

**THE EFFECTS OF AUTOMATED TECHNOLOGY ON THE
EXPERIENCE OF WORK**

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SUMMARY

The experience of agency, defined as “the experience of being in control both of one’s actions and, through them, of events in the external world” (Haggard & Tsakiris, 2009), is fundamental to a person-centric definition of work as “productive, agentic activity” (Weiss, 2014). The assessment of the *momentary* experience of agency, rather than of more generalized judgments of control within one’s work, allows for a more discrete analysis of the contexts within which experiences of control at work may be altered. Of interest to the current study is the context of automated technology. Automation was expected to have a negative effect on experiences of agency, such that individuals whose work was mediated by automated technology would have lower judgments of momentary control, effort, and responsibility than those individuals whose work was not mediated by technology.

This hypothesis was tested by examining two groups of 177 package car drivers from United Parcel Service (UPS): one group that used an automated technology, ORION, and one group that did not. As predicted, an independent samples t-test revealed that non-ORION participants reported significantly higher levels of momentary control than participants who used ORION. Additional analyses showed that attitudes towards technology, as represented by affinity for technology and ORION acceptance, differentially predicted levels of each agency facet: control, effort, and responsibility. Moreover, significant relationships were found between the agency facets, job autonomy, and perceptions of time. Limitations of the current study, as well as future research directions, are discussed.

CHAPTER 1. INTRODUCTION

Work may be defined as agentic, productive activity done for the purpose of changing the environment, often involving the creation of artifact (Weiss, 2014). Fundamental to this person-centric definition of work is the notion that people are *agentic doers*: people have intentions for their work and subsequently act towards their work goals. The term ‘agentic’ takes on several meanings in different contexts (Cote & Levine, 2002; Helgeson & Fritz, 1999), but the current focus refers to the definition of agency as an experiential feeling that arises from realizing one’s thoughts in actions and in the effects of those actions (Haggard & Tsakiris, 2009). This experiential (or phenomenological) aspect of control has received little attention in the Industrial/Organizational (I/O) literature, despite its centrality to the definition of work provided above. This definition of work, albeit more person-centric than is typically found in past I/O literatures, allows for a more fluid understanding of what it feels like to work, in the moment. Likewise, an examination of agency, as opposed to more generalized judgments of control at work, allows for a more discrete analysis of the contexts within which feelings of control may be altered.

One particularly salient work context that may affect an individual’s experience of agency is that of technology. Technology is ubiquitous across the daily tasks of most workers, and it is widely acknowledged that technology contributes to better and faster organizational production. However, little is understood about how technologies used in work might affect workers’ accompanying psychological experiences. Of interest to the current study is the effect of automated technology on a worker’s sense of agency. Automation is broadly defined as the performance of functions by technology that were

once performed by humans (Parasuraman, Sheridan, & Wickens, 2000). An organization's use of automated technologies significantly changes the ways in which its employees perform their jobs, although these changes have generally been examined across work outcomes, such as job satisfaction or job performance, rather than the experienced process of working itself (Mullarkey, Jackson, Wall, Wilson, & Taylor, 1997; Wall, Corbett, Martin, Clegg, & Jackson, 1990). Agency, an inherently phenomenological construct, is an apt lens through which to examine whether automation has momentary effects on the experience of work.

Although agency is a novel concept as applied to the work context, an interest in control is not. Constructs that tap into the control-related aspects of work contexts, such as job autonomy, as well as person-oriented constructs, such as locus of control and psychological empowerment, have been positively linked to a number of important work outcomes, including job satisfaction, job commitment, job involvement, job performance, and job motivation and negatively related to physical symptoms, emotional distress, absenteeism, intent to quit, and turnover (Judge & Bono, 2001; Spector, 2006; Spreitzer, 1995). Control is clearly intimately tied to important work and non-work outcomes, yet little is understood about the actual *experience* of control while working.

The momentary perspective of agency taken in the present investigation is a critical augmentation to the existing literature examining control-related constructs in the workplace for several reasons. First, many control-related constructs, including job autonomy, are referent to the amount of control offered in one's job. In this sense, job autonomy assesses the *opportunity* for feelings of control in one's work rather than the experience of control itself. A measurement of agency uses the experience as the target of

interest, rather than the features of one's job or work environment. Second, many extant control constructs represent relatively stable beliefs or orientations about the amount of control in one's life or job, whereas agency represents a potentially transient, momentary experiential state. This state-like focus allows for a more discrete analysis of the immediate ways in which the work context affects the experience of control in one's actions. Third, the assessment of both agency and job autonomy in the current study provides preliminary evidence regarding the extent of the relationship between state- and trait-like control constructs.

The main purpose of this investigation was to examine how automation affects experiences of agency at work. To do so, the present investigation examined the impact of an automated technology, ORION, on United Parcel Service (UPS) package car drivers' experiences of agency. Agency was examined along three facets of agency – control, effort, and responsibility – to account for the complex experiential qualities of the agency phenomenon. Exploratory analyses examined potential influential factors on the relationship between automation and agency, which included ORION tenure, job tenure, affinity for technology, and acceptance of ORION. Additional exploratory analyses examined the direct relationships between agency and aspects of job autonomy and flow-state experiences, respectively.

To provide an appropriate context for the study, this paper first provides brief literature reviews of agency and technology (from a postphenomenological perspective) and then introduces the current investigation. The first section provides a theoretical background to the sense of agency in a manner appropriate to an empirical investigation in a work setting. The second section outlines the theoretical and empirical justifications for the mechanisms

by which automation is expected to affect the sense of agency in actions at work. The third section describes the present investigation, including proposed hypotheses. The fourth section includes the methods of the current investigation, including participants, materials, and procedure. The fifth section describes the analyses and results, and the sixth section completes the paper with a detailed discussion of the analyses, the limitations of the study, recommended future directions, and a short conclusion.

CHAPTER 2. AGENCY

The experience or sense of agency may be broadly understood as “the experience of being in control of one’s own actions, and, through them, of events in the external world” (Haggard & Tsakiris, 2009, p. 242). This conceptualization of agency has typically been studied in areas of philosophy and cognitive psychology. Philosophers have tended to focus on the underlying structure of the agentic experience and the phenomenological components of agency (see for example, Bayne, 2008), whereas cognitive researchers have aimed to delineate the relationship between the neural activity that surrounds an individual’s actions and the emergent sense of agency (see for example, David, Newen, & Vogeley, 2008). However, the sense of agency is also well-suited for an empirical examination in the context of work.

In this section, I describe the aspects of agency that must be considered for an investigation of the experience of agency in a work setting. First, I outline the necessary distinction between the feeling of agency in the moment, and the retrospective judgment of agency that is captured in a more typical explicit, self-report measure. Second, I describe how the relationality, or predictability, component of agency is essential for its emergence, thus serving as the ‘mechanism’ of agency. Third, and finally, I describe the phenomenological contents of agency that will be of focus in the current investigation: control, effort, and responsibility.

2.1 Feeling vs. Judgment of Agency

To provide a clear understanding of what is being measured in a work-oriented examination of agency, I must first distinguish between the feeling of agency and judgment of agency. The feeling of agency (FoA) relates to the subjective experience of fluently controlling the action that one is currently making (Haggard & Tsakiris, 2009). The feeling of agency is temporally concurrent with action and does not have a conscious component of mental causation. Although people may feel a sense of control over their actions in the moment, it is unlikely that they are directing any conscious thought towards an experience of themselves as the agent of their actions. The judgment of agency (JoA), on the other hand, is the subjective notion of, “I did that”. The reflective nature of a JoA is inherently conceptual, such that a JoA represents individuals’ evaluations of their own activity to decide whether they were agentic in those actions (Haggard & Tsakiris, 2009). The JoA, then, is an aspect of one’s cognitions surrounding an activity, whereas the FoA simply occurs in tandem with one’s agentic actions. In this respect, the JoA appears more closely bound to the phenomenology of agency than does the FoA because the JoA occurs at a level of conscious awareness, whereas the FoA does not.

A FoA is normally a necessary condition for a JoA, such that one will not reflect and decide that mental causation occurred if such causation was not experienced during the action itself. However, a FoA is not usually a sufficient condition for a JoA. Haggard and Tsakiris (2009) point to the many movements that are made without conscious intention, such as pacing around a room or tapping a foot (referred to as ‘minimal actions’), which may not explicitly involve FoA but do involve JoA. A JoA involves additional cognitive processing through the monitoring of the effects of one’s actions, which then produces the notion that one has or has not mentally caused one’s actions. Thus, while an empirical

investigation of agency that relies on self-reports necessarily captures the JoA, the FoA most often accompanies the JoA and is therefore also assessed to some degree in such a design.

