

**A Matter of Perspective: The Cognitive and Sociomaterial Views on Distraction and
Digitalization in Learning.**

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Abstract

In this paper, a comparison is made between sociomaterial and cognitive approaches regarding digital distraction in learning. Cognitive approaches explain distraction via internal cognitive mechanisms. External factors are considered but only through via how the internal mechanisms process them. Sociomaterial approaches view distraction as the result of both material and immaterial actors, of which each has agency, all working together in a complicated web. Devices are not passive until used by a human. Instead, they have properties that encourage an individual to do certain acts and, together, create a certain outcome. The two approaches differ in their methodology and scope. However, similarities could also be found. Both approaches see a positive correlation between the use of digital devices and the occurrence of multitasking. Both paradigms agree that the individual can influence the amount of distraction digital devices create. Cognitive scholars could use sociomaterial literature to guide and inform their research in order to investigate complex phenomena such as distraction and the effects of digital technology in learning.

Keywords: Distraction, Sociomaterial, Cognitive theory, Digital distraction, psychology

A Matter of Perspective: The Cognitive and Sociomaterial Views on Distraction and Digitalization in Learning.

In the past decades, there has been a growing interest in the effects of digital technologies in learning environments. Currently, research in this domain covers a wide variety of topics, ranging from specific appliances such as phones to the general effects of digital technology on cognitive processes and learning. One of the topics of interest is distraction.

Problems with maintaining concentration or the underlying mechanisms of attention are not a new subject of interest. However, the rapid advance of technology in the past decades and the now common occurrence of digital devices in study environments pose a new avenue of research. The digitalization of education is developing rapidly, and electronic whiteboards, laptops, and the internet are common in the classroom.

One of the dominant theoretical frameworks in research into education and psychology in general is the cognitive paradigm. Cognitive research focuses on mental processes. It raises important questions about the internal cognitive mechanisms of memory, attention, and other mental processes. Cognitive theory tends to favor the idea that the way we process, value, and think of situations and stimuli influences the way they affect us and the behavior that follows, rather than external influences themselves having an inherent specific effect (Rummel et al., 2023). Cognitive models look at the human mind as a sort of computer. Information flows in from the outside world to be processed by humans via different mechanisms (Wickens, 2021). From this view, external or environmental influences are not completely disregarded. However, how we perceive our environment and what stimuli we notice or act on are controlled by cognitive processes that influence us and that, through our motivations and efforts, we influence ourselves (Wickens, 2021). The cognitive perspective examines concentration as a limited resource. The term limited resources pertains to the idea that our

brain has limited energy to use for certain tasks, such as studying or remaining focused (Andrade & Walker, 2023; Bowman et al., 2010). What humans perceive or pay attention to is not a matter of simply receiving sensory input, which then gets processed, but an interplay between both unconscious bottom-top and conscious top-down processes (Connor et al., 2004). When we open a social media page because of a pop-up, for example, this can be caused because we perceive it as more interesting and rewarding than a possibly dull lecture. Therefore, it draws our attention and when we open it, we choose to divert our resources to our screen instead of the lecture (Sorden, 2005). The cognitive school is one of the largest and most successful paradigms in psychology and has been used to explain a wide range of mental processes.

Over time, cognitive theories and models have developed to include social and motivational influences as well (Andrade & Walker, 2023; Moreno et al., 2010). However, the cognitive paradigm strives to explain how these influences affect us via the way our internal cognitive processes influence their strength and effect on us. Despite the cognitive paradigm's success, there has recently been a rise in approaches that disagree with this process of reducing external influences on the cognitive process on an individual level. One of these approaches is the sociomaterial. The sociomaterial theories, actor-network theory for example, are distinct from the cognitive perspective in that they do not put the focus on the individual. The individual is seen as a part of an intricate network of actors, all contributing to create certain outcomes (Alirezabeigi et al., 2020). It seeks to establish the connections between the social, or the humans, and the material, or the nonhumans. For example, a laptop or pen is not seen as an immobile object simply waiting to be used by an individual. Instead, they are considered as active participants that themselves contribute to the whole, enabling certain actions in tandem with the other parts of the system (Decuyper & Simons, 2016). From this point of view, looking at just the individual and inner processes is akin to looking at

a painting through a straw. One misses a large part of the picture by discounting the material because, in the sociomaterial view, both the social and the material are actively influencing each other. Objects should be given attention not just because of how the individual uses them, but because they actively influence and contribute to a dynamic system promoting and enabling certain actions or preventing them. In this sense, from a sociomaterial perspective, one cannot understand complex phenomena by simply observing what a person does with an object. Instead, it is more appropriate to investigate how the person and the object influence each other to perform a particular action and create the outcome of that action. In doing so, the sociomaterial paradigm allows and encourages one to look at factors that otherwise might be ignored.

Consequently, from the sociomaterial perspective, distraction is not inherently something resulting from our inner processes but instead the outcome of a broad range of factors influencing each other. Factors such as the extension of the classroom to the outside world via the internet and seating arrangements can, and should, be accounted for as well. A student's behavior of clicking on a social media pop-up instead of paying attention to the class cannot be explained by it drawing attention and the student simply diverting their attention to it.

