



Symmetrical and asymmetrical approaches to brand loyalty– The case of intelligent voice assistants

Wei He^a, Catherine Prentice^{b,1,*}, Xuequn Wang^c

^a School of Management and Economics, University of Electronic Science and Technology of China

^b School of Business, University of Southern Queensland, Australia, 37 Sinnathamby Blvd, Springfield Central, QLD, 4300, Australia

^c School of Business and Law, Edith Cowan University, Joondalup, WA 6027, Australia

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ABSTRACT

This study investigates symmetrical and asymmetrical relationships among intrinsic needs, consumer engagement, attachment, and brand loyalty in the case of intelligent voice assistants (IVAs). Conducted with IVA users in the United States, the research employs structural equation modelling (SEM) to examine direct, linear relationships and fuzzy-set qualitative comparative analysis (fsQCA) for exploring complex, non-linear relationships. The findings indicate that psychological needs, consumer interactions with IVAs, and emotional bonds significantly influence brand loyalty. Furthermore, the fsQCA method reveals that various combinations of these factors contribute to brand loyalty in distinct ways. This study advances the literature on consumer behaviour and branding by providing insights into both the symmetrical and asymmetrical antecedents of brand loyalty. The findings hold substantial implications for IVA manufacturers, marketers, and brand managers.

1. Introduction

In the digital era, intelligent voice assistants (IVAs) such as Google Home, Siri, and Alexa have significantly transformed consumer interactions with technology and brands. These AI-powered devices possess the capability to interpret, learn, and utilise data to perform various tasks, ranging from setting alarms and playing music to controlling smart home devices (Kaplan & Haenlein, 2019). IVAs have become increasingly integrated into households, assisting with everyday activities and providing a convenient interface for accessing information and services (Abeliansky & Beulmann, 2021). Often perceived as reliable and personable companions, IVAs are endowed with appealing and likeable traits that foster routine engagement and personal attachment (Kabacinska et al., 2021; Schweitzer et al., 2019; Scoglio et al., 2019).

Numerous studies have explored the factors that drive consumer engagement with IVAs, typically focusing on the devices' functional and technical attributes. For example, McLean and Osei-Frimpong (2019) suggest that perceived utilitarian, symbolic, and social benefits are pivotal to consumer engagement. Similarly, Fernandes and Oliveira (2021) highlight that perceived usefulness, trust, rapport, and social presence significantly influence the acceptance and utilisation of IVA devices. Additionally, Mclean et al. (2021) report that perceived

intelligence and usefulness are critical in shaping consumer engagement. While these features can indeed attract consumer interaction, there remains a gap in understanding how basic psychological needs influence engagement with IVAs from a consumer perspective. The psychological needs in question pertain to autonomy, competence, and relatedness (Deci & Ryan, 2012). Previous research indicates that personal, situational, and marketing factors can drive consumer engagement with a brand (e.g., Prentice et al., 2019b; Vander Schee et al., 2020). However, Prentice et al. (2020b) argue that consumer engagement can be internally motivated, independent of external stimuli. Building on this premise, the current study investigates how consumers' self-determined psychological needs impact their engagement with IVAs.

Consumer engagement has been extensively recognised in the marketing literature as a precursor to forming customer relationships with a brand or firm, often resulting in brand attachment and loyalty behaviours (e.g., Chairunnisa & Ruswanti, 2023; Li et al., 2020; Lim et al., 2022; Tuguinay et al., 2022). In the context of IVAs, daily interactions can lead to dependence and a personal attachment to these smart devices (Kabacinska et al., 2021; Scoglio et al., 2019). This attachment may extend to the brand associated with the IVA, such as an attachment to Siri extending to Apple. This phenomenon, known as the "halo effect",

* Corresponding author.

E-mail addresses: hew@uestc.edu.cn (W. He), cathyjournalarticles@gmail.com (C. Prentice), xuequnwang1600@gmail.com (X. Wang).

