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Autonomous Shopping Systems: Identifying and Overcoming Barriers to Consumer Adoption

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Abstract

Technologies are becoming increasingly autonomous, able to make decisions and complete tasks on behalf of consumers. Virtual assistants already take care of grocery shopping by replenishing used up ingredients while cooking machines prepare these ingredients and implement recipes. In the future, consumers will be able to delegate substantial parts of the shopping process to autonomous shopping systems. Whereas the functional benefits of these systems are evident, they challenge psychological consumption motives and ingrained human–machine relationships due to the delegation of decisions and tasks to technology. The authors take a cross-disciplinary approach drawing from research in marketing, psychology, and human–computer interaction to examine barriers to adoption of autonomous shopping systems. They identify different types of psychological and cultural barriers, and suggest ways to craft the online and bricks-and-mortar retail environment to overcome these barriers along the consumer journey. The article finishes with implications for policy makers and a future research agenda for researchers examining autonomous technologies.

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Introduction

Automation has changed many aspects of our lives. It entered the vernacular when Ford established an automation department in the 1940s and laid the ground for modern factories, cars, and airplanes. The future will be no less exciting as we move from the age of automation to the age of autonomy, with technologies becoming increasingly autonomous (Beer, Fisk, and Rogers 2014; Hancock 2017; Schmitt 2019). Physical robots with autonomous movement capabilities will transform warehousing while virtual assistants will act as personal digital concierges, interpreting consumers' needs and making decisions on their behalf. Already today, smart refrigerators can read the bar codes of your food, inform you about your fridge's contents, and help you order groceries online (Lifewire 2019).

The retail industry is particularly affected by these changes. A McKinsey report found that out of nineteen major industries the retail industry bears the greatest potential to create value by autonomous technologies and artificial intelligence (AI), amounting to over USD 600 billion annually (Chui et al. 2018). The current focus of the retail industry is on autonomizing customer service (e.g., through robots or chatbots), autonomizing payment (e.g., through AI-based self-checkout), and autonomizing delivery (e.g., through drones delivering last-mile goods to consumers; Baird 2018). These industry trends are also reflected in the academic literature, with recent research examining the role of predictive analytics in retailing (Bradlow et al. 2017), how retailers can leverage AI (Shankar 2018), and how new technologies change the future of retailing (Inman and Nikolova 2017; Grewal, Roggeveen, and Nordfält 2017).

In the current article, we explore a specific form of autonomous technology—autonomous shopping systems—to which consumers delegate shopping decisions and tasks. We define and distinguish autonomous shopping systems from related technologies (such as recommender systems and autonomous products) before providing an overview of the factors that enable their adoption. Based on a cross-disciplinary literature review and the integration of re-analyzed qualitative

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data, we identify four types of psychological barriers to adoption of autonomous shopping systems, along with cultural barriers. We then discuss how the online and bricks-and-mortar retail environments need to be crafted to reduce these barriers by suggesting targeted interventions along the consumer journey. We finish by exploring long-term consequences for consumers and society at large, and by suggesting a future research agenda that highlights research gaps in our understanding of autonomous technologies.

Our contribution is threefold. First, we define autonomous shopping systems and differentiate them from related technologies. Second, we identify key barriers to adoption of autonomous shopping systems. Third, we suggest specific measures for firms to overcome these barriers to adoption.

Autonomous Shopping Systems

The age of autonomy is arriving, as autonomous technologies move onto the scene to replace those that are merely automated[1] (Beer, Fisk, and Rogers 2014; Cefkin 2016; Hancock, Nourbakhsh, and Stewart 2019; Hancock 2017; Macy 2016). Although truly autonomous technologies are only emerging, scholars have commonly referred to a definition introduced by computer scientists in 1996, emphasizing that an autonomous technology senses the environment and acts on it "in pursuit of its own agenda" (Franklin and Graesser 1996, p. 6; see also Parasuraman, Sheridan, and Wickens 2000; Rijsdijk and Hultink 2003). We explore a specific form of autonomous technology that is of particular importance in a retail context.

We define autonomous shopping systems as technology to which consumers can delegate substantial parts of the shopping process, including shopping decisions and tasks. The system autonomously reaches a series of conclusions for consumers, such as which and how many items to buy and when to do so, based on input data. A current example is Boxed's Concierge that places orders on behalf of consumers when it anticipates that they are running low on an item (based on predictive analytics and without any customer engagement). Another example is Samsung's Family Hub Refrigerator that autonomously orders groceries (based on scanning items in the fridge), claiming further to be a hub to coordinate family activities. Whereas in these examples the systems' autonomy is limited to single tasks (e.g., reordering of specific items), more advanced autonomous systems will be able to take over increasingly larger and more complex shopping decisions (Rijsdijk and Hultink 2009; Schweitzer and Van den Hende 2016). For example, the system may choose apparel for a customer based on information on the customer's previous experiences, the customer's momentary feelings, the choices of similar customers, and environmental factors such as weather (Schlager, de Bellis, and Hoegg 2019).

Autonomous shopping systems change the shopping process profoundly by reducing or even eliminating the need for human decision making, thereby challenging deep-rooted human–machine relationships. On the one hand, removing the decision-making process provides advantages such as the alleviation of cognitive tradeoffs (Broniarczyk and Griffin 2014). On the other hand, consumers may be reluctant to forgo decision autonomy (Botti and Iyengar 2004; Wertenbroch et al. 2019), their self-regulatory resources may be depleted (Usta and Häubl 2011), and feelings of decision satisfaction may not ensue (Heitmann, Lehmann, and Herrmann 2007).

An early form of autonomous shopping systems is recommender systems, sometimes also referred to as virtual shopping assistants, which offer personalized recommendations based on algorithmic performance (Gomez-Uribe and Hunt 2016). Through identifying and matching products and services to consumers' needs (Köcher et al. 2019), recommender systems take a supporting role in consumer-shopping processes and decisions. Due to recent technological developments in the area of AI (Hildebrand 2019), recommender systems are increasingly transforming into autonomous shopping systems. Autonomous shopping systems go beyond providing suggestions and recommendations to the consumer by actively taking over shopping processes without the consumer's intervention. This novel type of technology displays high degrees of autonomy, changing how consumers experience and interact with these technologies (Grewal, Roggeveen, and Nordfält 2017; Hoffman and Novak 2018). In short, whereas recommender systems support the consumer decision-making process, autonomous shopping systems take over the consumer decision-making process.