2.2 Mechanism of Agency

The sense of agency relates individuals' thoughts and actions to changes in their immediate environment. The relationality component of agency may be examined in two ways: between one's intentions and actions and between one's actions and the effects of those actions. Pacherie (2007) posits that agency can arise from individuals' intentions, that is, their mental and sensorimotor representations of their actions, and their physical actions. An individual's sense of a match between intentions and actions is indicative of a sense of agency, although this relationship may differ depending on the type of action involved. For example, Gallagher (2012) suggests that actions for which individuals feel particularly skillful may not involve explicit intentions prior to action because those actions are somewhat automatized and the actions' outcomes are well-known. Despite the lack of FoA, however, these individuals may still experience JoA because the actions ultimately matched their expectations, even if those expectations were below the level of conscious awareness. Along these lines, the predictability of an action on behalf of the human agent is fundamental to the resulting sense of agency.

Additionally, Engbert, Wholschlager, and Haggard (2008) examined how the sense of agency is relational between individuals' actions and the subsequent effects of their actions. Engbert and his colleagues found that individuals' experiences of agency were triggered by individuals' own efferent motor signals (i.e., information relayed to the brain

regarding physical movement). Participants' verbal reports of agency experiences were found to generalize over different types of action-effect chains and were epistemologically private, such that individuals only reported feelings of agency for their own actions as opposed to observed actions. Engbert et al. (2008) interpreted these findings as indicative that individuals' sense of agency at least partially arises from the amount of predictability and control that individuals experience for their own actions versus others' actions.

2.3 Phenomenological Content of Agency

There are several qualities that are highly representative of the agentic experience. The following list of attributes is not meant to be an exhaustive characterization of agency, rather it is meant to exemplify the qualities of agency that can be meaningfully examined in a first-person research context focused on work. Feelings of mental causation and authorship are two qualities of agency that are highly emphasized in philosophy and cognitive literatures (Aarts, Custers, & Wegner, 2005; Bayne & Levy, 2006; Pacherie, 2007; Wegner & Wheatley, 1999), but examinations of those phenomena do not make much sense outside of precisely controlled laboratory settings. For context, mental causation refers to the experience of one's own intentions as the cause for one's movements and authorship refers to experiencing the "self as the source" of one's actions (Bayne & Levy, 2006).

For example, a study conducted by Aarts et al. (2005) examined individuals' self-reports of authorship over their actions within a computerized task in which the manipulations of timing and priming of participants' actions across trials affected feelings of authorship. However, in assessing the everyday work actions of normal participants (i.e.,

those who do not suffer from action control deficiencies, such as schizophrenia), it is unlikely that much variance would arise from questions of mental causation or authorship over actions. In other words, these feelings of causation and ownership over one's actions are largely inherent in all voluntary actions for normal individuals and thus would not be meaningful to study here. Given the current interest in the sense of agency in the real-world context of work and working, I narrow my focus to the phenomenological characteristics of effort, control, and responsibility within agency for the purposes of this investigation.

2.3.1 *Effort.* The experience of effort within a sense of agency refers to the need to invest energy and will-power into actions (Bayne & Levy, 2006). Effort is integral to the sense of agency because the phenomenology of effort routinely accompanies judgments of self-initiated action to some degree. Although effort is an experiential quality of agentic actions, it is unlikely that feelings of effort initiate the sense of agency. That is, a perception that an action is effortful is not essential to an emergent sense of agency, rather, as will be explained below, one may also feel a high sense of agency within an effortless action. The complexity involved in the experience of effort in agentic actions demonstrates that it is not a causal factor of agency, and its emergence may instead depend on the context within which the agentic action is embedded.

Experiences of effort may be task dependent, such that as the physical or mental requirements of a task decrease, the experiences of physical or mental effort jointly decrease (Bayne & Levy, 2006). As mentioned earlier, highly skillful actions may not require prior intentions, and they also may not involve a discernable degree of effort. The relationship between perceived effort and skill is driven by the degree to which individuals

can successfully predict the outcomes of their actions (Bayne & Levy, 2006). For example, if a basketball player feels confident in making a free-throw shot, based on prior knowledge of successful shots, that shot may not be perceived as very effortful. However, this level of perceived effort may be increased if the shot is missed and the prior prediction of the action's outcome becomes inaccurate.

2.3.2 Control. The feeling of control over one's actions is definitional to the sense of agency. The sense of control can be broadly understood as the perceived match between what one is expecting to happen and what actually happens. As may be apparent from this definition, there is a unique relationship between feelings of control and effort within the sense of agency, although this relationship may change under different circumstances (Pacherie, 2007). For example, an experience of high agency may be described as a state of 'effortless control', wherein a high predictability of one's actions (i.e., high control) is coupled with a low need for mental or physical resource investment (i.e., low effort). However, Pacherie (2007) posits that a high sense of agency might also arise from the experience of high effort and low control because some level of resistance to one's actions can sharpen one's sense of self in relation to the immediate environment. Thus, although the most typical sense of agency may emerge from a relationship between feelings of high control and low effort, it is possible that these experiences form a more quadratic, rather than linear, relationship in the production of a sense of agency.

The relationality or predictability aspect of control is representative of the underlying mechanism of agency itself, which provides further support for the inherent nature of control in the sense of agency. Pacherie (2007) posits that a generalized sense of

control within agentic experiences may be further reduced to feelings of control at the three distinct levels of action specification. At the first level, individuals must formulate their intentions for action, which are future-oriented (F-intentions), at which point they feel control if there is a conceptual match between their planned and actual actions. The second level involves the implementation of action (Pacherie refers to this stage as presented-directed intentions, or P-intentions), in which individuals experience control if there is a match between the predicted and actual perceptual effects of their actions. The third and final stage of action specification is the individual's sensorimotor control over the action, represented by motor intentions or M-intentions. Pacherie suggests that while motor control is relatively automatic, which presupposes conscious feelings of control, there is a chance that feelings of control could be reduced at this stage when the predicted and actual sensory components of certain physical movements are noticeably misaligned. Thus, a strong sense of control is the product of high levels of match between expectations and reality at each of these distinct stages of action specification and execution.

2.3.3 Responsibility. Finally, individuals' experiences of agency are often if not always accompanied by a sense of responsibility, due to the situation of individual' actions within a broader society (Haggard & Tsakiris, 2009). Responsibility within the framework of this study refers to the "state or fact of being accountable or to blame for something" (Responsibility, 2016) In most modern communities, individuals are held accountable for their actions, good or bad, if they are believed to be of sound mind. However, if an individual is thought to be mentally unstable, and perhaps the mental causation or authorship component of the sense of agency is diminished, the perceived amount of responsibility for accompanying actions is

also reduced. For example, a person who destroys a neighbor's flower bed while sleepwalking is not thought to be responsible for that action because that person had no awareness during the action. Relatedly, that individual may not feel responsible for that action to the same degree compared to an action performed while not sleepwalking.

The notion of predictability is significant to the sense of responsibility, much like it is to the other characteristics of the agentic experience. Legally, for example, individuals are believed to be more responsible for premeditated illegal actions than for those actions that are committed in the 'heat of the moment' (Haggard & Tsakiris, 2009). The notion that one has planned an action and has potentially weighed the consequences of the outcome is indicative of a higher amount of responsibility, and perhaps relates to a more salient experience of responsibility for the actor in question. Although feelings of responsibility may originate from societal norms rather than innate mental processes, the experience of being responsible or not responsible for one's actions is inseparable from any action that is done in the context of those societal norms. Likewise, the phenomenology of responsibility may not be salient in a FoA, but may be readily available in a JoA, due to the cognitive activity involved in recognizing the implication of one's actions within the broader social context.

2.3.4 Summary. The phenomenological characteristics of agency presented here represent several distinct ways of conceptualizing the experience of agency. Firstly, feelings of control appear to be mechanistic to the sense of agency, whereas effort and responsibility simply appear to phenomenologically salient aspects of the agentic experience without being causal to feelings of agency. Moreover, feelings

of effort and control appear to be directly embedded into an innate agentic experience, whereas responsibility appears to represent a socially-driven component of agentic actions. In this regard, whereas effort and control may be represented in both FoA and JoA, the feeling of responsibility may only be represented in JoA. These distinctions further emphasize the phenomenological variance associated with agency and the need for conceptual clarity within this topic.