When it comes to research on the effect of digitalization in education, there is still much to discover. However, it seems that regarding learning, the positive influences of technology are often mentioned most and the negative effects less (Aagaard, 2017). Indeed, the use of technology is often lauded for its ability to deliver many different forms of studying. Students being able to search for information quickly, use text, audio, and video fluently in class and educational games are examples of how technology can be used to enhance the learning process. However, there is criticism regarding this trend of researching just the benefits of technology, which is what some call a positivist point of view, specifically

from those who endorse sociomaterial research methods. Educational research often uses the cognitive paradigm, which sees the act of learning as something that can be accurately studied on an individual level. Sociomaterial scholars argue that the learning process is complicated, and to understand it, one must look at the whole system (Luke, 2022; Sorden, 2005). For example, Selwyn (2011,713-718) explains that the academic study of digital technology is dominated by an inherent positivity, causing educational research to lack a critical perspective on the use of digital technology. This is especially relevant when it comes to the subject of distraction. The use of phones, laptops and tablets creates many possibilities for acquiring knowledge. However, at the same time, these technologies offer plenty of opportunities for distraction. For example, several sources where students were observed, interviewed, or both on the use of their devices in the classroom show that digital technologies create ample opportunities, and perhaps even lower the bar, for distractions to occur (Aagaard, 2017; Luke, 2022; Schraube, 2024). The importance of investigating the role of digital technology in learning is, therefore, not to be underrated. In the following pages, we look at the effect of digital technology on distractions and learning. We will discuss both the cognitive and the sociomaterial views on this subject. These are radically different theoretical frameworks and therefore a discussion on the differences in views and possible points of consensus could lead to new insights regarding the subject.

Analysis

In the following subsections, we will discuss distraction and digital technology as seen from both the cognitive and sociomaterial paradigms.

The cognitive paradigm has a long history on which newer models and theories have been built. The sociomaterial framework, however, is a heterogeneous paradigm with many methods and theories that, despite being based on the same paradigm, often do not attempt to build general models and theories. Therefore, the conceptualization of distraction will first be

discussed for both the cognitive and sociomaterial paradigms. Once we have a clear understanding of the conceptualization of distraction, whether it is internally or externally originated, we will discuss the topic of the agency. When discussing agency, we want to know how we can reduce distractions, as seen from each of the paradigms. In the last subsection, we will discuss distraction, multitasking and digital technology specifically. For each of these three parts there will be attempts to contrast the two paradigms on each of the three levels.

Distraction: internal or external?

When researching the nature of distraction, one important question one might ask is, “Where does distraction come from?”. To answer this question, we need to determine if distractions are the result of internal processes or caused by external forces.

Cognitive psychology has long been interested in the mechanisms of attention and distraction. When discussing attention in relation to the cognitive paradigm, we can discern two broad models: filter or selective attention models and resource models (Wickens, 2021). It is also essential to differentiate between internal and external distractions related to our thoughts and environmental stimuli respectively.

Donald Broadbent was one of the first to provide a selective attention model (Andrade & Walker, 2023). Models of selective attention try to provide insight into the processes that decide when we notice or ignore incoming stimuli. In his model, Broadbent proposed that sensory information such as color, pitch or size when captured by humans, goes through a mental filter. This filter then determines which stimuli will be ignored and which will be attended to. Broadbent saw this process as a bottom-top or early process, meaning it happens subconsciously. He used the fact that people who are asked about unattended stimuli can only give vague descriptions to substantiate the idea that once information is deemed as unimportant there is no further processing of the stimuli (Broadbent, 1957).

Broadbent's model had several shortcomings, however. The inability of the model to explain human's ability to discern meaningful information from otherwise ignored stimuli gave rise to newer models of attention. One of the earliest examples is Treisman's attenuation model (1964). This model stated that information we do not pay attention to is not ignored but rather attenuated. This allows us to discern meaningful information even when attention is not wholly directed towards certain stimuli. Contemporary models and theories of selective attention have incorporated both the bottom-up process of selection and the top-bottom process, often called motivational accounts of attention (Andrade & Walker, 2023). According to models of selective attention what we pay attention to is partly subconsciously decided based on simple characteristics. However, our own motivations, the meaning we give to certain sensory stimuli, can still bring otherwise ignored stimuli into our attention.

The second type of theories of attention is resource theories. Resource theories state that we have a limited amount of working memory capacity. This capacity is taxed when we perform tasks using our working memory, such as studying. The same capacity is also used to attenuate our surroundings, either while focusing on a task or whilst currently not engaged in a specific task. Resource theories explain distraction as a lack of cognitive reserve, which leads to attention being drawn to task-irrelevant stimuli (Moren & Park, 2010, pp.9-28). This lack of cognitive reserve, synonymous with capacity, can be explained in part by personality and cognitive factors as well as other factors such as being hungry or other bodily discomfort, low motivation and how an individual judges being able to control their own attention (Kane et al., 2017). Despite selective and resource models being distinct from each other in their focus, they are not mutually exclusive. They are often used together in contemporary theories to explain the nature of distraction. Wickens (2021), for example, describes how the two intertwine. Filtering environmental information is not an automatic process but uses cognitive resources. Together, these theories provide a comprehensive model for explaining how

humans get distracted. Older models, such as Broadbent's filter model, were limited to bottom-up internal processes; however, more recent models have incorporated motivational and resource theories to explain various phenomena. However, it is important to note that despite the distinction made between different sources of distraction and the conceptualization of internal and external distraction, the root cause of distraction is mostly considered to be within the individuals themselves.