Another type of autonomous technology is autonomous products. We define autonomous products as being characterized by the delegation of manual tasks to technology. Autonomous products take over tasks from consumers that typically require time and effort, leaving consumers the opportunity to take part in other activities (Leung, Paolacci, and Puntoni 2018; Rijsdijk and Hultink 2003). In fact, many autonomous products free consumers from daily chores, such as cooking a meal (delegated to a cooking machine), mowing the lawn (robotic lawn mower), and travelling from place to place (self-driving car). Whereas these products may be connected to other products and systems (e.g., the cooking machine may be integrated into a smart home system), they are meant to accomplish a manual task (e.g., cooking). Although automated products have a long history (e.g., food processors and automatic transmission in cars), it is only now that products are being equipped with higher levels of autonomy (Hoffman and Novak 2018; Porter and Heppelmann 2014; Rijsdijk and Hultink 2003, Rijsdijk and Hultink 2009). Note that smart and/or connected devices (with the Internet of things comprising these products) are related to autonomous products but do not necessarily exhibit high levels of autonomy. Importantly, whereas consumers delegate manual tasks to autonomous products, autonomous shopping systems typically involve both the delegation of decisions and tasks (or,

[1] Whereas automated technologies are designed to accomplish a specific set of largely deterministic steps and are made up of simple reflex-like rules, autonomous technologies learn, evolve, and permanently change their functional capacities based on the input of operational and contextual information (Infosys 2019). Automated and autonomous technologies are best thought of as a continuum: Technologies that were originally automated with a well-defined set of inputs and outputs may become increasingly autonomous and "smarter" over time as consumer demands and technological infrastructure change.

more generally speaking, mental and physical tasks) related to shopping. Thus, autonomous shopping systems are superordinate to autonomous products.

Fig. 1 provides a simplified decision tree that indicates how autonomous shopping systems differ from related technologies and when consumers tend to adopt these systems. It does so along the four main sections of this article: autonomous shopping systems, enablers of adoption, barriers to adoption, and overcoming barriers to adoption.

Enablers of Adoption

Consumers embrace new technologies for different reasons. Well-known models in marketing and management indicate why new technologies tend to be adopted (e.g., perceived ease of use and perceived usefulness) and why they tend to be rejected (e.g., salient financial and performance risks; Antioco and Kleijnen 2010; Arts, Frambach, and Bijmolt 2011; Schepers and Wetzels 2007; Venkatesh, Thong, and Xu 2012). These models further show the moderating roles of consumer demographics (e.g., age) and psychographics (e.g., innovativeness) while highlighting the gap between adoption intention and behavior, with properties such as high innovation complexity increasing adoption intention but decreasing actual adoption (Arts, Frambach, and Bijmolt 2011; Venkatesh, Thong, and Xu 2012). Whereas some of these findings can be transferred to autonomous shopping systems, these systems likely display additional enablers of (and barriers to) adoption due to their unique characteristics—such as the delegation of the decision-making process.

An obvious motivation of adopting autonomous shopping systems is their functional benefit. Predecessors such as recommender systems have been associated with a series of benefits for consumers, including reduced search costs, more efficient purchase decisions, and ultimately better decision making (Häubl and Trifts 2000; Xiao and Benbasat 2007). Autonomous technologies promise even higher degrees of functionality. A system described as autonomously ordering and cooking food for consumers based on their needs and preferences was perceived as allowing for healthier diets, along with many other functional benefits (Schweitzer, Gollnhofer, and de Bellis 2019). The functional aspects of autonomous technologies are particularly important for consumers with low expertise and low identification with the task (e.g., consumers who do not identify themselves as cooks are more likely to adopt a cooking machine; Leung, Paolacci, and Puntoni 2018; Schweitzer, Gollnhofer, and de Bellis 2019).

In addition, autonomous shopping systems are expected to be efficient and to enable time savings. In fact, a key argument for many of these technologies is that they free up time—time that can be used for other, potentially more meaningful tasks (de Bellis, Johar, and Schweitzer 2019). Research in social psychology showed that consumers were happier when they spent money on a time-saving purchase, such as paying for housecleaning, than when they spent money on a material purchase, such as a new pair of fancy shoes (Whillans et al. 2017; see also Hershfield, Mogilner, and Barnea 2016). Whereas time savings are also an inherent benefit of autonomous products (and related technologies), other aspects are unique to autonomous shopping systems.

Autonomizing the shopping process promises cost savings, as the system is able to compare prices of various retailers and to order items at the optimal point in time (e.g., when they are on sale or before their demand peaks). As autonomous shopping systems make the decision-making process obsolete, they provide further advantages such as the alleviation of cognitive tradeoffs (Broniarczyk and Griffin 2014). Most of all, autonomous shopping systems promise unprecedented levels of ease of use and convenience, which in turn are strong drivers of adoption (Willems et al. 2017; Wu 2018). Convenience, that is, consumers' time and effort perception (Berry, Seiders, and Grewal 2002), has the ability to make other options unthinkable and has been referred to as "the most underestimated and least understood force in the world today" (Wu 2018, p. 1). In fact, convenience emerged as main driver of the adoption of smart products in a representative survey, before "following technology trends" and time savings (Zimmermann et al. 2019).

Barriers to Adoption

New technologies frequently struggle in the marketplace, demonstrating the difficulty of convincing consumers to adopt technologies that are novel and unknown to them. Barriers to adoption are one reason for the high failure rate, as they prevent consumers from trying out new technologies. One such barrier is the lack of technology readiness, which may lead to frustration when dealing with new technologies (Parasuraman 2000). Technology readiness affects customer attitude indirectly through perceived innovation characteristics (Roy et al. 2018). Furthermore, demographical factors such as age and socio-economic status likely act as barriers to adopting new technologies (Lee and Coughlin 2015), and may determine adoption even more strongly than consumer innovativeness (Im, Bayus, and Mason 2003).