CHAPTER 3. AUTOMATED TECHNOLOGY

Automated technology is becoming more pervasive across many different work sectors. According to a recent report by authors from McKinsey & Company (Chui, Manyika, & Miremadi, 2015), up to 45% of activities currently performed by human workers could be automated by simply adapting existing technology. While some forms of automated technology entirely replace human workers, other forms of automation are built to assist or work *with* human workers (Parasuraman et al., 2000). The use of these technologies changes the kinds of tasks performed by a human worker, as well as the kinds of experiences formed while working. The experience of working as a cashier becomes qualitatively different if self-checkouts are introduced across the cashier's workplace. Actions that were once independently held by the human worker become shared with automated technology. This shared action is the precise mechanism through which I hypothesize that the experience of agency may be altered.

In this section, I present the argument for the suitability of automated technology as a context within which to examine changes to individuals' experiences of agency at work. First, I discuss relevant theory stemming from the philosophy of technology literature, taking a postphenomenological approach to the current research question. Second, I present the available empirical findings on the relationship between automation and agency and explain how the current study seeks to replicate and expand upon those results.

3.1 Theoretical Support

A postphenomenological perspective of technology posits that humans who use technology have an emergent experience of ‘technologically mediated intentionality,’ in that the relationship between humans and their world environments are mediated by technology (Verbeek, 2005). Mediation, in this context, refers to the individuals’ engagement to the world through technology. Intentionality, much like the concept of agency, takes on different meanings in different areas of philosophy. Broadly, intentionality refers to the direction of individuals’ actions towards the world. In this definition of technologically mediated intentionality, provided by Verbeek (2005), ‘intentionality’ represents the combination two different kinds of intentionalities: the phenomenological definition provided by Ihde (1990) and the more general definition given above.

Ihde’s (1990) definition more specifically focuses on the notion that technologies have a “certain directionality, an inclination or trajectory that shapes the ways in which they are used (Verbeek, 2005). Verbeek offers an example originally provided by Don Ihde in referencing the differences in writing styles produced by a fountain pen, typewriter, and word processor. Although these technologies are neutral in themselves, they each exert a distinct influence on an individual’s work activity. An individual with a fountain pen may write slowly and deliberately, whereas the same individual might quickly jot down any idea that comes to mind on a laptop. The differences in these experiences may not reach a level of conscious awareness within the activities themselves (i.e., present within an FoA), yet are fairly easy to distinguish in a JoA. Together, these definitions suggest that individuals’ actions and accompanying experiences of those actions are altered, to some extent, when they are carried out with the use of different types of technologies.

Put another way, technologically mediated intentionality implies that humans' actions and concomitant perceptions are no longer the result of humans alone, but are jointly shared with the technology. Verbeek offers the example of a human shooting a gun: the human nor the gun alone are responsible for the flying bullet; the action is shared between the subject and object, as it were. The reality of the gun shot cannot be understood as involving the human agent nor the gun in isolation, as the action could not have taken place without both human and technological artifact. Thus, any experiential phenomenon, such as agency, that accompanies action in the absence of technology, is necessarily changed when technology is introduced.

As previously outlined, agency arises when individuals experience a match between their intentions ('intentions', in this case, referring to 'motives' or 'objectives') and subsequent action, or between their actions and subsequent effects of those actions. When the experience of action is altered by the use of automated technology, it is expected that experiences of agency will also be altered. It is this phenomenological shift caused by the use of automation that affects agency, rather than any specific quality or characteristic of the technology itself. To the contrary, Verbeek (2005) argues that the consideration of "intrinsic properties" held by technology as influencing humans' relation to the world is misguided: "Artifacts (technologies) can only be understood in terms of the relation that human beings have to them...The insight that technologies cannot be separated from their use contexts implies that they have no 'essence'; they are what they are only in their use" (p.117).

Referring to the notion of "matches" between intentions and actions, and actions and effects, I suggest that automated technology decreases the extent to which this

matching occurs, because individuals do not have privileged access to the operational tendencies of technologies, as they do with their own minds and bodies. For example, when an individual first uses a computer, there exists a high degree of uncertainty about what will happen when certain buttons are pressed, because the individual has never experienced the outcomes of those actions before. However, over time, the individual becomes more experienced with the actions associated with that computer, and gains familiarity with the related intention-action and action-effect chains. Thus, I expect that time influences the relationship between automation and agency, such that increased experience (time) with a given automated technology is associated with recoveries of agentic experiences.

3.2 Empirical Evidence

The position taken in the current study is aligned with the postphenomenological perspective towards technology: the effects of automation on individuals' sense of agency in work stems from the phenomenological shift accompanying the change from individual action towards shared action, which reduces the familiarity or predictability associated with that action. In support of this argument, there is empirical research that shows that feelings of agency decrease as actions become shared with, or even taken over, by automated technology.

Berberian, Sarrazin, Le Blaye, and Haggard (2012) found that as levels of automation increased, feelings of agency decreased. In that study, as participants were exposed to higher levels of automation in an aircraft simulation task, their judgments of agency decreased. Moreover, participants' implicit levels of agency, measured by intentional binding effects, also decreased as level of automation increased, which provides

complementary support for the negative effects of automation on agency. Intentional binding is the phenomenon wherein individuals verbally report a shortened amount of time between agentic actions and the effects of those actions, which is an effect that does not occur for actions that are not accompanied by feelings of agency (Moore & Obhi, 2012). Intentional binding is considered an implicit measure of agency because individuals are not aware of the temporal bias that occurs from actions accompanied by feelings of agency versus those that are not. The intentional binding effect is robust across laboratory studies of agency (Barlas & Obhi, 2013; Berberian, et al., 2012; Demanet, Muhle-Karbe, Lynn, Blotenberg, & Brass, 2013), although it has not been examined in real-world contexts, perhaps due to the high temporal sensitivity required to detect such an effect.

Although promising, Berberian et al. (2012) represents the single empirical attempt to examine the relationship between automation and agency. The present investigation sought to replicate these findings in a more robust research design. The Berberian et al. (2012) study only included thirteen participants and took place in a highly controlled laboratory design. The present investigation included 177 participants and examined automation's effects on agency within a naturally-occurring parallel between individuals in the same job: half of the individuals used an automated technology, ORION, and half of the individuals did not. Although the current investigation relied primarily on explicit judgments of agency to detect automation effects, individuals' perceptions of time at work were also measured. Beyond the main relationship between automation and agency, I was interested in examining the relationship between time perception and agency. I suggest that a positive relationship, if found, between time perception and feelings of agency, such that time is perceived as moving more quickly when actions are judged as agentic, would

provide support for the notion that the unconscious temporal effects of intentional binding may be, to some extent, subjectively apparent within a broader scope of agentic actions.

CHAPTER 4. CURRENT INVESTIGATION

Provided with a phenomenological framework for both agency and technology, I now turn to propositions regarding their interactions to be tested in this study. Specifically, this section focuses on the effects of automated technology on individuals' reported sense of agency within the three domains previously discussed: effort, control, and responsibility. I also present exploratory hypotheses regarding factors that might influence the relationship between automation and agency.

The present investigation utilized a participant sample of package car drivers from the logistics and distribution company, United Parcel Service (UPS). The sample was divided into two groups: one group that used automated technology while driving and one that did not. The automation of interest was a proprietary operational technology called On-Road Integrated Optimization and Navigation (ORION), which uses advanced algorithms to gather and calculate data to provide UPS drivers with optimized routes. ORION was classified as an automated technology for the present study because it performs the route selection task for drivers that have the technology in place, whereas the drivers who do not use this technology must rely on their personal experience with their respective driving areas to select their routes. The non-ORION drivers still had detailed schedules that constrained their package routes, but the selection of driving routes from point A to point B was their own: They had no other routing technology that directed their course between package drop-offs and pick-ups.