Investigating this distinction, Rummel and colleagues (2023) state that internal and external distraction are different facets of a global distraction factor. They studied college students in an experiment to determine the extent to which internal and external distractions are correlated. Interestingly, the results showed that students who were put in the experimental condition without environmental distraction reported higher amounts of internal distraction, such as daydreaming. The students assigned to the group with a high number of environmental distractions reported higher external but lower internal distractions. Their experiment provided supporting evidence to the idea that distraction is something that lies within the person. When we have little external stimuli to distract us, we tend to experience more internal distraction and vice versa; in both cases, distraction occurred to a relatively similar extent. This example shows how, from the cognitive paradigm's view, distraction can be explained via internal mechanisms and individual factors.

In contrast to the cognitive paradigm, the sociomaterial approaches do not look at the individual to explain the nature of distraction. Aagaard (2015) criticizes cognitive psychology for its assumptions. He states that this idea that our mind is fully in control and our bodies are simply mechanical instruments acting on their will is an oversimplification. When a student is browsing Facebook instead of studying or paying attention to the lecture, from the sociomaterial perspective, this is not caused solely by internal cognitive factors. Instead, the student and the laptop, as well as all other actors such as, for example, the sitting arrangement

or the teacher, perform a certain action together, here learning, and creating the outcome of distraction (Decuypere & Simons, 2016). The laptop allows students to extend themselves beyond the classroom. The laptop also allows students to search for information themselves directly and use it during class, which Aagaard (2017) describes as movement outside-in. However, the laptop also allows students to move inside-out of the classroom via social media or other programs or websites. Aagaard (2017) states that this distraction, or inside-out movement, differs from distraction that might occur without the laptop, such as daydreaming or doodling, because the impulse to check social media only comes when technology that allows it is present in the classroom. From this point of view the material, in this case the laptop, actively influences the outcome by allowing or creating possibilities that are otherwise not present.

The sociomaterial paradigm sees the classroom and other systems as emergent and being acted upon by a network of social and material actors. Both the material and social have agency, such as the laptop creating possibilities and affordances otherwise not available, instead of agency being a purely human ability (Valasmo et al., 2022). Valasmo and colleagues discuss how the entanglement of the actors' mobile phones and the app Snapchat, when used by a student during class, are part of the enactment of the lesson itself. Through the actors' entanglement, the classroom can reach far beyond the room itself.

During observations Valasmo and colleagues (2022) describe how a student is using snapchat during class. The student receives a pop-up that they have a Snapchat message. However, the message can only be read if the student actively swipes and unlocks their phone. This is an example of an embodied action. From a sociomaterial perspective, as described earlier when discussing Aagaard's (2015) criticism of cognitive psychology, many interactions require embodied, physical actions and effort, such as physically touching a

phone screen in this case. Therefore, the mind should not be seen as a separate ethereal entity controlling a mechanical body.

Another example provided by Valasmo and colleagues (2022) is how turning off the vibration and sound of the phone allowed an observed student to use it without disturbing others in the class. The student used their phone in between the teacher's explanation and so could use the phone without missing much information. The student making sure that the phone does not disturb the enactment of teaching is described as the student defining the space given to the actor, the phone. These are examples of how sociomateriality allows for describing circumstances and actions that, in the cognitive paradigm, could be missed or explained as the student being distracted.

The sociomaterial and cognitive paradigms clearly differ in their stance on distraction being internally or externally conceptualized. Where cognitive scholars take external stimuli and factors into account, their effect or outcome is caused by cognitive mechanisms. Therefore, the root cause of distraction is mainly considered to be within the individuals themselves. In contrast to this, sociomaterial scholars propose that distraction, or the act of learning itself, is not the outcome of just an internal mechanism but the result of an assemblage of different actors, human and non-human, that together perform the act of learning and create the outcome of distraction. Separate from this conceptualization, there is another factor that is relevant when it comes to distraction, and that merits discussion: Agency.

Agency, do we have control over being distracted?

The idea that distraction lies within us or results from an intricate system might allow us to understand its source. However, it is equally important to understand how we can influence the factors contributing to distractions.

From a cognitive perspective, if someone is distracted, this is partly caused by personality traits, which tend to remain stable over time (Kane et al., 2017). However, there are several ways to prevent being distracted. As discussed, resource theories state that distraction occurs mainly when cognitive resources are overloaded. In addition to resource theory, the filter theories try to explain that the stimuli we attend to are decided both through bottom-up and meaning-making top-down processes. According to the cognitive paradigm, one way to avoid taxing cognitive reserves is to focus on one task instead of several at a time. Students who often task switch, for example, studying and simultaneously texting, must spend significantly more time studying than students who multitask less. Furthermore, students who task switch more often tend to use fewer effective methods of studying and have a higher amount of distracting apps on their devices than students who multitask less (Rosen et al., 2013). A negative effect of using laptops and phones during studying, when used for off-task and on-task behavior as well, was also found by David and colleagues (2015). Specifically, social media apps were harmful, whereas the use of devices to listen to music was not found to impact studying negatively and even lowered environmental distraction. A possible point of interest is that mobile phones are often used for listening to music and social media as well, which is found to be one of the main distractions during studying, and the question remains if the beneficial effect of music offsets the possibility of being distracted by the phone.