¹ Orcid: <https://orcid.org/0000-0002-7700-3889>.

describes how positive impressions of one entity can influence perceptions of related entities (Nisbett and Wilson, 1977). The halo effect has been widely examined in consumer behaviour and branding literature, primarily focusing on its magnitude and influence (e.g., Nicolau et al., 2020; Park et al., 2011). However, no study to date has examined how the factors influencing a primary object (e.g., an IVA) might affect any associated entities (e.g., a brand) through the halo effect (Appendix A). This study aims to fill this gap by examining the linear relationship between psychological needs, consumer engagement, attachment, and brand loyalty. Specifically, it explores how psychological needs drive consumer engagement with IVAs and how this ongoing engagement fosters attachment to these intelligent devices, ultimately evolving into loyalty to the associated brand.

Proposing only a linear symmetrical relationship, however, is overly simplistic and may not capture the complexities of real-world interactions. Urry (2005) suggests that relationships between variables are often non-linear, influenced by unexpected interruptions and situational factors. Complexity Theory (Byrne and Callaghan, 2022) supports this view, positing that systems are characterised by constant change, uncertainty, and non-linearity. Reflecting this complexity, the current study also examines the potential for an asymmetrical relationship between the proposed antecedents (psychological needs, consumer engagement, and attachment) and the outcome (brand loyalty). The following section discusses the relevant literature and rationale for the proposed relationships.

2. Theoretical framework and hypothesis development

2.1. A linear symmetrical relationship

2.1.1. Psychological needs and consumer engagement

Self-determination theory (Ryan & Deci, 2000) explains how psychological motivations, emotions, and personality traits influence human behaviour in social contexts. Self-determination theory identifies three basic human needs: autonomy, competence, and relatedness. Autonomy reflects individuals' desire to experience volitional choices in their behaviours (deCharms, 1968). Competence encompasses individuals' desire to optimally accomplish challenging activities (Skinner, 1995). Relatedness specifies individuals' desire to develop and maintain mutual respect and care for others (Baumeister & Leary, 1995). Self-determination theory has been applied in various contexts such as social media (Li & Wang, 2017), materialism (Kasser, 2002), product attachment, and brand loyalty (Huang et al., 2015; Ilicic et al., 2016).

Within the marketing literature, consumer engagement is recognised as a multidimensional concept encompassing cognitive, emotional, and behavioural dimensions (e.g., van Doorn et al., 2010; Brodie et al., 2011; Hollebeek et al., 2014). Engagement represents an interactive connection and experience with a human (e.g., service representative), an entity (e.g., a service organisation), or an object (e.g., IVA) (Brodie et al., 2011). Research has shown that consumer engagement influences purchase and loyalty behaviours (e.g., Chen et al., 2022; Thakur, 2019). Consequently, organisations seek various means to engage consumers, such as premium services (e.g., Prentice et al., 2019b), and technologies like artificial intelligence (Prentice & Nguyen, 2020; Prentice et al., 2020a; Wei & Prentice, 2022). These organisational initiatives induce consumer engagement, referred to as induced engagement.

However, Prentice et al. (2020b) argue that consumers may voluntarily opt to engage with a brand and its associates without any marketing endeavours or incentives. This type of engagement is termed volitional engagement, driven primarily by internal factors such as social identity (Prentice et al., 2019a) and consumer personality traits (Vander Schee et al., 2020). In the context of IVAs, consumer engagement may be self-determined. IVAs provide consumers with a range of services (e.g., setting alarms, playing music, interacting with smart home appliances) through simple voice interactions. The initiative to interact with an IVA is self-determined, driven by the needs for

autonomy, competence, and relatedness as outlined in SDT (Deci & Ryan, 2012).