Barriers to adoption are often not only functional but also psychological and cultural (Antioco and Kleijnen 2010; Schepers and Wetzels 2007). Thus, consumers may value the benefits of a new technology but may nevertheless not adopt it because of how they feel about the technology. This is in line with research highlighting that consumption is not only driven by functional aspects but also by playful and fun aspects (Holt 1995; Okada 2005). Identifying and categorizing these "hidden" barriers to adoption is especially important for autonomous shopping systems due to their novelty and unique features, which in turn has implications for the firms providing these systems.

Research in marketing has shown that consumers may resist autonomous technologies for various reasons. For example, research has shown that perceived complexity and perceived risks (e.g., performance risks) may limit the adoption of autonomous products (Rijsdijk and Hultink 2003). Specifically, highly autonomous products were perceived as riskier and more complex, with perceived risk negatively influencing consumer valuations. In addition, innovation characteristics such as perceived uselessness and intrusiveness can increase consumers' resistance to these technologies (Mani and Chouk 2017). More

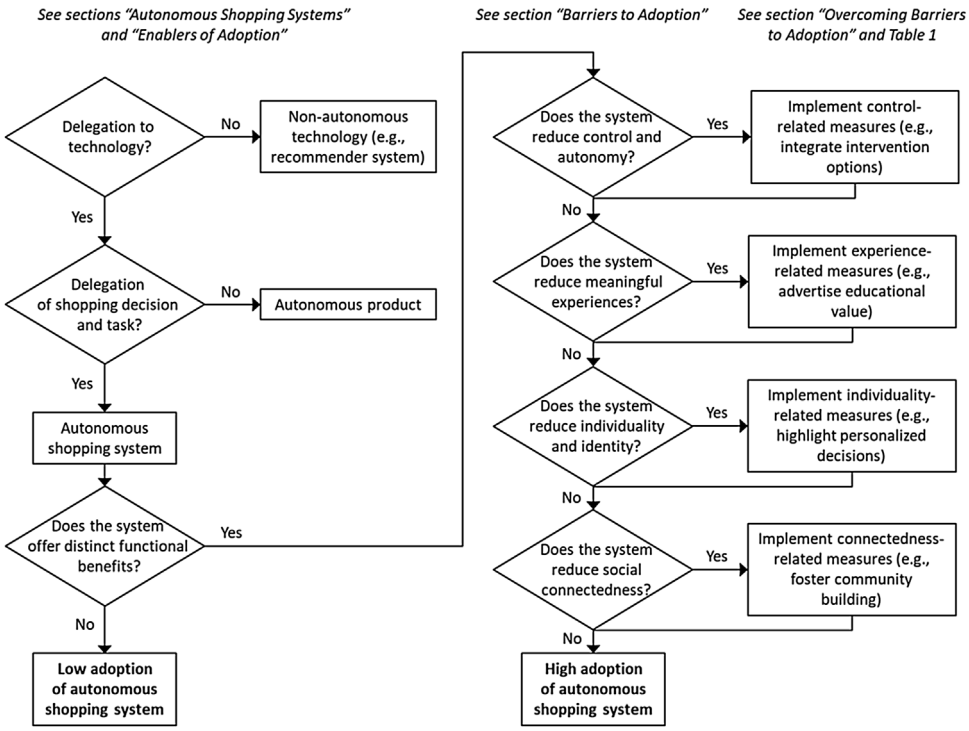

Fig. 1. Classification and adoption of autonomous shopping systems.

generally, research has found that consumers are averse to algorithms (which underlie autonomous technologies) because consumers more quickly lose confidence in algorithms than humans after seeing them make the same mistake (Dietvorst, Simmons, and Massey 2015).

Work on the adoption of autonomous technologies provides us with more detailed insights into psychological barriers to adoption. An extensive qualitative study by Schweitzer, Gollnhofer, and de Bellis (2019) identified four major categories of psychological barriers to the adoption of autonomous shopping systems, based on four key human desires. Specifically, the study explored consumers' perceptions of an advanced technology that autonomously manages the grocery shopping and food preparation process for consumers based on their needs and preferences, thereby involving the delegation of both decisions and manual tasks. The study included 30 semi-structured interviews and four focus groups with innovative informants in China, Switzerland, and the US. The findings demonstrate that delegating decisions and manual tasks to an autonomous shopping system prompts four trade-offs between functional and psychological consumption motives. We draw upon research in different areas such as psychology, sociology, and marketing to elaborate on these four barriers next.

Control and Autonomy

Perceived control is the belief that outcomes depend on one's own actions—and not on destiny, circumstances, other people, or external forces (Rotter 1966). Perceived control results in improved cognitive performance, more positive affect, and greater outcome satisfaction (Botti and Iyengar 2006), whereas perceived loss of control induces negative feelings such as stress or even depression (Peterson and Stunkard 1992). Consumer research has shown that perceived control is an important driver in consumption. For example, when consumers perceive limited control over outcomes in their lives, they seek control in consumption by choosing items that feel structured due to inherent boundaries (Cutright 2012) or by choosing "lucky products" that provide the illusion of control (Hamerman and Johar 2013). The striving for control is closely linked to individuals' need for and sense of autonomy, an innate psychological need (Ryan and Deci 2000) and one of the key characteristics of human self-awareness and motivation (Wertenbroch 2019)—not to be confused with a technology's level of autonomy (Hoffman and Novak 2018; Rijsdijk and Hultink 2003).

Consumers' perception of losing control may be the most evident and best documented barrier to adopting autonomous technologies, with multiple studies demonstrating this effect in varying contexts (Jörling, Böhm, and Paluch 2019; Puntoni et al. 2019; Schweitzer and Van den Hende 2016; Schweitzer, Gollnhofer, and de Bellis 2019). In the context of new products, consumer research identified desire for control (i.e., the need to personally control outcomes in one's life) as barrier to adoption, as new products diminish one's sense of control and mastery over the environment because the inherent uncertainty is perceived as a threat (Faraji-Rad et al. 2017). Perceived control has been associated with psychological ownership (Atasoy and Morewedge 2018) and was shown to be more important in tasks that are identity-relevant (Leung, Paolacci, and Puntoni 2018). Finally, positive outcomes achieved by autonomous products

are more likely attributed internally, whereas negative outcomes are more likely attributed externally, that is, to the autonomous product (Jörling, Böhm, and Paluch 2019).