Changing the environment to limit distraction via music or other means is generally effective only in reducing external distractions (David et al., 2015). However, as discussed earlier, when external distractions are not present, distractions of an internal nature tend to increase. One way to effectively reduce both types of distraction is by using task selection and self-assessment training. Students who followed cognitive training courses in task selection and self-assessment improved significantly in the time spent focused on studying compared to

students without training (Kostons et al., 2012). This supports the theory that motivational factors, personality and cognitive processes influence distraction.

From a sociomaterial paradigms perspective, distraction and its prevention are not just the product of cognitive processes. Sociomaterial paradigms see agency as being distributed amongst actors in a network of relations. Agency is not located within an individual but emerges from the network and the interactions within it (Valasmo et al., 2022). When someone is distracted from studying or another task that requires sustained attention, it can be seen as a breakdown. A breakdown refers to an interruption of the routine of a system stemming from the interplay between the actors that are part of that system (Alirezageibi et al., 2020). Breakdowns can have several reasons such as a change of rules, a failure of a part of the system, or worldly events. Alirezageibi and colleagues (2020) interviewed a student who mentioned having to quit social media because they felt drawn to check it which caused them to be distracted. Being drawn to check the phone is an example of how materials themselves can start rhythms that automate actions and influence us. However, the fact that rhythms can emerge from a system that might cause distraction does not mean that an individual has no agency. The student deleting social media or a school limiting device usage via policy changes could be described as a system breakdown as well, changing it to limit the distraction caused by certain artifacts. Ivaturi and Chua (2015) describe how people tend to use multiple devices for work or learning, such as phones and laptops, and select these devices based on certain affordances they themselves give to these devices. For example, they found that laptops were more often described and used for work, while phones or tablets were used for leisure and off-task use. The use or performativity of material artifacts is not predetermined or a priori. Affordances of the material are subject to contextual influences as well as interpretation of the individual. The performance of materials is, therefore, not something inherent to the actual functions of the material alone but rather the product of the

combination of the affordances granted by the material and an individual's thoughts and actions (Ivaturi & Chua, 2015). Humans, therefore, have agency over the use of their material. However, this is different from the cognitive idea that we use items for off-task use because we are distracted, for instance, using a phone during class to text. Instead, from a sociomaterial perspective, both the phone's ability to be used in a specific way and the ideas we have about phone usage come together to create the outcome and possibility of distraction. This relates to the idea that agency is distributed amongst all actors in a system, and it is not just the result of a single individual. The above example illustrates how the entanglement of actors in a system comes together to create specific outcomes.

Despite both the material and social being seen as equally contributing and all having agency, sociomaterial paradigms do not discount the fact that humans can act upon our environment and change the material to fit our purpose better. From the examples given above, one could see how, from a sociomaterial perspective, the cognitive paradigm might be inadequate to fully describe the phenomenon of distraction by simply looking at the cognitive processes. However, there is also a crossover between the paradigms. The cognitive models that describe how our motivations and feelings influence how specific input, such as a phone message, influences our behavior is similar to that of the sociomaterial, where individuals' ideas and feelings regarding a certain device give that device particular affordances which in turn influences how it itself can influence the individual. We can also use the abilities of the material and embodied actions to reduce distraction. Valasmo and colleagues (2023) showed how a student could change the settings of his device to be able to use it during class without disturbing the teaching process and using the device without missing much of the class itself. This, however, takes effort from the individual as they must consciously adjust their behavior and the phone to the class's needs. In the case described in the paper, both the app and the phone are entangled flexibly, allowing the student to adjust them for use in the classroom. By

changing the settings and limiting the amount of pop-up messages or keeping the phone on the desk, the student exerts agency and limits the amount of embodied action needed, such as picking the phone up to read messages or swipe away notifications, controlling the degree in which the app and phone distracts and the student or disturbs the lesson.

In short, both the sociomaterial and cognitive paradigms agree that we can control or limit distractions to a degree. Sociomaterial approaches state that by using the affordances of the material, we can limit their ability to distract; we can adjust material artifacts to the needs of the task. Cognitive scholars describe limiting distractions by changing the environment to reduce stimuli. Interestingly, both the cognitive and sociomaterial perspectives agree that it takes a certain amount of effort to limit the distractions present. However, the difference is that cognitive models see this effort as needed because the distractions come from within the individual. As such, the individual must expend effort to remain focused. In contrast, sociomaterial scholars see a need to adjust the material and its affordances to the needs of the task, not because we are solely responsible but because the material allows certain adjustments to be made and, in doing so, works with the individual to create the outcome.