4.1 Control

Perceptions of control are fundamental to the phenomenon of agency. An examination of perceived control is not foreign to studies focused on technology and is in fact a central issue to a common topic in the field of automation known as the ‘out-of-the-loop performance problem’ (Endsley & Kiris, 1995). The out-of-the-loop (OOL) performance problem refers to the tendency for individuals to become less situationally aware, less vigilant, and more complacent within tasks coupled with automated technology. Berberian, Le Blaye, Maille, and Sarrazin (2012) suggest that these performance decrements may be fundamentally related to individuals’ decreased sense of agency in automation-related performance tasks and, more specifically, to their decreased sense of control. In an experimental study, Kumar and Srinivasan (2013) manipulated participants’ perceived levels of control¹ at the perceptual-motor level and at the goal level to examine the associated effects on the sense of agency. The results from that study suggested that the sense of agency differed hierarchically based on the amount of control that participants experienced in each trial, such that individuals with more control experienced higher levels of agency. Thus, I propose the following:

H1a. Judgments of control will be lower for individuals who use automated technology than for those who do not.

4.2 Effort

The examination of the effects of automated technology on feelings of effort during work is perhaps the most relevant to an I/O psychology perspective. Automation (and

¹ It is somewhat unclear whether this study truly measured control, or if they simply measured authorship/mental causation. The current study will improve upon many of the mentioned studies of agency by precisely outlining distinct constructs to more clearly delineate the nature of agency and its relationship to automated technology.

technology in general) is favored in the workplace due to its capacity to reduce the workload and effort expenditure of human agents. As previously noted, perceived effort within the sense of agency relates to the experience of needing to invest energy and will-power into one's actions (Bayne & Levy, 2006). Demanet et al. (2013) discovered a positive relationship between physical effort and the sense of agency, such that as individuals were required to exert more physical effort, their sense of agency (as measured by intentional binding) increased as well. Although mental effort, rather than physical effort, may be more relevant to the current study's focus, Bayne and Levy (2006) suggest that physical and mental effort may be understood as exerting similar effects on the sense of agency. The objective amounts of energy and will-power needed to perform tasks that are shared with automated technology are necessarily reduced in comparison to actions that are performed independently. Indeed, Kaber, Onal, and Endsley (2000) found that higher levels of automation were related to lower levels of perceived workload, which may be considered a close approximation of perceived effort. Thus, I propose the following:

H1b. Judgments of effort will be lower for individuals who use automated technology versus those who do not.

This evidence presented above also suggests that the relationship between experiences of effort and control will be altered within actions accompanied by technology versus actions those that are not. Under circumstances that are not mediated by technology, it is proposed that perceptions of high control are most often accompanied by perceptions of low effort, and vice versa. Returning to the example of the skillful basketball player: a free throw shot is not perceived as effortful because there is a high degree of perceived control over the action, perhaps due to a combination of well-trained muscle memory and

amassed experiences of successful shots. However, a player that is new to basketball may perceive each shot as highly effortful and in turn feel low control over each shot, due to the inability to predict the outcome of shot. However, the two hypotheses above indicate that ORION exerts a negative effect on both control and effort, potentially decreasing the extent to which they are negatively related. Thus, I propose the following:

H1c. There will be a significant difference between the correlation of effort and control in the non-automation group and the correlation between effort and control in the automation group.

4.3 Responsibility

The responsibility component of the sense of agency likely arises from the cultural and societal notions regarding individual action, rather than from isolated experiences of action (Haggard & Tsakiris, 2009). Within the context of work, this experience of responsibility over one's actions appears important. Individuals who feel responsibility over their actions in work may experience a greater investment in the outcomes of those actions, which could have benefits towards the quality of work outcomes, for example. Although Faunce (1958) suggested that automation *increased* workers' feelings of responsibility over their work, there is reason to believe that sentiments may have shifted in the last six decades.

Flemisch et al. (2012) highlight the issue of responsibility within the human-automation relationship, stating that although one's level of authority and control may be reduced in a non-optimized automation scenario, one's objective amount of responsibility (within society) remains unchanged. However, this argument does not pertain to the

subjective levels of responsibility that one feels over a set of actions, which may indeed be diminished when feelings of control and authority, for example, are also diminished. Latour (1994) suggests that through technical mediation, wherein individuals perform actions with or through technology, the responsibility for those actions are “spread out over the ensemble of parts” (Verbeek, 2005, p. 156). A person interacting with a highly automated technology, then, perhaps experiences an even lower level of responsibility than would be the case with a non-automated technology due to a lower involvement in the action generation process. Thus, I propose the following:

H1d. Judgments of responsibility will be lower for individuals who use automated technology than for those who do not.

4.4 Exploratory Hypotheses

Beyond the main effects of automation on the experience of the various components of agency, it is expected that there will be several factors that influence this relationship.

4.4.1 ORION tenure. As mentioned previously, the proposed mechanism by which automation affects feelings of agency is a reduction in the predictability and knowledge of the potential outcomes of one’s actions, as the actions become shared with the technology. Predictability for the outcomes associated with ORION-coupled actions is expected to increase as one gains more experience with ORION, which should be reflected in the length of their ORION tenure. Thus, although individuals who have ORION are expected to have lower levels of agency than their non-ORION counterparts, it is expected that individuals who have longer

tenures with the technology will have higher levels of agency than those who have just acquired ORION:

H2a. There will be a positive linear relationship between ORION tenure and control in the ORION group.

H2b. There will be a positive linear relationship between ORION tenure and effort in the ORION group.

H2c. There will be a positive linear relationship between ORION tenure and responsibility in the ORION group.

4.4.2 Driver-ORION tenure. Like the exploratory analyses regarding ORION tenure, there is also an expectation that drivers who acquire the technology at some point into their driving tenure, as opposed to new drivers who start their jobs with ORION, will have fundamentally different experiences with the technology, and in turn, experience different effects to their feelings of agency. Drivers who have historically relied on their own personal experiences to navigate their respective driving routes may interpret the acquisition of the ORION technology as a loss to a meaningful aspect of their work roles, as opposed to drivers who have never undergone such a transition. The removal of the decision-making aspect of route selection through ORION is necessarily more salient for drivers who once experienced that decision-making process in their work roles than it is for drivers who acquire ORION during onboarding and never know differently. The drivers who experience this salient loss of work complexity, I contend, will experience

lower levels of agency relative to their unaffected counterparts. Thus, I propose the following:

H3a. Participants whose driver tenures exceed their ORION tenures will report lower levels of control than participants whose driver tenures match their ORION tenures.

H3b. Participants whose driver tenures exceed their ORION tenures will report lower levels of effort than participants whose driver tenures match their ORION tenures.

H3c. Participants whose driver tenures exceed their ORION tenures will report lower levels of responsibility than participants whose driver tenures match their ORION tenures.

4.4.3 Affinity for technology. It is also recognized that individuals have different generalized orientations to technology (Edison & Geissler, 2003). Some people understand themselves to be “tech-savvy,” whereas others prefer to avoid new technological advancements at all costs. Given these fundamentally different relationships with technology, it is likely that experiences of agency will be differentially affected by technology use as well. Namely, individuals who enjoy technology more may undergo less of a “hit” to their feelings of agency when using technology compared to individuals who have more negative perceptions of technology. Thus, I propose the following:

H4a. There will be a positive linear relationship between affinity for technology and judgments of control.

H4b. There will be a positive linear relationship between affinity for technology and judgments of effort.

H4c. There will be a positive linear relationship between affinity for technology and judgments of responsibility.

4.4.4 ORION acceptance. Expanding upon the previous set of hypotheses regarding affinity for technology, there is also an expectation that attitudes towards ORION, specifically, will be related to agentic experiences in a positive direction. That is, if participants feel that ORION is a positive aspect of their jobs, they may not experience a loss of agency as great as those who dislike ORION or feel that it is a burden to their work. Thus, I propose the following:

H5a. There will be a positive linear relationship between ORION acceptance and judgments of control.

H5b. There will be a positive linear relationship between ORION acceptance and judgments of effort.

H5c. There will be a positive linear relationship between ORION acceptance and judgments of responsibility.

4.4.5 Job autonomy. Although the examination of agency within a work context is a novel contribution of the current study, it is expected that agency will be related to similar, well-examined measures of control in the I/O literature. Particularly, it is expected that the control aspect of agency, which reflects participants' experiences of control in the moment, will be positively related to their judgments of job autonomy, which reflect individuals' more stable, generalized attributions of control within their work roles. Thus, the current study proposes the following:

H6. There will be a positive, linear relationship between judgments of control and job autonomy.