We argue that the perception of losing control is particularly pronounced for autonomous shopping systems because of their high degrees of decision delegation, which is at odds with one's desire for control (Leotti, Iyengar, and Ochsner 2010). In the context of decision delegation to humans, research has shown that perceived loss of control inhibits delegation (Aggarwal and Mazumdar 2008). Similarly, autonomous systems have been related to feelings of disempowerment: A health monitor collecting personal health and dietary data and making dietary suggestions triggered feelings of technology dependence in consumers, reducing their intention to adopt such systems (Schweitzer and Van den Hende 2016). More advanced autonomous shopping systems that actively drive shopping decisions have been associated with compromised self-determination and the threat of being manipulated into buying non-desired products (Schweitzer, Gollnhofer, and de Bellis 2019). In addition, they likely undermine consumers' sense of autonomy, which can have negative effects on consumer well-being (André et al. 2018).

The desire for control may not be uniformly pronounced across markets. Early research in psychology indicated that consumers' desire for control differs depending on their cultural background, with desire for control being lower in the East than in the West (Weisz, Rothbaum, and Blackburn 1984). Whereas more recent research has argued that this effect may be limited to Japan (Hornsey et al. 2019), these cultural differences are reflected in the cross-cultural construct "uncertainty avoidance" (i.e., the way that a society deals with uncertainty), which shows a similar pattern for the US, India, and China (Hofstede 2019). Interestingly, the differences in desire for control seem more pronounced within Asia than between the East and West, and may be explained by the influence of Confucian teachings on Chinese culture, which emphasizes submission of control to authority, as well as individuals in China being less concerned with controlling future outcomes than individuals in India. These cultural differences have been shown to have direct practical implications. In a cross-cultural study, framing a new product as control-increasing (vs. control-reducing) led Indian consumers to evaluate the product as more favorably, whereas Chinese consumers were not sensitive to the differential framing (Faraji-Rad et al. 2017).

In sum, evidence from different studies and disciplines indicates that a lack of perceived control and autonomy acts as barrier to the adoption of autonomous shopping systems. This effect seems more pronounced in the West due to an increased desire for control in Western cultures.

Meaningful Experiences

Autonomous shopping systems not only endanger consumers' perception of control, but may also strip consumers of meaningful experiences and the ability to learn from them. Experiences are sensory perceptions and emotional feelings in consumption processes that have been shown to increase consumer well-being more than material goods (Gilovich, Kumar, and Jampol 2015) and can elicit experiential rewards (Csikszentmihalyi 2000; Holbrook and Hirschman 1982). In turn, experiential rewards are associated with skill development while fostering creativity and a playful form of discovery (Schweitzer, Gollnhofer, and de Bellis 2019).

A series of studies by Hoffman and Novak examined the relationship between consumers and smart products, arguing that these devices own unique capacities for interaction and thus create novel consumer experiences (Hoffman and Novak 2018; Novak and Hoffman 2019). Instead of focusing on the experiences that *emerge with* these technologies, we focus on the experiences *replaced by* these technologies. We argue that experience-oriented consumption motives are especially threatened when manual tasks are delegated to technology. It has been found that completing mundane tasks and chores is a form of counter-rumination and an effective way to escape heavy thoughts by focusing the mind on a material task—something that is clearly reduced when using autonomous shopping systems (Schweitzer, Gollnhofer, and de Bellis 2019).

In addition, mundane tasks can provide meaning to people. Whereas certain types of experiences may not make one happy, they can nevertheless add meaning to one's life (Baumeister et al. 2013). For example, even daily chores like cooking or cleaning may result in feelings of meaningfulness, which are especially important in an era where technological advances have alienated producers of products from their consumers (Van Osselaer et al. 2019). This relates to the finding that negative experiences, deriving from diverse sources such as arguing or personal losses, can also add meaning to life (Vohs, Aaker, and Catapano 2019).

In the context of meaningfulness, one has to consider the process as much as the outcome—that is, the way that things get done, and not just whether they get done. For example, people choose to climb mountains not only for the view, but also for the challenge of getting to the top (Loewenstein 1999), while cooking a delicious meal is more meaningful than just enjoying the same meal. Thus, even though the meal may taste better if a cooking machine prepares it for you, you lose the meaning because of delegating the process of preparing the meal. As autonomous shopping systems largely take over the process, they may not benefit consumers who strive for meaning (Puntoni 2018). In fact, our initial empirical evidence demonstrates that meaningfulness is a potent barrier to adoption of autonomous technologies (de Bellis, Johar, and Schweitzer 2019). Specifically, consumers who value effort and hard work (as denoted by the Protestant work ethic) and therefore attribute meaning to manual tasks are less likely to adopt autonomous (vs. non-autonomous) products.

In light of cultural differences in the valuation of effort and hard work (Cheng, Mukhopadhyay, and Schrift 2017), we examined two proxies of adopting autonomous technologies across major markets. Results showed that a country's valuation of effort and hard work was negatively correlated with its readiness for automation and acceptance of autonomous vehicles (de Bellis, Johar, and Schweitzer 2019). These results were robust when controlling for factors such as economic status and prevalence of vehicles. Thus, countries that value effort and hard

work more (e.g., India) seem more hesitant to adopt autonomous technologies.

In sum, autonomous shopping systems endanger meaningful experiences, which may inhibit the adoption of these systems. This is especially pronounced in countries that place more emphasis on meaning and hard work.

Individuality and Identity

Another psychological barrier to adoption is consumers' perception of losing their individuality when employing autonomous shopping systems. Individuality relates to the inherent human motive of perceiving and portraying oneself as being separate from other people, with numerous studies showing that consumption allows for distinction from other individuals (Snyder and Fromkin 2012; Tian, Bearden, and Hunter 2001).