Multitasking

We have discussed the way in which distraction, as well as the role of agency, are conceptualized by both perspectives. In the following pages, we will discuss distraction, multitasking, and digital technologies. Digital technology in educational settings is a common occurrence these days. Accompanying this rise of digital devices is a rise in multitasking, with research suggesting students and workers switch between work and studying and another task every few minutes (Rosen et al., 2013). Using devices, often multiple at once, during class or other activities has become common, going as far as younger people being seen as and thinking of themselves as better multitaskers than older generations. This is, however, not supported by research, which shows that students who multitask perform worse academically

than their peers who multitask to a lesser degree (Aagaard, 2019; Bowman et al., 2010). Another point of interest is that, especially in cognitive literature, multitasking is often mentioned regarding distractions as an adverse effect of using digital devices for learning. However, as Aagaard (2015) argues, cognitive literature focuses mainly on the result, not the process, of multitasking.

Since multitasking is often not expanded on beyond it being seemingly linked to the digital device and the outcome of multitasking often being distraction, Aagaard (2019) states that the terms as they are used in cognitive literature are interchangeable. One can quickly see the validity of the statement. For example, researching a university that required all students to use laptops in class showed that students were using the laptops regularly during class for non-study-related tasks and activities (Fried, 2008). Despite this occurrence being described as multitasking at first, later in the analysis, the words distractors and distractions are used. Multitasking is relevant because it is connected to distraction and the use of digital devices and clearly shows the differences between the two paradigms.

An example of cognitive research on multitasking is that of Rosen and colleagues (2013). They show how the rise of digital devices in educational settings has led to increased multitasking behavior, with 91 percent of students reporting sending and receiving text messages during lectures. They also found that social media apps were most prevalent when looking at students' off-task use of mobile devices. Students who multitask by switching between paying attention to a lecture and the use of devices for non-educational as well as educational purposes have been found to retain less information and make slower learning progress. The effects of using a laptop for multiple tasks were shown to negatively impact peers who can see the screen of the distracted student as well (Sana et al., 2013). Rosen and colleagues (2013) measured the time between students switching from their assignments to social media or other off-tasks and compared students who spend more time multitasking with

students who spend more time on their assignments via their grades. They used this data, cognitive load theory, and motivational theories to explain these differences. This is in line with the main idea of cognitive theories that, in the end, it is not the devices themselves but our cognitive processes and needs, needs being both basic human necessities such as social contact as well as goals, that determine if we are being distracted. The effects of the technology, in this case, a laptop, are not discussed or explored further than how students used the device. This is also shown in Sana and colleagues paper (2013). They also reaffirm that students often multitask using laptops and mobile phones during class, both for learning-related activities and distractions such as YouTube or social media. They explain how doing multiple tasks at the same time makes the tasks compete for cognitive resources, which is detrimental to learning outcomes; even when the different tasks being performed were all learning-related, the negative effects remained, e.g., note-taking on the laptop being less effective than notes taken on paper. Sana and colleagues (2013) do consider that the laptop is different from an actual paper notepad; however, the properties of the laptop that make it so are not explored.

Sociomaterial scholars also have a great interest in technology and its effects, such as increased multitasking behavior. However, in contrast to the cognitive perspective, they are generally less interested in quantifiable data from which to draw conclusions. Instead, the focus is on how a specific outcome comes into existence. From a sociomaterial perspective, technology does more than wait for an individual to use it. Digital devices actively participate and allow and encourages the human to perform certain acts. This makes digital devices interesting as, from the sociomaterial perspective, the changes they bring to a system can be profound, such as extending a classroom beyond its physical walls to the outside world (Aagaard, 2017). Therefore, measuring the number of devices used for on and off-tasks and then using correlational statistics to see if the use of multiple devices is correlated to worse

academic performance, from a sociomaterial perspective, could be seen as a reductionistic method that disregards that learning is a complex phenomenon with many active participants, both material and human (Aagaard, 2017; Valasmo et al., 2023). An example of the difference between the two approaches is the paper of Ivaturi and Chua (2015) mentioned in the agency chapter. They looked at multiple device usage and switching between devices for different tasks, multitasking behavior, and its impact on performance. Notably, they too mention how research has focused little on the negative effects of devices (See, e.g., Aagaard 2017 for another example). For Ivaturi and Chua (2015), the effect of multitasking on performance was not specifically of interest. Instead, the focus was on how multiple devices and the human together created the outcome of multitasking and multiple device usage. However, they do not disregard the outcomes either, they do mention how using multiple devices and multitasking led to less productivity and how certain devices seemed to encourage off-task behavior more than others, leading to multitasking and distraction. Similarly, Luke (2022), when discussing the effect of lecture recordings, mentions how students can pause the video in order to answer texts or do other off-task behavior. Instead of focusing on the student's time spent on multitasking behavior or looking at the extra time needed to finish a recorded lecture, not the outcome but the process is the focus. This allowed for a detailed description of how the lecture recording allowed the students and the material to create an environment suitable for learning outside the classroom.