4.4.6 *Flow-state.* Although there are no empirical findings on the relationship between agency and experiences of flow-state, there have been theoretical suggestions that experiences of agency may be altered in flow state due to the salient experience of ‘effortless control’ and concurrent loss of self-awareness (Bayne, 2008; Pacherie, 2007). Pacherie (2007) suggested that if the self-awareness component of a flow-state is not diminished too greatly, then the control-salient aspects of flow-state would increase the experience of agency, although agency could be diminished if the sense of self is entirely eradicated. Thus, the current study proposes the following:

H7a. There will be a negative relationship between the loss of self-consciousness component of flow-state and the control component of agency.

Another salient component of the flow-state experience is an altered perception of time. As previously mentioned, the foremost implicit measure of agency, the intentional binding effect, emerges from individuals’ subjective reports of shortened time intervals between their actions and the effects of their actions. Within agentic actions, individuals’ report that this time interval is shorter than is objectively true, hence the action and subsequent effect appear to be perceptually “bound.” I suspect that the intentional binding effect may enter subjective awareness across several agentic actions and is perceived as time passing more quickly than is objectively true. Thus, I propose the following:

H7b. There will be a positive relationship between the time perception aspect of flow-state and the control component of agency.

CHAPTER 5. METHOD

5.1 Participants

One hundred and seventy-seven package car drivers from United Parcel Service (UPS) were contacted through a random oversampling procedure along the following factors: (a) use or non-use of ORION technology, (b) ORION tenure, (c) driver tenure, and (d) driving area classification. Oversampling is a technique that involves purposefully selecting more individuals from a naturally existing group than is proportional to their size in the population to achieve a more precise estimate of their true properties. This strategy was used in the current study to achieve similar group sizes in a two-group design, comparing drivers who use the ORION technology to those who do not. At the time of the data collection, drivers who did not use the ORION technology only represented approximately 5% of the package car driver population, as the planned roll-out ORION technology throughout the company was almost completed. Although the roll-out of this technology to centers was not based systematically on any potentially confounding factors, such as center performance or resources, the factors used in the oversampling method were applied to the sampling procedure of participants in both groups to minimize potential differences between groups along these demographics.

There was an original list of 200 drivers who were contacted to participate in the study, 125 drivers who used the ORION technology and 75 drivers who did not. Of this original list, 97 ORION drivers and 21 non-ORION drivers completed the survey. A priori power analyses suggested that a total sample size of 200 participants would be necessary to achieve 80% power, and given the drastic difference between group sizes, an additional

list of 75 non-ORION participants were contacted to participate in the study. This procedure resulted in a total sample size of 177 participants, consisting of 105 ORION drivers, and 72 non-ORION drivers, at which point recruitment was stopped.

After the data were collected and examined, data cleaning procedures included a simple check of participant-entered Employee IDs to ensure that participants reported belonging to the group that the sampling strategy intended. This measure was particularly important, as the ORION technology was continually rolled out throughout data collection, so it was possible that some participants acquired the technology shortly before completing the survey, despite having been recruited to participate as a non-ORION driver. This cleaning procedure revealed 21 Employee IDs that did not match the intended group membership, which resulted in a final sample size of 156 participants, consisting of 88 ORION drivers and 68 non-ORION drivers.

5.2 Materials

5.2.1 Agency. To assess agency judgments, six original items were used to reflect the three dimensions of interest: control, effort, and responsibility. Instructions for these items asked participants to think about their experiences while working and to place themselves in the mindset of their work activities while they answered the questions. Each agency facet was measured by two items. The first set of facet-specific questions measured the *extent* to which an individual felt control, effort, or responsibility while they were working on a 5-point Likert scale ranging from 1 (*None at all*) to 5 (*A great deal*). The second set of facet-specific questions measured the experienced amount of control, effort, or responsibility while working

on a 5-point Likert scale ranging from 1 (*Never*) to 5 (*Always*). I developed these items for the purposes of this study, as the assessment of agency in a real-world work context among the present dimensions (i.e., momentary feelings of control, effort, and responsibility) is a novel contribution of the current study. Item reliabilities are discussed in the results section below.

5.2.2 *Managerial support.* Given the quasi-experimental design, a two-item control measure was employed to ensure that the participants in the two different groups did not exhibit differences on a measure theoretically unrelated to the presence of automation on experiences of agency at work. The two control measure items were taken from the Perceived Organizational Support scale (POS; Eisenberger, 1986) and specifically related to participants' perceptions of managerial support (e.g., "My manager strongly considers my goals and values"). Both items were measured on a 7-point Likert scale ranging from 1 (*Strongly disagree*) to 7 (*Strongly agree*). Non-significant differences between the two groups on this measure would provide support for the similarity of the two groups except for the presence or absence of automated technology in their work. Item reliabilities are discussed in the results section below.

5.2.3 *Affinity for technology.* Affinity for technology, or 'technology optimism,' was measured using 10 items taken from the Affinity for Technology scale developed by Edison and Geissler (2003). The items assessed individuals' level of positive affect towards technology on a 5-point Likert scale from 1 (*Strongly disagree*) to 5 (*Strongly agree*). An example item from this scale is, "I enjoy learning new computer programs and hearing about new technologies". The reported Cronbach's

alpha for this scale by the original authors was .88 (Edison & Geissler, 2003) and was .91 in the current study.

5.2.4 *ORION acceptance.* To assess the extent to which participants like ORION specifically, 15 items adapted from the Technology Acceptance Scale by Venkatesh and Davis (2000) were used measure the following attitudes about ORION: perceived usefulness, perceived ease of use, result demonstrability, subjective norm, image, and output quality. The items were slightly modified to replace the general target from “the system” to “ORION”. Perceived usefulness was measured with four items, perceived ease of use and results demonstrability were measured with three items each, and the other attitudes were each measured with one item. All items were measured on a 7-point Likert scale ranging from 1 (*Strongly disagree*) to 7 (*Strongly agree*). The reported Cronbach’s alphas for the multi-item subscales ranged from .86 to .98 in the Venkatesh and Davis (2000) study and ranged from .71 to .94 in the current study, except for the Perceived Results scale, which was .39 in the current study.

5.2.5 *Job autonomy.* Job autonomy was measured with six items from the Work Design Questionnaire (WDQ; Morgeson & Humphrey, 2006). These six items were taken from the Task Characteristics section of the WDQ, with three items representing Decision-Making Autonomy and three items representing Work Methods Autonomy. Morgeson and Humphrey (2006) reported Cronbach’s alphas of .85 for Decision-Making Autonomy and .88 for Work Methods Autonomy, and the current study found alphas of .90 and .87, respectively. An example of a Decision-Making Autonomy item is, “The job gives me a chance to use my personal initiative or

judgment in carrying out the work”, and a Work Methods Autonomy item example is, “The job allows me to make decisions about what methods I use to complete my work.” All items were measured on a 5-point Likert scale ranging from 1 (*Strongly disagree*) to 5 (*Strongly agree*).

5.2.6 *Flow-state*. Flow-state experiences were measured with a subset of eight items adapted from the Flow State Scale (FSS), developed by Jackson and Marsh (1996). The FSS is a 36-item scale designed to measure the following subscales of flow state experiences: challenge-skill balance, action-awareness merging, clear goals, unambiguous feedback, concentration on task at hand, sense of control, loss of self-consciousness, transformation of time, and autotelic experience. Items relating to time transformation (e.g., “Time seems to alter [either slows down or speeds up]”) and a loss of self-consciousness (e.g., “I am not concerned with what others may be thinking of me”) were chosen for the current study.

The time transformation items were adapted for the current study from a general emphasis on time alteration (e.g., time slowing up or down) to be direction-oriented (e.g., time slows down). This change was implemented so that a more precise relationship between agency and perceptions of time could be delineated. Each item, including the loss of self-consciousness items, was also modified to have a present-oriented focus, rather than a past-oriented focus of the original items.

Jackson and Marsh (1996) reported coefficient alphas of .82, and .81 for the time transformation and loss of self-consciousness subscales, respectively, although the current study found coefficient alphas of .68 and .56. Although some

of the loss of inter-item agreement between the time transformation items may be due to the altered language, mentioned above, it is less clear why the self-consciousness items performed so poorly in this study context. Each factor was measured with four items on a 5-point Likert scale from 1 (*Strongly disagree*) to 5 (*Strongly agree*). Although there is a flow-state scale developed specifically for the work context (Work-Related Flow inventory, WOLF; Bakker, 2008), the FSS items were more aligned with the experiential focus of the current study.