Autonomous shopping systems can be a threat to consumers' perceptions of individuality and their general identity. In other words, consumers may fear that autonomous shopping systems are less able to account for their individuality. This is in line with research showing that consumers perceive AI as being less able than humans to account for their unique characteristics and circumstances, which in turn drives their resistance to AI in the medical area (Longoni, Bonezzi, and Morewedge 2019). It further corresponds to views that today's technologies of individualization are technologies of mass individualization that are surprisingly homogenizing (Wu 2018). In addition, Leung, Paolacci, and Puntoni (2018) showed that automated products may not be desirable when identity motives drive consumption. Specifically, consumers who strongly identify with a particular activity (e.g., cooking) use the self-signaling utility of consumption by attributing consumption outcomes internally to their own actions. Thus, consumers resist automated features when these features hamper the attribution of identity-relevant consumption outcomes to themselves. Besides these identity threats, research has shown that autonomous technologies can also trigger self-threats—for example, when one's job is taken over by a human worker versus a robot (Granulo, Fuchs, and Puntoni 2019).

Autonomous technologies may also pose more substantial threats to consumers' individuality. In an extreme form, autonomous technologies may produce equal, uniform consumers who think and behave similarly (Schweitzer, Gollnhofer, and de Bellis 2019). For example, individuals may adjust toward each other due to the use of aggregated consumer data that evens out the peculiarities of individuals. In response, consumers may refuse specific decisions made by autonomous shopping systems and eventually discard (or not even adopt) the technology to regain (or keep) their decision-making power. In addition to consumers seeing their own individuality in jeopardy, consumers may also fear that the diversity of other entities is constrained, such as small businesses that may not be considered by autonomous shopping systems (Schweitzer, Gollnhofer, and de Bellis 2019).

In sum, autonomous shopping systems endanger consumers' motive of perceiving and portraying themselves as unique individuals.

Social Connectedness

A final psychological barrier relates to consumers' perception of being disconnected and excluded from social settings. Consumption caters to the need to belong and the desire for interpersonal attachments and is able to create social connectedness (Loveland, Smeesters, and Mandel 2010; Troisi and Gabriel 2011). In addition, consumption can strengthen communal bonds whereas social exclusion results in changes of consumption (Mead et al. 2011).

Research on how technology usage affects consumers' social connectedness is surprisingly scant. In the context of online social networks, mixed empirical results have been reported. Whereas the usage of these networks has been associated with shallow social ties and the creation of a source of alienation and ostracism (Allen et al. 2014; Twenge 2013), it provides an opportunity to develop and maintain social connectedness and foster the creation of online groups and communities (Allen et al. 2014; Grieve et al. 2013). Whereas new technologies have been found to increase social connectedness for older consumers living at home by providing social support and reducing isolation (Morris et al. 2014), replacing human social interactions with machines can have negative effects on customer satisfaction, brand performance, and marketing relationships (Puntoni et al. 2019).

We argue that threats to social connectedness are particularly pronounced for autonomous shopping systems, as they reduce the interpersonal and communal aspect of shopping and consumption. For example, grocery shopping typically offers ample opportunities for social interaction between consumers and with cashiers, with retailers starting to offer "chatter checkout" lines to help customers socialize on their shopping trips (Stern 2019). As shopping systems become increasingly autonomous and consumers do not necessarily need to leave their homes for shopping, these systems hamper consumers' opportunities to socially connect and bond with others (Schweitzer, Gollnhofer, and de Bellis 2019). Thus, autonomous shopping systems may override the emotional and human touch in shopping and consumption that leads to integration, bonding, and social connectedness.

In sum, autonomous shopping systems endanger consumers' social connectedness, as they strip them of opportunities to socially interact and bond with others.

Culture

Besides the discussed psychological barriers there are various cultural barriers that influence and potentially limit the adoption of autonomous shopping systems along the consumer journey (Shavitt and Barnes 2019). For example, cultural differences can determine whether we trust robots as they shape our interpretation of agency-based, appearance-based, and social-relational criteria (Coeckelbergh 2012). In Japan, consumers are more likely to accept care robots due to friendly robot manga and Shinto beliefs that all objects are life forms deserving dignity and respect (Belk 2019). As a result, Japanese consumers are apt to regard robots as household members rather than seeing them only in terms of their functionality, which is more common

in the West (Shaw-Garlock 2009). In the context of autonomous vehicles, cultural differences were found when it comes to moral decisions such as the Trolley Problem, a classic thought experiment in which individuals have to weigh up the lives of different entities. For example, Eastern consumers showed a less pronounced preference to spare young (vs. older) individuals relative to Western consumers. Also, autonomous vehicles and other technologies need to be adapted to culture-specific customs, such as to express politeness and social harmony in Japan (Cefkin 2016).

Are there cultural differences with regard to the four discussed psychological barriers? To provide preliminary evidence on this issue, we reanalyzed the qualitative data from Schweitzer, Gollnhofer, and de Bellis (2019) in terms of cultural differences between the US and China. We coded the thoughts of each of the 19 American and Chinese informants according to the aforementioned psychological barriers and computed a score denoting the relevance of each barrier per informant, coded as "barrier is not relevant" (0), "somewhat relevant" (1), or "highly relevant" (2). First, we found control and autonomy to be the most dominant psychological barrier of autonomous shopping systems without finding any cultural differences on the surface ($M_{US} = 1.80$, $M_{CN} = 1.78$). However, a cultural pattern did emerge when considering different types of control threats. Specifically, American consumers seemed more concerned with the value-based rationale of control than Chinese consumers ($M_{US} = 1.40$, $M_{CN} = 1.11$). For example, American consumers related to control rather as a virtue in life (e.g., "in life, you have to make your own decisions") while highlighting privacy issues and the fear of being manipulated. This is expressed by the following quote:

> Privacy to me is possessing control over one's own information and experience, and possessing a lack of, almost like reliance in others. I know that harps back to autonomy. But, it's just like, the notion of having the lack of reliance on others and a greater reliance on one self, being the most informed version of yourself regarding your own condition [. . .] is just something innately that I enjoy experiencing.