Both the cognitive paradigm and sociomaterial paradigms describe how digital devices change our study practices and impact our levels of distraction, with multitasking being mentioned regularly by scholars of both paradigms. However, their differences become more apparent when looking at multitasking. The cognitive scholars' approach to explaining outcomes and reactions via cognitive mechanisms results in multitasking being, in practice, indistinguishable from distraction as a term. Despite recognizing that the use and rise of

digital devices in learning environments leads to an increase in multitasking behavior, there is seemingly little difference between a paper investigating distraction and learning or multitasking and learning. In contrast, sociomaterial scholars approach multitasking similarly to distraction itself as well. However, the sociomaterial approaches allow scholars to look at more than the outcome. The why and how regarding the way technology is used and multitasking occurs can and is described as well.

Discussion

When looking at both the sociomaterial and cognitive paradigms regarding distractions in learning and digital technology, there are some significant differences between them. Cognitive theories favor the idea that internal cognitive processes determine the amount of distraction that an individual experiences. Therefore, the cognitive theories related to distraction try to explain it via internal mechanisms and individual factors. These factors include an individual's cognitive reserves, a limited amount of mental "energy" that we have, and motivational and personal factors (Andrade & Walker, 2023; Wickens, 2021). These together provide a framework for cognitive theorists to explain the processes behind being distracted. Sociomaterial theories and authors incorporate the individual when discussing distraction and learning; however, from this perspective, a single individual is not seen as the only actor with agency and an ability to influence outcomes (Alirezabeigi et al., 2020).

The sociomaterial and cognitive paradigms clearly differ in both ontological and epistemological views. Cognitive theorists assume we can reduce complex phenomena such as learning and distraction to internal processes to explain different outcomes. Sociomaterial theorists argue that many parts, both material and immaterial, work together at any given time to create certain outcomes. Internal processes are not discarded as not being real or relevant; however, they argue that there is a broad range of things that should be seen as equally important as well. A phone is not just a latent object until an individual decides to use it, but

instead, the phone allows and encourages the individual to do certain things (Decuyper & Simons, 2016). One could say the main difference is the scope of their views and research. However, this might be too simple a distinction. Cognitive theories could be seen as having a smaller scope, the individual, but they do not completely discard outside influences. Cognitive theories allow for motivational and social factors to be incorporated, as well as environmental factors (Kane et al., 2017; Wickens, 2021). However, in the end these factors are seen as a flow of input of which the result is determined via one's own internal mechanism. At the same time, sociomateriality might look at a broader, zoomed-out angle incorporating objects as well as features such as the relation between teacher and student. Sociomateriality incorporates factors of macro level, such as the rules of a university regarding phone use per example, as well as meso, such as the effects of a student's peers in or outside the classroom, and micro level, the way a specific student uses the setting of a mobile app to limit distraction for example (Luke, 2022).

Therefore, it is not unexpected that these two paradigms differ in how they explain phenomena. Where cognitive theories see distractions as being internal, the sociomaterial theories see them as the result of an intricate system. Agency lies with the individual in cognitive theories. In contrast, sociomaterial theories see agency as being distributed; each object or actor in a system contributes to the outcome. These differences between the two approaches however does not mean that it is impossible to reconcile one with the other.

There are multiple occasions where the two paradigms agree, multitasking being an example. Multitasking, as discussed earlier, is a common occurrence and both sociomaterial and cognitive research has been giving it attention when discussing distraction via digital technology. In the body, several papers were discussed from both perspectives regarding multitasking and its relation to digital technology and distraction. Here, the differences and similarities between the paradigms are more easily seen. Both paradigms do agree that

multitasking has a negative effect on academic performance, as well as recognizing how an increase in digital devices used led to an increase in multitasking and distraction (Bowman et al., 2010; Ivaturi et al., 2015). However, where sociomaterial approaches allow looking at the process of using multiple devices or performing several tasks at the same time in-depth, the cognitive literature, via using internal mechanisms and heavy use correlation statistics, merely explains the effects of multitasking and in doing so seems to lack a clear distinction in between multitasking behavior and distraction.

Scholars are still exploring the relatively recent rise of digital technology, its use in educational settings, and its effects. From a cognitive perspective, a student being distracted by their phone is partly a new phenomenon. For example, phones grant access to social media, increasing an individual's exposure to stimuli that otherwise would not be present, that have a social reward associated with them, such as notifications and texts. Humans, as social creatures, are generally predisposed to attend to social stimuli, which draws our attention to them (Rusz et al., 2018). However, the effect of the phone and social media notifications would still be explained similarly to a student doodling or talking to their neighbors during class instead of studying. At first glance, this could be seen as correct since the exact underlying mechanism should be at work in both scenarios from a cognitive viewpoint. The literature used for this paper from the cognitive perspective, therefore, seems to give more insight into the effects of digital distraction. However, it does not clearly explain how this is different from distraction in general. This causes the papers used, despite the majority being about digital technology and its effects, to be similar to those that focus on distractions in general. The cause for this similarity in method and results seems to stem from the fact that if cognitive scholars use the same models to explain a certain outcome, the conclusions will be similar to those concerning other related phenomena that, via similar mechanisms, produce

the same outcome. This, however, might not actually explain how and if digital technology specifically and uniquely influences us.

