its characteristics should be mentioned at least:

- Decomposition of entire work orders and the respective goals into sub-goals;
- Development of the optimized sequence of the sub-goals and operations;
- If necessary, fixation of points in time for beginning and completion of sub-goals, and, thus, determination of the speed of work;
- Identification of conditions of implementation of the sub-goals and operations;
- Development or retrieval of strategies or technologies of implementation; and
- Development or retrieval of suitable means, materials, and necessary partners of (sub-) goal implementation.

Action Implementation: Levels of Regulation and Routinization

If aging corresponds with tenure in a job with low dynamics regarding mental demands, the repetition may go along with routinization. On one hand, routinization may shift the levels of regulation from intellectual processes to knowledge-based or automated skills (Welford, 1958). On the other hand, routinization may shift conscious intellectual processes or verbalizable

knowledge-based processes to unconscious processes; for example, the regulation through verbalizable knowledge into the regulation through tacit knowledge (Hassin, 2014). Empirical research into the consequences of routinization for mental action regulation at work is sparse.

Tournier, Mathey, and Postal (2012) compared younger participants ($M = 21$ years) with older participants ($M = 67$ years) in an experimental study and found that high routinization in daily life activities was associated with low cognitive flexibility in older adults. While older adults exhibited a decrease in cognitive measures (working memory, speed of processing, attention), no changes were observed in self-reported routinization.

In industrial settings, Ohly, Sonnentag, and Pluntke (2006) reported routinization to be related positively to proactive and creative behavior of employees due to additionally available cognitive resources. Age-dependent effects are not reported. Rietzschel et al. (2016) reviewed two meta-analyses and found no strong evidence for an association between age and creativity at work. However, drawing upon seven additional primary studies, they report some positive associations between age and creativity at work and label these interrelations to be "complex" (i.e., nonlinear and moderated by context or individual characteristics).

A shift in levels of regulation due to routinization may also help to avoid errors due to an overload of intellectual processing requirements. In an observational field study on ageing and errors in computer-based work, Birdi, Pennington, and Zapf (1997) drew upon action regulation theory in order to test the hypothesis that older workers would make more errors than young workers at the intellectual and sensorimotor level of regulation, but not at the intermediate level of flexible action patterns (terminology as used in the study), which is strongly shaped by routinization. After controlling for computer experience, older workers were found to make more errors at the intellectual level but not at the other levels. Cognitive work demands moderated this finding, with a stronger age-intellectual error relationship under high cognitive demands.

Concerning the age−error relationship, it is important to consider context and type of error. Elfering, Grebner, and De Tribolet-Hardy (2013) cite evidence that while age related positively to self-reported errors, higher age was found to be associated with a lower risk of commuting accidents. Similarly, Elfering, Grebner, and Ebener (2015) report a bivariate negative correlation between age and failure in action execution in health care nurses.

Moreover, with increasing age of employees, and, thus, restrictions in prospective memory, it may be hypothesized that action execution changes its structure. Planning in advance of younger employees may be neglected by older employees in favor of detailed planning while doing. This might even become advantageous if conditions are suddenly changing during execution. However, empirical evidence in paid work seems not to be reported so far.

Checking Own Procedures and Results: Feedback Processing in Action Regulation Across the Work Lifespan

The questions here do not revolve around managerial tactics of communicating performance feedback but employees' own processing of feedback from their procedures and results as prerequisite of learning or even of job crafting (Wang, Burlacu, Truxillo, James, & Yao, 2015). Feedback-based experience—to be distinguished from transferred knowledge—increases with extended possibilities to gain and apply experience. However, the capability for feedback-based learning and, albeit to a lesser degree, for generalization, may decline with age, as suggested by the results of an experimental study by Simon and Gluck (2013). However, the generalizability of experimental "testing the limits" conditions to real-world situations that rather require average long-term performance is unclear.