At the same time, Chinese consumers seemed more concerned with the consequence-based rationale of control ($M_{US} = 0.40$, $M_{CN} = 0.67$). They emphasized more that autonomous technologies may lack the accuracy to understand and account for the varying preferences and emotions, as expressed by the following quote:

> Maybe I have a sudden change of mind and I have. . . I really want to have some special kind of food that day, but the technology won't tell my mind. It would just do what the data shows. It will do whatever is good for me, but I want to have something maybe not that good for me. And it cooks something I don't like [. . .] Because I sometimes have the feeling for eating some special food, some specific one. I have the specific food in my mind, what I want to eat that day. So, I will change it.

Second, we found no cultural differences with regard to the relevance of meaningful experiences ($M_{US} = 1.10$, $M_{CN} = 1.11$), implying that experiential rewards and skill development seem equally threatened by autonomous technologies across markets. Third, we found that American consumers tended to express individuality concerns more frequently than Chinese consumers ($M_{US} = 0.70$, $M_{CN} = 0.56$), in line with cross-cultural research showing that American (Chinese) consumers tend to focus on the individual (group) due to their independent (interdependent) social environments (Nisbett and Masuda 2003). Fourth, we found that American (vs. Chinese) consumers expressed a higher threat of losing social connectedness ($M_{US} = 0.80$, $M_{CN} = 0.56$), which may be explained either by the higher importance of social connectedness in the West or by the belief that autonomous technologies allow for social interactions in the East (Belk 2019).

In sum, we presented preliminary evidence for cultural differences in the adoption of autonomous technologies: American consumers tended to express more threats with regard to the value-based rationale of control, individuality, and social connectedness, whereas Chinese consumers expressed more threats with regard to the consequence-based rationale of control. These psychological and cultural barriers are important factors that need to be considered when developing and marketing autonomous shopping systems. Finally, it is important to note that self-selection likely plays a role in the adoption of these systems. In other words, consumers for whom the benefits outweigh the costs of psychological and cultural barriers are more likely to adopt these technologies (see Fig. 1).

Overcoming Barriers to Adoption

Having identified and grouped a range of barriers to adoption of autonomous shopping systems, we turn our focus from the consumer to the firm by discussing targeted interventions to increase adoption of these systems. Table 1 provides an overview of possible interventions to overcome the psychological and cultural barriers of autonomous shopping systems discussed in the previous section. In so doing, we differentiate between the physical product and the service level, which may require different types of interventions. Consider the example of a smart refrigerator. The system has physical properties (i.e., the fridge including its consumer interface) for which similar interventions can be derived as for autonomous products—such as anthropomorphism. However, the system also includes a service (i.e., ordering and delivering groceries), for which more specific interventions are needed—such as personalization. We elaborate on some of Table 1's proposed interventions next.

Targeted Interventions

Consumers are less likely to feel psychological ownership over autonomous shopping systems because of reduced feelings of perceived control (Atasoy and Morewedge 2018; Weiss and Johar 2013). For example, it has been argued that consumers may not establish the same degree of ownership for autonomous (vs. manual or automatic) vehicles because the self-controlling features of autonomous vehicles compromise consumers' feelings that these objects are under their control (Atasoy and Morewedge 2018). One way to increase psycholog-

Table 1
Possible interventions for firms to reduce barriers to adoption by barrier and intervention level (physical product vs. service).

Barriers	Interventions at the physical product level	Interventions at the service level
Control and autonomy	Anthropomorphize product and packaging to increase feelings of ownership	Frame system as control-increasing in marketing communication to ensure decision power
	Display technology in physical store; provide assistance and allow for extensive testing at point of sale	Allow for choices and integrate intervention options to prevent perceived disempowerment
	Provide money-back guarantee to increase consumer confidence	Be transparent why and how certain (important) decisions were made
Meaningful experiences	Highlight busy everyday life and time freed up by technology	Foster consumer learning in identity-relevant domains (e.g., by use of gamified elements)
	Advertise meaningful activities and experiences that can be undertaken instead of manual tasks	Advertise educational value to promote experiential growth
	Do not devalue daily chores in advertising and do not replace skills that are key to self-signaling and identity	
Individuality and identity	Foster consumer interactions on online social networks on unique outcomes achieved	Allow for consumer interaction to foster creativity
	Advertise ability of technology to match unique consumer personality	Advertise unique decisions and personalized solutions to foster customer centricity
	Provide opportunity to mass-customize product features (e.g., related to appearance or functionality)	Set pricing that allows for feelings of individuality
Social connectedness	Promote electronic word of mouth and incorporate other users into consumption experience	Integrate gamification and other interactive elements to foster community building and customer engagement
	Ensure social presence at time of purchase by sales on online social networks and for group purchases	Strengthen symbolic value of brands to transport feeling of connectedness
	Promote online reviews that emphasize the social character of technology	Implement measures especially for segment with high need to belong (e.g., as inferred from online social networks)
Culture	Advertise effort that can be put into other activities during freed-up time in markets that value effort and hard work more (e.g., India)	Advertise decision autonomy and ensure transparency in Western markets
	Leverage context effects and match autonomous features to prevalent culture	Advertise accuracy of technology and understanding of varying preferences in Eastern markets
		Implement measures to increase individuality and connectedness in Western markets

ical ownership is to anthropomorphize the physical properties of autonomous shopping systems, which has been shown to increase trust in technologies (de Visser, Pak, and Shaw 2018; Waytz, Heafner, and Epley 2014; see also Hoffman and Novak 2018 for different types of anthropomorphism). Anthropomorphism can also lead to more psychological warmth—as long as the technology (e.g., a consumer robot) is not too human-like, in which case anthropomorphism can backfire due to the so-called uncanny valley effect (Kim, Schmitt, and Thalmann 2019). We recommend anthropomorphizing the physical properties of autonomous shopping systems, be it in advertising, packaging, or the design of the technology itself.

To tackle the barrier of control, marketers may emphasize consumer control when positioning the autonomous shopping system. One way to reduce this barrier is through careful framing of the system. A tag line that emphasizes consumer control (e.g., "Take Charge of Your Taste Buds with this New Sensation Blend") was found to be more effective for new technologies than a tag line that implies reduced consumer control (e.g., "Let this New Sensation Blend Take Charge of Your Taste Buds"; Faraji-Rad et al. 2017). A framing approach can also be used to tackle the barrier of experiences. Instead of emphasizing that the autonomous shopping system is replacing a potentially meaningful task, marketers may promote that the system is freeing consumers to spend time on more meaningful activities and authentic experiences. For example, have the cooking machine prepare the meal so that you can spend more time with your family. In fact, some companies seem to have adopted this already, with household appliances manufacturer Vorwerk claiming that its Thermomix (a cooking machine) makes delicious meals while promising "more family time" and "things that, with time, turn into memories." We recommend promoting the control-increasing aspects of autonomous shopping systems while highlighting meaningful activities that can be pursued during the time freed up by use of these systems.