This contrasts with the sociomaterial viewpoint, which sees digital technology as adding wholly new features otherwise not present to the equation. As discussed earlier, Aagard (2016) described how phone use allows for both outside-in and inside-out movement. In essence, a phone allows for the outside world to be incorporated into the classroom, looking for extra information online during class or texting a friend who is elsewhere. From this view, texting a friend is not just the same as talking to your neighbor. Instead, the phone creates the possibility for actors outside of the classroom to participate in and influence the outcome of the activity being performed, such as studying. Viewing it in such a different way, sociomaterial scholars can discover and discuss the processes that underly phenomena otherwise not discussed or discovered and as such, can illustrate how digital technology, or other material artefacts, uniquely change and contribute to create certain outcomes.

This is not to say that sociomaterial approaches are superior to those of the cognitive paradigm. Sociomaterial literature, despite creating interesting new insights about distraction and learning, often seems to fall short of providing a common language and concise conclusions from which to create practical advice. For example, lecture recordings and their effect were discussed in the analysis (Luke, 2022). However one might find it hard to use the results of the paper to give a concrete answer to questions such as “How can we optimize the use of lecture recordings?” or “Do the benefits of lecture recordings for students outweigh the negatives compared to live lectures?”. Questions such as these could be better answered via cognitive literature.

Based on the literature discussed in this paper, I argue that the perspectives would stand to gain a lot by incorporating each other. Sociomaterial research can provide insight into complex processes, such as distraction and digital devices, showing effects and influences that

a cognitive viewpoint would not discover. Cognitive research could use the sociomaterial literature to guide them to new research questions and help sociomaterial scholars to provide more practical advice. This could be valuable and help alleviate problems such as multitasking and distraction, which are interchangeable terms in cognitive literature regarding distraction. Another possible benefit is that it might allow cognitive scholars to integrate the complexity of phenomena such as learning in their models and theories.

Finally, it is important to acknowledge that this thesis is limited in scope. Only a relatively small number of papers was used and there was a preexisting familiarity only with the cognitive paradigm.

Conclusion

When comparing the two paradigms, the cognitive and the newly emergent sociomaterial, both similarities and differences are quite clear. Cognitive approaches tend to focus on the individual to explain the effects of social, material, and environmental factors. They see the effects of digital technology regarding distraction mostly as it being another factor that taxes our cognitive reserve and draws our attention via stimuli. In contrast, sociomaterial literature describes how distraction results from many actors influencing each other to create it. Here, digital technology is entangled with the individual to create possibilities and outcomes. However, to a degree, both perspectives have similarities. For example, they seem to agree that an individual has agency. However, from a cognitive standpoint agency is explained via factors such as using our mental energy properly. Sociomaterial approaches explain our agency as being distributed between all actors in a network. However our ability to use the affordances of digital technology to limit their ability to distract the individual can influence the amount of distracting stimuli a device can produce. Furthermore, both agree that one of the effects of the rise of digital technology is the rise of multitasking. Cognitive literature mainly sees this as a negative phenomenon, whereas

sociomaterial literature tends to describe the system behind it rather than mainly describing the effect on academic performance. The implications of this paper are that to explain and research complex phenomena, such as learning and distraction, both the sociomaterial and cognitive scholars should use the insights and literature from each other to increase understanding and guide research. Possible interesting research questions incorporating both paradigms would be whether students feel that devices extend their classroom beyond its walls and how the degree to which they have these feelings taxes their cognitive reserves or how can cognitive models be adjusted to incorporate the complexity of distraction and learning as described by found in sociomaterial literature.

References

- Aagaard, J. (2015). Drawn to distraction: A qualitative study of off-task use of educational technology. *Computers And Education/Computers & Education*, 87, 90–97.
<https://doi.org/10.1016/j.compedu.2015.03.010>
- Aagaard, J. (2015). Media multitasking, attention, and distraction: a critical discussion. *Phenomenology And The Cognitive Sciences*, 14(4), 885–896.
<https://doi.org/10.1007/s11097-014-9375-x>
- Aagaard, J. (2016). Breaking down barriers: The ambivalent nature of technologies in the classroom. *New Media & Society*, 19(7), 1127–1143.
<https://doi.org/10.1177/1461444816631505>
- Aagaard, J. (2019). Multitasking as distraction: A conceptual analysis of media multitasking research. *Theory & Psychology*, 29(1), 87–99.
<https://doi.org/10.1177/0959354318815766>
- Alirezabeigi, S., Masschelein, J., & Decuyper, M. (2020). Investigating digital doings through breakdowns: a sociomaterial ethnography of a Bring Your Own Device school. *Learning, Media & Technology/Learning, Media And Technology*, 45(2), 193–207. <https://doi.org/10.1080/17439884.2020.1727501>
- Andrade, M., & Walker, N. (2021). Attention. In *Psycho 126: Cognitive Psychology* (pp. 198–209). Libretexts.
[https://socialsci.libretexts.org/Bookshelves/Psychology/Cognitive_Psychology/Cognitive_Psychology_\(Andrade_and_Walker\)](https://socialsci.libretexts.org/Bookshelves/Psychology/Cognitive_Psychology/Cognitive_Psychology_(Andrade_and_Walker))
- Bowman, L. L., Levine, L. E., Waite, B. M., & Gendron, M. (2010). Can students really multitask? An experimental study of instant messaging while reading. *Computers And Education/Computers & Education*, 54(4), 927–931.
<https://doi.org/10.1016/j.compedu.2009.09.024>