5.3 Procedure

Local managers of the selected package car drivers were contacted through email by members of the UPS Corporate Office to alert them of the survey participation request for their drivers. Managers then contacted the randomly selected drivers in their centers and asked them to complete the surveys at the beginning of their shifts. If the selected drivers were not available, managers were told that they could substitute another driver from their center to take the survey instead. The surveys were delivered online through the Qualtrics platform and estimated completion time for the survey was approximately ten minutes.

CHAPTER 6. RESULTS

The results discussed below are presented in three sections. The first section includes a description of the reliability check and agency item validation procedures. The second section outlines the findings of the primary analyses regarding differences in agency experiences between the ORION and non-ORION groups. The third and final section includes the findings of the exploratory analyses.

6.1 Reliability Checks

A two-item measure, perceptions of managerial support, was examined as a control measure to ensure similarity across the ORION and non-ORION groups, notwithstanding the ORION technology and related experiential effects. For two-item measures, Eisinga, Grotenhuis, and Pelzer (2013) recommend the use of the Spearman-Brown formula, due to its lower susceptibility to bias than Cronbach's alpha or Pearson correlation coefficient. The internal consistency of the two managerial support items was $\rho = .94$, which demonstrates strong agreement between items. The correlation between ORION group membership and the composite of the managerial support measure was $r = .07$, $p = .40$, indicating a non-significant difference between the two groups. Although this confound check does not ensure total similarity between the two groups, it does provide some support for the notion that the drivers across the two groups had comparable experiences in their work roles, outside of the influence of ORION.

The six items developed to assess the three aspects of agency for the purposes of this study were subjected to reliability and confirmatory factor analyses following data

collection. The Spearman-Brown reliability estimates for each of the two items were $\rho = .65$ for control, $\rho = .45$ for effort, and $\rho = .59$ for responsibility. Each of these reliability estimates are below the recommended cutoff of .70 proposed by Nunnally and Bernstein (1994), an issue that is explored in the Discussion section. The correlations for the three facets can be seen in Table 1.

Table 1 - Correlations between Agency, Autonomy, and Flow-State Variables

Facet	1	2	3	4	5	6
1. Control	–					
2. Effort	.21**	–				
3. Responsibility	.53**	.42**	–			
4. Decision-Making Autonomy	.63**	.24**	.44**	–		
5. Work-Methods Autonomy	.54**	.20*	.34**	.75**	–	
6. Time Transformation	.18*	.33**	.29**	.33**	.25**	–
7. Loss of Self-Consciousness	-.00	-.16*	-.19*	.01	.04	-.15

* = $p < .05$, ** = $p < .01$

A confirmatory factor analysis (CFA) was performed on a three-factor model of agency, with each factor representing the two-item composites for control, effort, and responsibility. The factors were all specified to correlate with one another. CFA indicated a good fit, $\chi^2 = 6.64$, $df = 6$, $p = .36$, RMSEA = .026, CFI = .996. Thus, despite the low internal consistency within each of the facets, the CFA supports a conceptualization of these items along three distinct yet related facets

6.2 Primary Analyses

Independent sample t-tests were conducted to examine differences in the three facets of agency, control, effort, and responsibility, between the ORION and non-ORION groups to test the primary hypotheses. In support of Hypothesis 1a, the t-test for control revealed a significant difference between the ORION and non-ORION groups on feelings of control, $t(154) = -2.91, p < .01$, such that the group who used ORION reported significantly lower feelings of control than the group who did not use ORION. The t-tests for effort and responsibility were both non-significant, indicating a lack of support for Hypotheses 1b and 1d regarding differences along these facets between the ORION and non-ORION groups (see Table 2).

Table 2 - T-tests for Agency by ORION membership

	ORION membership									
	Automation			No			95% CI for Mean			
	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	Difference			
							<i>t</i>	<i>df</i>		
Control	3.57	.97	88	4.01	.87	68	-.73, -.14		-2.91**	154
Effort	4.24	.75	88	4.23	.65	68	-.22, .24		.093	154
Responsibility	4.22	.71	88	4.31	.69	68	-.32, .13		-.820	154

** = $p < .01$

Hypothesis 1c predicted that there would be a significant difference in the correlation between effort and control in the ORION group compared to the correlation between these facets in the non-ORION group. However, a Fisher's r-to-z transformation revealed that there were no significant differences between these correlations, $z = .38$, $p = .76$ (based on a two-tailed hypothesis), so Hypothesis 1c was unsupported.

6.3 Exploratory Analyses

Hypotheses 2a-c predicted positive, linear relationships between the amount of experience with technology, operationalized as ORION tenure, and the three facets comprising agency. Simple linear regression analyses of effort, control, and responsibility on ORION tenure all revealed non-significant results. The results from these analyses can be seen on Table 3, which also include the next set of analyses regarding the combination of ORION and job tenures as a predictor.

Table 3 - Regressions of Agency on ORION and ORION/Job Tenure Variables

Predictor	ORION Tenure				ORION/Job Tenure			
	<i>B</i>	<i>SE B</i>	β	R^2	<i>B</i>	<i>SE B</i>	β	R^2
Control	-0.89	.09	-.10	.010	-0.32	.23	-.15	.020
Effort	0.05	.07	.07	.005	0.08	.1823	.05	.002
Responsibility	-0.01	.07	-.02	.000	-0.12	.17	-.08	.006

Hypotheses 3a-c predicted differences in agency between drivers who started their driving positions with ORION versus those who acquired the technology some amount of time into their driving tenure. Dummy coding was implemented to distinguish drivers

whose job tenure matched their ORION tenure with a 0 and drivers whose job tenure exceeded their ORION tenure with a 1. This coding scheme was conservative and imprecise because of the different response options for ORION tenure (e.g., less than 1 year to 5 years) and job tenure (e.g., less than 1 year to more than 20 years). Using only exact matches between responses for ORION and job tenures for the group coded as a 0 produced a group size of $n = 25$. Likewise, using only responses in which job tenure undoubtedly exceeded ORION tenure for the group coded as a 1 produced a group size of $n = 63$. The results of the three independent sample t-tests using this dummy coding procedure all failed to reach significance, thus Hypotheses 3a-c were unsupported. Detailed results can be found in Table 3.

Hypotheses 4a-c predicted positive, linear relationships between affinity for technology and the three aspects of agency. Simple linear regressions revealed that affinity for technology was a significant predictor of control, $F(1,154) = 11.98, p < .001$, effort, $F(1,154) = 12.08, p < .001$, and responsibility, $F(1,154) = 12.84, p < .001$. Interestingly, these analyses included participants from both groups, indicating that a general liking of technology was related to increased feelings of agency, even for those individuals who did not use ORION. The within-group analyses fell in the same directions. Thus, Hypotheses 4a-c were supported and results can be found in Table 4.

Table 4 - Regressions of Agency on Affinity for Technology

Outcome Variable	<i>B</i>	<i>SE B</i>	β	R^2
Control	0.47	.09	.38**	.14
Effort	0.20	.07	.21**	.05
Responsibility	0.30	.07	.33**	.11

** = $p < .01$

A post hoc univariate general linear model (GLM) analysis examined the prediction of control by affinity for technology and ORION group membership, including an interaction term. The main effect of affinity for technology remained significant, $F(34, 101) = 1.67, p = .03$, and the main effect of ORION was also significant, $F(1, 101) = 20.26, p < .001$, such that participants in the non-ORION group reported significantly higher levels of affinity for technology than the ORION group. The interaction term between affinity for technology and ORION group membership, however, failed to reach significance, $F(19, 101) = 0.99, p = .48$.

Hypotheses 5a-c predicted that ORION acceptance would be positively, linearly related to the three aspects of agency. Within the ORION acceptance scale, there were several subscales of interest: usefulness, ease of use, relevance to work, and results demonstrability. There were also three single items that represented the subjective norm, image, and output quality associated with ORION, respectively. The results of the simple linear regressions for control are presented in Table 5 and they all indicate significant relationships besides those for subjective norm and image.