One key to overcoming the psychological barriers of meaningful experiences and social connectedness may lie in brands and branding. Research on brand communities suggests that consumers come together as parts of a broader assemblage, providing new experiences to consumers and greater community engagement (Algesheimer, Dholakia, and Herrmann 2005; Hoffman and Novak 2018). In the context of autonomous shopping systems, brand communities may partly compensate for the loss of meaningful experiences and social connectedness. An example is again Vorwerk's Thermomix, which integrates users in innovation processes and promotes community building, with the business model being largely based on word-of-mouth referrals (as it is exclusively distributed by sales representatives; Kröper, Bilgram, and Wehlig 2017). In addition, the symbolic value of brands likely caters to consumers' inherent need to

belong, highlighting the importance of strong, symbolic brands. Brands are also able to reduce the perceived uncertainty and risk associated with autonomous technologies (Rijsdijk and Hultink 2003). This is even more important when considering that by using autonomous shopping systems consumers are effectively relinquishing benefits they gained through mass production and were amplified through the Internet—such as evaluating various alternative brands and comparing prices (Hoffman and Novak 2018). We recommend placing special emphasis on strengthening the brand of autonomous technologies and promoting brand communities.

To address the barrier of individuality, companies may cater to consumers' feelings of uniqueness by employing mass customization and personalization, two one-to-one marketing concepts that both aim to achieve an experience tailored to consumers (de Bellis et al. 2019b). Whereas mass customization achieves a tailored experience by having consumers explicitly state their individual preferences, personalization does so by leveraging customer data. Thus, retailers may introduce and advertise mass-customized physical properties of autonomous shopping systems by having consumers select both exterior features (e.g., design-related properties such as the color and size of the technology) and interior features (e.g., functionality-related properties such as the type of integrated tools), which in turn likely promotes feelings of uniqueness (Franke and Schreier 2008). Having the opportunity to customize and intervene provides additional advantages, as has been shown in the context of algorithms where providing consumers the opportunity to modify algorithms reduced consumers' aversion toward algorithms (Dietvorst, Simmons, and Massey 2018).

For autonomous shopping systems, retailers may not only make use of but also promote their personalization mechanisms, which seems particularly important in light of research showing that perceived personalization can be more effective than actual personalization (Li 2016). Personalized customer experiences may also help consumers to create more meaningful relationships with brands (Puntoni et al. 2019). In addition, these systems may foster creativity by serendipity (i.e., radical changes in the evaluation of what is interesting, followed by an outcome in which the initially unexpected turns out to be both explicable and useful; Corneli et al. 2019), and retailers may provide consumers the opportunity to either opt in or out. We recommend employing mass customization at the physical product level and personalization at the service level of autonomous shopping systems.

Interventions and the Consumer Journey

New technologies influence the consumer journey in myriad ways (Hamilton and Price 2019). At what stage of the consumer journey do barriers to adoption of autonomous shopping systems become salient to consumers, and when are the proposed interventions most effective? In line with prior research, we distinguish between three broad consumer journey stages (Lemon and Verhoef 2016). In the pre-purchase phase, advertisements and promotions can effectively be employed to reduce specific threats (e.g., framing of technology as control-increasing). This phase is crucial to increase the awareness of and familiarity with autonomous technologies—be it via retail technologies in bricks-and-mortar shops (Willems et al. 2017) or appropriate category labels in online searches (Moreau, Markman, and Lehmann 2001). As autonomous products include only some properties of autonomous shopping systems (i.e., delegation of manual tasks without decisions), retailers could make use of a foot-in-the-door technique where consumers start with the autonomous product and only then include the autonomous decision-making element after consumers get used to the first technology.

In the purchase phase, the reduction of uncertainty associated with autonomous shopping systems is key (Faraji-Rad et al. 2017; Rijsdijk and Hultink 2003), which can be achieved by providing assistance at the point of sale (e.g., by salespeople or chatbots; Hildebrand and Bergner 2019). In light of research showing that consumers feel most loss of control at the final purchase step when delegating decisions (Aggarwal and Mazumdar 2008), consumers must have the feeling that their purchase is in their hands. In the case of autonomous shopping systems, it is particularly important to have consumers experience the efficiency and time saving aspects of the technology (e.g., by extensive trial runs). In the post-purchase phase, customer sales and usage data can help identify usage barriers and implement appropriate measures (e.g., provide customer assistance). This phase is crucial to provide unique experiences to consumers, to ensure understanding and potentially educate consumers, and to incorporate other users into the consumption experience, ultimately increasing customer retention and customer loyalty.

Discussion

In this article, we have introduced autonomous shopping systems and have identified a range of psychological and cultural barriers to adopting this novel technology. On this basis, we proposed a series of targeted interventions for retailers. In this final section, we take on the perspective of policy makers, discussing broader implications for society, as well as the perspective of researchers, proposing a future research agenda.

Autonomous technologies bring a wide range of societal changes with them (Huang and Rust 2018; Puntoni et al. 2019). Technology reliance can have a series of unintended negative consequences, such as technology addiction, diminished sense of competence and free will, reduced actual and perceived consumer autonomy, and degradation of automated skills (Castelo and Lehmann 2019; Wertenbroch et al. 2019). A major concern relates to negative information disclosure and privacy issues, which have been shown to reduce trust in technology (Okazaki, Li, and Hirose 2009). However, these systems can also have unintended positive consequences that are serendipitous (Belk 2019). For example, autonomous shopping systems may lead to more deliberate and less impulsive shopping, which can reduce consumers' financial risks. Also, these systems may lead to enhanced satisfaction with shopping outcomes, even though consumers may fail to recognize this due to the decision delegation to these systems (Botti and Iyengar 2004).