Since older adults have been shown to exhibit a preference for positive information, Van de Vijver, Ridderinkhof, and De Wit (2015) examined and confirmed the hypothesis that older adults benefit more from positive than negative feedback, albeit under conditions of large feedback magnitudes. Similarly, in an observational study by Birdi and Zapf (1997), older workers reported a stronger negative emotional response to an error during computer-based work than younger workers. In addition, following an error, older workers reported less likelihood than younger workers to solve the task on their own. However, the question remains whether this is to be considered a pure effect of age or whether generational influences play a role, too. Finally, in a time-production task (i.e., a task that required participants to react to a visual stimulus after a prespecified temporal lag) with feedback given to improve accuracy, older participants performed more poorly than young participants and older participants performed even worse after negative feedback (Wild-Wall, Willemssen, & Falkenstein, 2009). Overall, both younger and older participants benefited more from positive than from negative feedback.

Band and Kok (2000) reported a reduction of the rate of corrected errors with age in an experimental mental rotation task. Again, the results of such experimental "testing the limits" approaches may not correspond with the results of well-trained daily life activities, for example, professional jobs.

The role of meta-cognition, especially of reflection in addition to mere feedback processing, was tested experimentally by Anseel, Lievens, and Schollaert (2009). Reflection combined with feedback enhanced performance on a web-based work simulation better than feedback alone. The role of age was not reported.

Finally, the issue of feedforward in mental action regulation across the work lifespan seems to be neglected by empirical research so far. Therefore, the question "under which circumstances do workers apply planning as an instrument of mental testing and improving mentally developed procedures before their actual execution, and are there age differences?" must remain unanswered for now.

CONCLUSION

This contribution referred to a specific type of action regulation, i.e., the regulation of actions in paid work across the work lifespan, since most people are to execute paid work during an essential part of their lifespan. Neither the regulation of actions in experimental research, nor in the household or during leisure time were of interest here. "Work lifespan" designates the period of occupational work between the end of occupational training and retirement.

Longitudinal as well as cross-sectional evidence on action regulation in paid work across the work-lifespan is sparse so far. This is due to several reasons.

The relevance of some studies for action regulation in paid work seems to be limited. For example, peoples' goals changes across the lifespan is a widely researched topic. However, only few employees may choose the goals of their paid work as they like. Nevertheless, the approach of psychological contracts (idiosyncratic deals) will possibly be of more interest for further research on this topic.

However, the main reason are differing levels of research: Action regulation is a higher order approach in comparison to its components, like feedback or planning. There are only few studies on the level of entire action regulation (cf. Section 2.1), most consider the level of individual components of action (cf. Section 2.2). However, an entire system of action regulation is more than the sum of its components (e.g., feedback, planning). Consequently, the characteristics of mental action regulation as a system may qualitatively differ from those of its individual components. The main topic of our contribution, however, is the entire regulation of actions across the work-lifespan.

Thus, further research in the area of the entire mental action regulation in paid work across work-lifespan is necessary and may offer stimulating results, since paid work does have a decisive impact on most adults. Research efforts should combine approaches on the function of mental requirements and learning on the job for employability and health with approaches of mental action regulation and of mental development of adults.

So far, the most essential empirical findings emphasize the importance of mentally demanding job content (cf. ISO 6385; ISO, 2016) and, thus, of a mentally stimulating action regulation across work life, including learning requirements of a specific kind, that is, continuous, difficult learning on the job. These requirements contribute to long-term mental health even beyond the work lifespan.

In summary, the design or redesign of the demands for action regulation in paid work across the work lifespan turns out to be the key to mentally healthy aging. Such job design should implement the approach of "design for all," that is, for youngsters and seniors alike. Its main characteristic

should be autonomy or control, that is, degrees of freedom to develop individualized action strategies at paid work in accordance with employees' competencies. Concerning the work lifespan, SOC strategies are of pronounced importance. The present situation of fundamental shifts toward highly qualified work in ageing societies may provide a further point in designing, redesigning, and crafting mentally demanding job requirements that contribute to personal development along the lifespan.

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