- Broadbent, D. E. (1957). A mechanical model for human attention and immediate memory. *Psychological Review*, 64(3), 205–215. <https://doi.org/10.1037/h0047313>
- Connor, C. E., Egeth, H. E., & Yantis, S. (2004). Visual Attention: Bottom-Up versus Top-Down. *CB/Current Biology*, 14(19), R850–R852. <https://doi.org/10.1016/j.cub.2004.09.041>
- David, P., Kim, J., Brickman, J. S., Ran, W., & Curtis, C. M. (2014). Mobile phone distraction while studying. *New Media & Society*, 17(10), 1661–1679. <https://doi.org/10.1177/1461444814531692>
- Decuyper, M., & Simons, M. (2016). On the critical potential of sociomaterial approaches in education. *Teoría de La Educación/Teoría de La Educación*, 28(1), 25–44. <https://doi.org/10.14201/teoredu201628125>
- Fried, C. B. (2008). In-class laptop use and its effects on student learning. *Computers And Education/Computers & Education*, 50(3), 906–914. <https://doi.org/10.1016/j.compedu.2006.09.006>
- Ivaturi, K., & Chua, C. E. H. (2015). Exploring Multi Digital Device Usage: A sociomaterial perspective. *International Conference On Information Systems*. <https://aisel.aisnet.org/cgi/viewcontent.cgi?article=1466&context=icis2015>
- Kane, M. J., Gross, G. M., Chun, C. A., Smeekens, B. A., Meier, M. E., Silvia, P. J., & Kwapil, T. R. (2017). For Whom the Mind Wanders, and When, Varies Across Laboratory and Daily-Life Settings. *Psychological Science*, 28(9), 1271–1289. <https://doi.org/10.1177/0956797617706086>
- Kostons, D., Van Gog, T., & Paas, F. (2012). Training self-assessment and task-selection skills: A cognitive approach to improving self-regulated learning. *Learning And Instruction*, 22(2), 121–132. <https://doi.org/10.1016/j.learninstruc.2011.08.004>

- Luke, K. (2020). The pause/play button actor-network: lecture capture recordings and (re)configuring multi-spatial learning practices. *Interactive Learning Environments*, 30(6), 1011–1027. <https://doi.org/10.1080/10494820.2019.1706052>
- Moreno, R., & Park, B. (2010). Cognitive Load Theory: Historical Development and Relation to Other Theories. In *Cambridge University Press eBooks* (pp. 9–28). <https://doi.org/10.1017/cbo9780511844744.003>
- Rosen, L. D., Carrier, L. M., & Cheever, N. A. (2013). Facebook and texting made me do it: Media-induced task-switching while studying. *Computers in Human Behavior*, 29(3), 948–958. <https://doi.org/10.1016/j.chb.2012.12.001>
- Rummel, J., Wöstenfeld, F. O., Steindorf, L., & Röer, J. P. (2023). Effects of cognitive load on perceived internal and external distraction and their relationship with attentional control. *Journal Of Cognitive Psychology*, 36(1), 165–181. <https://doi.org/10.1080/20445911.2023.2273576>
- Rusz, D., Bijleveld, E., & Kompier, M. A. J. (2018). Reward-associated distractors can harm cognitive performance. *PloS One*, 13(10), e0205091. <https://doi.org/10.1371/journal.pone.0205091>
- Sana, F., Weston, T., & Cepeda, N. J. (2013). Laptop multitasking hinders classroom learning for both users and nearby peers. *Computers And Education/Computers & Education*, 62, 24–31. <https://doi.org/10.1016/j.compedu.2012.10.003>
- Schraube, E. (2013). First-person perspective and sociomaterial decentering: Studying technology from the standpoint of the subject. *Subjectivity*, 6(1), 12–32. <https://doi.org/10.1057/sub.2012.28>
- Selwyn, N. (2011). Looking beyond learning: notes towards the critical study of educational technology. *Journal Of Computer Assisted Learning*, 26(1), 65–73. <https://doi.org/10.1111/j.1365-2729.2009.00338.x>

- Sorden, S. D. (2005). A Cognitive Approach to Instructional Design for Multimedia Learning. *Informing Science*, 8, 263–279. <https://doi.org/10.28945/498>
- Treisman, A. M. (1960). Contextual cues in selective listening. *Quarterly Journal Of Experimental Psychology*, 12(4), 242–248.
<https://doi.org/10.1080/17470216008416732>
- Valasmo, V., Paakkari, A., & Sahlström, F. (2022). The device on the desk – a sociomaterial analysis of how Snapchat adapts to and participates in the classroom. *Learning, Media & Technology/Learning, Media And Technology*, 48(3), 429–443.
<https://doi.org/10.1080/17439884.2022.2067176>
- Wickens, C. (2021). Attention: Theory, Principles, Models and Applications. *International Journal Of Human-computer Interaction*, 37(5), 403–417.
<https://doi.org/10.1080/10447318.2021.1874741>