Table 5 - Regressions of Control on ORION Acceptance subscales

Predictor	<i>B</i>	<i>SE B</i>	β	<i>R</i> ²
Usefulness	.20	.06	.33**	.11
Ease of Use	.28	.06	.44**	.19
Relevance to Work	.16	.06	.26*	.07
Results Demonstrability	.20	.09	.27*	.05
Subjective Norm	.08	.07	.12	.02
Image	.10	.06	.18	.03
Output Quality	.22	.06	.39**	.15

* = $p < .05$, ** = $p < .01$

The only ORION acceptance facet that significantly predicted effort was usefulness, $F(1,86) = 4.29, p = .04$ (See Table 6), and the significant predictors for responsibility were ease of use, $F(1, 86) = 5.97, p = .02$, results demonstrability, $F(1,86) = 4.30, p = .04$, and output quality, $F(1,86) = 4.59, p = .04$ (See Table 7). Thus, Hypotheses 5a-c were partially supported, with more support for Hypotheses 5a and 5c and only slight support for Hypothesis 5b.

Table 6 - Regressions of Effort on ORION Acceptance subscales

Predictor	<i>B</i>	<i>SE B</i>	β	<i>R</i> ²
Usefulness	.10	.05	.22*	.050
Ease of Use	.05	.05	.10	.010
Relevance to Work	.03	.05	.07	.010
Results Demonstrability	.08	.07	.20	.010
Subjective Norm	-.01	.06	-.01	.000
Image	-.03	.05	-.06	.004
Output Quality	.05	.05	.11	.010

* = $p < .05$

Table 7 - Regressions of Responsibility on ORION Acceptance subscales

Predictor	<i>B</i>	<i>SE B</i>	β	<i>R</i> ²
Usefulness	.07	.05	.17	.030
Ease of Use	.12	.05	.26*	.070
Relevance to Work	.08	.05	.17	.030
Results Demonstrability	.14	.07	.22*	.050
Subjective Norm	.02	.05	.04	.002
Image	-.01	.04	-.01	.000
Output Quality	.09	.04	.23*	.050

* = $p < .05$

Hypothesis 6 predicted a positive correlation between judgments of control and job autonomy. Job autonomy was comprised of two subscales, autonomy in decision-making and autonomy in work methods. Control was significantly related to decision-making autonomy, $r = .63$, $p < .01$, and to work methods autonomy, $r = .54$, $p < .01$. Thus, Hypothesis 6 was supported. Although there were no formal predictions made about the effort or responsibility facets of agency, each had significant relationships with both methods of job autonomy as well, ranging in correlations from $r = .20$ to $.44$. These results are included on Table 1.

Hypotheses 7a and 7b predicted positive correlations between the control facet of agency and the loss of self-consciousness and time transformation components of flow-state, respectively. The correlation between control and loss of self-consciousness was non-significant, $r = -.003$, $p > .05$, although the correlation between control and time transformation was significant, $r = .18$, $p < .05$, such that perceptions of time moving more quickly than normal were related to high levels of control. Thus, Hypothesis 7a was unsupported and 7b was supported. Post-hoc exploratory analyses examined the relationships between loss of self-consciousness and time transformation with the effort and responsibility facets as well. The loss of self-consciousness facet was negatively related to effort, $r = -.16$, $p < .05$, and responsibility, $r = -.19$, $p < .05$, and the time transformation facet of flow-state was positively related to both effort, $r = .33$, $p < .01$, and responsibility, $r = .29$, $p < .01$. Interestingly, the time transformation facet was also significantly correlated with each of the job autonomy subscales. Each of these correlations is included in Table 1.

CHAPTER 7. DISCUSSION

This investigation examined the relationship between an automated technology, ORION, and package car drivers' experiences of agency at work. The theoretical framework was informed by postphenomenological theory to replicate and expand upon past experimental findings about the effects of automation on the sense of agency to a robust, real-world work context. It was expected that drivers who used ORION would report lower feelings of agency than drivers who did not use ORION because of the decreased ability to predict the outcomes of shared actions with the technology. Other factors under examination were hypothesized to influence the relationship between automation and agency or to be of theoretical relevance to the agency construct.

It is important to note that the primary set of hypotheses regarding the relationship between agency and technology were quasi-experimental in nature, such that differences in self-report measures were analyzed across two pre-existing groups, whereas all the exploratory hypotheses dealt with relationships between self-report items. Thus, it is possible that the relationships from the exploratory analyses could be potentially inflated due to common method bias (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). Overall, there were some interesting relationships uncovered in the current study, but much is left to be learned. This section includes an interpretation of the results from the current study, including recommended future directions, followed by a broad discussion of the limitations and a brief conclusion.

7.1 Main effects of automation on agency

The primary hypotheses regarding the effects of ORION on drivers' experiences of agency were partially supported along the control facet. An independent samples t-test revealed that non-ORION participants reported significantly higher judgments of control than did ORION participants, although the t-tests for effort and responsibility failed to reach significance. It must be acknowledged that the control facet, rather than effort or responsibility, is most central to the definition of agency provided throughout relevant literatures (Gallagher, 2012; Pacherie, 2007; Haggard & Tsakiris, 2009). Often, the terms 'agency' and 'control' are used interchangeably to refer to the same phenomenon, so it is meaningful that this facet showed differences between the two groups of drivers. However, it is not clear that this pattern of findings is indicative of the importance of control to the sense of agency relative to effort and responsibility. As previously noted, the two-item scales used to assess these facets did not perform adequately, especially for effort and responsibility. Although this psychometric problem may be the most important reason that effects were not found, a lack of consideration for the organizational context within which the study was embedded may also be to blame. As emphasized in the introduction, the interactions between humans and technologies cannot be well understood without a thorough understanding of the contexts within which they are embedded.

The organizational context of UPS undoubtedly had a strong influence on drivers' perceptions of the ORION technology. Although the introduction of ORION provided a considerable cost savings to the organization, the implementation of this new technology also allowed UPS to add more stops to drivers' routes each day. Thus, while drivers' work may have become mentally less effortful through the off-loading of the route selection task, the physical effort required to perform their jobs likely increased because of the increased

number of stops per route. In this respect, a serious limitation of the current study was the failure to distinguish between mental and physical effort within the two-item effort subscale. Likewise, the current study may have failed to capture the complexity of what *responsibility* meant to package car drivers with high safety standards within the UPS organization. Admitting to feeling irresponsible during working hours, despite assurances of confidentiality, may have been perceived as a risk to job security for many drivers. While it is promising that momentary feelings of control appear to be important to the understanding of the experience of working with technology, the lack of support for the effort and responsibility facets should not eliminate these qualities from consideration in future research. Rather, the development of a more psychometrically sound agency scale to test these qualities more precisely appears to be a necessary next step.

7.2 Agency and automation: The effects of time

The two sets of analyses that examined the effects of tenure with technology on control, effort, and responsibility both revealed insignificant results on all three facets of agency. The first set of analyses in this topic simply examined the prediction of agency by job tenure, and the second set examined the prediction of agency by a consolidation of job tenure and ORION tenure. The latter predictor was formulated to examine whether there was a difference in levels of agency between drivers who started driving with ORION and drivers who acquired ORION some period of time into their driving tenure.

The lack of findings in these analyses was particularly disappointing, as they would have offered some insight into a more complex understanding of how technology affects feelings of agency at work. It was expected that increased exposure to ORION would have

attenuated the negative effects of the technology on individuals' sense of agency. Underlying this proposition was the belief that the actions and related outcomes of ORION would become more apparent after continued use, which would be directly related to the emergence of the sense of agency from the match between intentions and actions and between actions and the effects of those actions. However, there was no evidence to suggest that this phenomenon occurred in this examination.

It is possible that the measures within the current investigation were too crude to detect the desired effects in these analyses. The scale options for the job tenure item were very broad (e.g., 1-5 years), which prevented a more precise analysis of the effects of time on agency. This issue also plagued the coding procedure for the combined ORION and job tenure predictor, as mentioned in the results section. Future investigations that seek to examine the temporal relationship between technologies and the sense of agency may benefit from a more precise operationalization of the time component to detect changes in levels of agency.

7.3 Agency and attitudes towards technology

The next set of analyses in this study was concerned with the impact of drivers' attitudes towards both general technology and specifically towards ORION on their reported levels of agency across the three facets. Although there were several significant findings, the patterns of results are not straightforward. The affinity for technology results, for example, indicated positive, linear relationships between a positive orientation to technology and feelings of control, effort, and responsibility at work, as was expected. However, the results were consistent across groups, so the presence or absence of ORION

clearly did not impact the nature of these relationships. Moreover, the test of the interaction term between affinity for technology and ORION group membership to predict feelings of control appeared to be in the right direction, but failed to reach significance.