Table 2
Research agenda to advance the understanding of consumers' perception of autonomous shopping systems and related technologies.

Topic	Research questions	Related research
Self and identity	Do consumers classify autonomous products they own as "self" despite the products' high degree of autonomy?	Weiss and Johar (2016)
	Do consumers classify conventional products that were autonomously ordered by shopping systems as "self"?	
	How do autonomous products affect product-related identities and task performance?	Chung and Johar (2018)
	How does scarcity affect the adoption of autonomous technologies along the consumer journey?	Hamilton et al. (2019)
Branding	The role of brands in the age of autonomy: Do autonomous technologies "kill brands" or do they increase the importance of brands?	Galloway (2017)
	How can branding of autonomous technologies emphasize authentic and grounded experiences?	Morhart et al. (2015)
	How does the first physical impression of a (largely intangible) autonomous technology influence brand perceptions?	Moreau (2019)
Time and meaning	What do people do with the time freed up by autonomous products? Is more time always better?	Whillans et al. (2017)
	How do expected time gains due to autonomous shopping systems differ from unexpected (windfall) time gains, which are used for more hedonic activities?	Chung et al. (2019)
	Given that the freed-up time may increase boredom and boredom has been related to creativity, can these systems foster creativity?	Mann and Cadman (2014)
	How and when do we derive meaningfulness from performing manual tasks?	de Bellis et al. (2019b)
	Are autonomous technologies becoming a tool for success in life, as they allow the largest amount of time to be spent on the most meaningful activities?	Rudd, Catapano, and Aaker (2019)
Control	How does the importance of perceived control change with the increasing adoption of autonomous technologies? Will it be valued less?	
	What are the distinct roles of locus of control, self-efficacy, and maximizing tendencies in the adoption process?	
Social	Do shoppers perceive a trade-off between personalization gains and privacy issues?	Inman and Nikolova (2017)
	How do consumers disadopt autonomous technologies (behavior cessation) when they perceive that long-term determents outweigh short-term benefits?	Lehmann and Parker (2017)
	What are the perceived social risks of autonomous technologies (besides documented performance risks)?	Rijsdijk and Hultink (2003)
	What kind of relationships do consumers build with autonomous technologies that act on behalf of consumers?	Novak and Hoffman (2019); Schweitzer et al. (2019b)
	What is the role of perceived collaboration versus competition with a machine and can the former be fostered to increase adoption?	Seeber et al. (2019); Wilson and Daugherty (2018)
	On which interventions should retailers focus when they are conflicting (e.g., increase perceptions of social connectedness vs. individuality)?	
Consumer theories	How do concrete versus abstract construal levels influence autonomous technology adoption?	Trope and Liberman (2010)
	What role does process versus outcome mental simulation play given that autonomous products take over the task process?	Escalas and Luce (2004)
	Besides autonomy and relatedness, how can competence be integrated to account for self-determination theory?	Ryan and Deci (2000)
	How do fixed versus growth mindsets influence the delegation of decisions to autonomous shopping systems (especially with regard to experiences)?	Dweck (2008)

As technologies become highly autonomous, policy makers must ensure that future human–machine interactions are focused on the consumer's needs and preferences to maintain and increase consumer well-being. In establishing relationships with autonomous shopping systems that carry out actions on our behalf, autonomy should be designed with the ability to repair trust to ensure future technologies maintain and repair relationships with their human collaborators (de Visser, Pak, and Shaw 2018; Hancock 2017). A key question for policy makers to ask is what consumers do with the time freed up by use of autonomous shopping systems. Do they engage in meaningful tasks such as social relationships and physical activities that ultimately provide consumers with more meaningful and healthy lives—or would the ensuing boredom lead to more time spent on less meaningful activities (e.g., smartphone use, virtual reality) or even to engaging in harmful behaviors (e.g., drugs, violence)?

These questions indicate that our understanding of consumers' perception of autonomous shopping systems is still in its infancy, providing a plethora of avenues and opportunities for future research. Table 2 presents a series of research questions and gaps that we believe are relevant. They are grouped into seven broad topics: self and identity, branding, time and meaning, control, social, and consumer theories. Besides our focus on autonomous shopping systems, we also pinpoint research questions that concern related technologies such as autonomous products. We hope that this future research agenda helps to increase the understanding of autonomous technologies for the sake of both consumers and firms.

The current research introduced autonomous shopping systems. We identified factors that are relevant for the adoption of these systems and suggested targeted interventions for retailers to overcome adoption barriers. Autonomous shopping systems will profoundly change consumers' shopping and consumption behavior, with implications not only for the consumer journey but also for the future role and relevance of retailers.Executive Summary

Technologies are becoming increasingly autonomous, able to make decisions and complete tasks on behalf of consumers. Virtual assistants already take care of grocery shopping by replenishing used up ingredients while cooking machines prepare these ingredients and implement recipes. In the future, consumers will be able to delegate substantial parts of the shopping process, including shopping decisions and tasks, to autonomous shopping systems. These systems change the shopping process profoundly by reducing or even eliminating the need for human decision making. Given these unique features, the authors ask three questions: How are autonomous shopping systems characterized? What are key barriers to consumer adoption? And how can these barriers be overcome from a firm's perspective?

Autonomous shopping systems autonomously reach a series of conclusions for consumers, such as which and how many items to buy and when to do so, based on input data. Whereas the functional benefits of these systems are evident, they challenge psychological consumption motives and ingrained human–machine relationships due to the delegation of decisions and tasks to technology. The authors take a cross-disciplinary approach drawing from research in marketing, psychology, and human–computer interaction to examine barriers to adoption of autonomous shopping systems. They identify four types of psychological barriers (i.e., control and autonomy, meaningful experiences, individuality and identity, and social connectedness) along with cultural barriers. Having identified key adoption barriers, the article suggests ways to craft the online and bricks-and-mortar retail environment to overcome these barriers along the consumer journey, along with implications for policy makers.

The contribution of the article is threefold. First, it defines autonomous shopping systems and differentiate them from related technologies. Second, it identifies key barriers to adoption of autonomous shopping systems. Third, it suggests specific measures for firms to overcome these barriers to adoption.

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