Regarding the ORION acceptance analyses, the various ORION acceptance subscales displayed differential relationships with each facet of agency. All ORION acceptance subscales were positively related to the control facet except for subject norm and image, which suggests that the immediate experiential aspects of the technology were important to drivers' feelings of control (e.g., how easy ORION is to use and how relevant ORION is to the job), whereas the more socially laden aspects of ORION appeared less important.

For the effort facet, only the usefulness subscale of ORION acceptance was a significant predictor and the direction of the relationship was non-intuitive. That is, as ratings of ORION usefulness increased, so did reported levels of effort. This perplexing result may be due to the failure to distinguish between mental and physical effort within the effort items, as mentioned above, or perhaps it is simply a statistical artifact. Likewise, the responsibility facet was significantly predicted by ease of use, results demonstrability, and output quality of ORION. It is not clear that these findings follow a distinguishable pattern in relation to the other ORION acceptance subscales that failed to predict feelings of responsibility and no facet-specific hypotheses were made for these analyses. Taken together, these results suggest that more theorizing is needed to understand the role of attitudes about technology, both general and specific, in the relationship between technology and the sense of agency.

7.4 Agency and job autonomy

The next set of analyses tested the relationship between the three agency facets and job autonomy. The control facet of agency was conceptualized to represent momentary feelings of control during work, whereas job autonomy was conceptualized to represent long-term, stable beliefs about the amount of control in one's job. The significant correlation found between control and job autonomy provides support for this notion. Although this finding is largely intuitive, the empirical evidence from the current study provides quantitative support for more complex research in this novel area. Moreover, additional analyses revealed that the effort and responsibility facets of agency were also positively correlated with both subscales of job autonomy. These results suggest that the diverse phenomenology of the sense of agency, beyond momentary feelings of control, may contribute to attitudes regarding job autonomy. Future research should examine agency in relation to additional work attitudes, such as job satisfaction and engagement, as well as work outcomes, such as job performance and turnover.

7.5 Agency and flow-state

Finally, the findings regarding control and flow-state also provided new insights to the understanding of agency. Counter to expectations, there was not a significant relationship found between control and the loss of self-consciousness facet of flow-state. However, additional analyses revealed that the loss of self-consciousness facet was significantly negatively related to effort and responsibility. The way the loss of self-consciousness items were worded may have been more salient in relation to feelings of effort and responsibility, as opposed to feelings of control, as they were all referent to an

awareness of self in relation to others. Future work should develop items that more specifically capture the pure presence of awareness over one's actions, rather than the awareness of one's actions as they relate to others. Moreover, a laboratory study that examines the relationship between implicit measures of agency and explicit measures of self-consciousness, as affected by technology or other agency-altering conditions, may provide a more precise understanding of these relationships.

Despite mixed findings for the loss of self-consciousness facet, the time transformation component of flow-state was found to be significantly related to all three agency facets. The original time transformation items developed for the FSS were modified for the present investigation, such that a directionality of transformation (time moving faster or slower) could be determined. The positive relationship between time transformation and the agency facets in this study indicated that quickened perceptions of time were related to higher judgments of control, effort, and responsibility.

This finding aligned with the study's prediction, which was founded in the robust intentional binding effect that occurs within agentic actions in laboratory studies (Berberian, Sarrazin, et al., 2012; Demanet et al., 2013; Obhi & Hall, 2011). It was suspected that the intentional binding effect, which holds true for agentic actions but not non-agentic actions, might extend to participants' subjective awareness across a host of agentic actions. As a reminder, the intentional binding effect refers to the tendency for individuals to unconsciously report a shortened time interval between their actions and the effects of their actions. In other words, the time between their actions and effects is perceived as passing more quickly than is true. The current finding regarding perceptions of quickened time passage in relation to high levels of agency provides some support for

the subjective awareness of intentional binding effects and future research should explore the boundaries of this relationship in the work context.

7.6 Limitations

There were several limitations to the present investigation. The most salient issues affecting this study were constraints due to the organizational context of UPS. The data collection was time-constrained by the systematic roll-out of the ORION technology, which was causing the non-ORION comparison group to disappear altogether. This factor made recruitment of non-ORION participants difficult and forced a non-desirable oversampling recruitment method to achieve necessary power. However, the achievement of comparable demographics between groups, in terms of driver tenure and location, helped to offset these concerns.

Additionally, the fact that many, if not all, of the participants in this study were members of the Teamsters union complicated the research relationship between the participants and the corporate team who leveraged the data collection. The corporate team prioritized the confidentiality and privacy of participants' survey responses, which prevented the collection of any identifying demographic information, including gender, age, and race/ethnicity. These factors should be included in future examinations of agency and technology in the workplace, especially age. Past research has shown that older adults today have a fundamentally different relationship with technology than younger adults (Czaja et al., 2006), indicating that age that might also be expected to influence the relationship between automation and experiences of agency.

Another limitation of the present investigation was the utilization of a cross-sectional design, rather than a longitudinal design. Ideally, the present data collection would have occurred before ORION was implemented to any drivers, and the adoption and impact of the technology on drivers' experiences of agency would have been examined over several months or years. This methodology would have allowed for a more conclusive understanding about the directionality of many of the relationships under present investigation. Nonetheless, the utilization of the current sample was meaningful. The ability to examine the influence of an authentic automated technology across otherwise equal work roles in an organizational setting was a rare opportunity. Although it may be more difficult to uncover a "thin" phenomenology, like agency, in a naturalistic setting, it is useful to determine how relationships between variables may change or become more obfuscated outside of a laboratory experiment.

Finally, a major limitation of the present investigation was the inability to examine more relationships between agency and work-related variables of interest mentioned above, like job performance, job satisfaction, and engagement. As previously mentioned, most of the participants enrolled in the present investigation were Teamsters, which meant that any time allotted for survey participation was entered as over-time pay. This cost constraint severely limited the length of the survey, which prevented an examination of several additional novel relationships. Although survey administration cost is an issue across many research endeavors, future efforts should focus on uncovering more work-related aspects of agency to examine the extent to which momentary feelings of agency are related to dynamic job performance or shifting levels of engagement, for example.

7.7 Final thoughts and next steps

Perhaps the most notable consideration of the current design is that only one kind of technology was examined: the broad, abstract principles taken from postphenomenological theory were applied to the ORION technology within a specific work role in a single organization. The current findings or lack thereof must be understood within this constraint – it is at this point unclear whether these findings would extend to other types of technologies, work sectors, or organizational contexts or if the uncovered relationships are idiosyncratic to the situational features measured here. Thus, future research is needed to replicate, convey and explain differences, and augment complexity to the current findings across a variety of technology and worker relationships.

To achieve this aim, I believe that a taxonomy for the phenomenological impact of different technologies is a necessary first step. As previously noted, the experiential effects of technologies cannot be understood by examining the objective properties of technologies themselves (Verbeek, 2005). Rather, technologies must be examined as they exist in functional relation to humans to account for the psychological experiences that accompany their use. Liker, Haddad, and Karlin (1999) offer several suggestions as to how features of the human-technology relationship might affect concomitant work experiences, one of which is the reason for the introduction of the technology. Liker and his colleagues suggest that the objectives and decision processes surrounding the implementation of a certain technology in a work role can have a meaningful impact on the worker's subsequent experiences working with that technology. For example, if a technology is framed and introduced as a work enhancement, such that the human worker has more time to spend on interesting projects and ideas, it may be expected that the worker experiences an increase in feelings of agency. Conversely, if a technology is implemented into a position with the

managerial intention of the eventual removal of the human worker, the human worker might experience an extreme loss of agency in that role. These contemplations and similar notions were inspired by the current design and must be explored in more systematic detail in future research attempts in this area.

7.8 Conclusion

In summary, the present investigation represented a novel attempt to uncover relationships related to automated technology and experiences of agency in the workplace. The theoretical framework was informed by postphenomenological theory of technology. The findings regarding differences in levels of control between ORION and non-ORION groups provide preliminary support for the notion of technologically mediated intentionality, although more research is needed to further clarify these relationships. There also appear to be several variables that are relevant to a study of agency and technology, including attitudes towards technology, job autonomy, and flow-state experiences. Future research in this domain should expand on this set of constructs to further delineate the role of agency within the first-person experience of working.

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