Autonomy is reflected in consumers' volitional choice to engage with an IVA for tasks such as ordering food or choosing music at their discretion. Competence is manifested in consumers' sense of effectiveness and confidence in interacting with an IVA. The ongoing advancement of technologies enhances the intelligence of these IVAs, eliciting intelligent responses from consumers. Relatedness is evident in how a consumer resonates with an IVA's performance, as seen in the IVA's ability to predict the consumer's patterns of demand, such as setting regular alarms, adjusting sound volume, regulating room temperature, and controlling lighting according to the consumer's preferences. These advanced features and functions of IVAs prompt consumers' self-determined engagement. Consistent with the foregoing discussion, the following hypothesis is offered:

H1: The need for a) autonomy, b) competence, or c) relatedness is significantly related to consumer engagement with an IVA.

2.2. Consumer engagement, attachment, and loyalty

Consumer engagement is manifested in five aspects: absorption, attention, enthusiasm, identification, and interaction (So et al., 2016). Absorption suggests that an individual is fully focused and deeply engrossed in their interaction with the target object (Scholer & Higgins, 2009). Attention refers to the degree of attentiveness an individual directs towards an object (Scholer & Higgins, 2009). Identification is the perception of belongingness (Tajfel & Turner, 1985), while interaction infers participation (Verhoef et al., 2010; van Doorn et al., 2010). In the case of IVAs, absorption can indicate consumers' immersion in conversing with an IVA; attention is manifested in exclusive interactions with the IVA; enthusiasm is shown in consumers' novelty and joy in engaging with the IVA; and identification and interaction indicate consumers' close affinity with these intelligence devices.

Attachment refers to the psychological and emotional connection between two entities: an individual, a group, or an object (Saldanha et al., 2020). The role of attachment in human relations, as suggested by Bowlby (1969), has been used to explain the relationship between consumers and brands (Fournier, 1998; Japutra et al., 2014; Loureiro, 2014; Malär et al., 2011; Park et al., 2013; Saldanha et al., 2020). Attachment derives from a deep bond known to exist between human beings and is also found in consumer-brand relationships (Fournier, 1998). Consumers tend to develop a close relationship with a brand because of their engagement or affinity with a particular product (Park et al., 2013; Thomson et al., 2005).

Engaging with an IVA can be an emotionally gratifying experience, enhancing emotional attachment to the device. For instance, asking an IVA to play a favourite song or setting an alarm becomes a daily routine that eventually develops into personal attachment to the IVA and the associated brand. Consumer behaviour research has shown that attachment can lead to brand loyalty (Harrigan et al., 2017; Rasooli-manesh et al., 2021). Consistent with this discussion, the following hypothesis is offered:

H2: Consumer engagement with an IVA is significantly related to emotional attachment to the IVA.

H3: Emotional attachment to an IVA is significantly related to brand loyalty.

2.3. The asymmetrical relationship

While consumer engagement with an IVA may result from psychological needs, the self-determination process often aligns with engagement behaviours, simultaneously eliciting attachment to the IVA and loyalty to the IVA brand, rather than following a strict cause-effect relationship. Assemblage theory accounts for this concurrent process,

suggesting that the assemblage emerging over time is influenced by the communal and agentic roles of both the user and the object (Hoffman & Novak, 2018). The agentic role reflects how much the consumer, or the object, influences the assemblage (i.e., the part affects the whole through decision-making capabilities). The communal role indicates how much the consumer, or the object, benefits from the assemblage (i.e., the whole affects the part, allowing the consumer to expand their abilities beyond what they could achieve without the IVA). This theory has been utilised to understand consumer experiences with the Internet of Things (Hoffman & Novak, 2018), and smart devices (Hoffman et al., 2016).

In the context of IVAs, while psychological needs may drive consumers' engagement with these intelligent assistants, the development of attachment and loyalty involves a more complex, non-linear relationship. For instance, autonomy involves making volitional choices without feeling pressured, and engagement behaviour can be volitional (Prentice et al., 2020b). Autonomy may coincide with IVA engagement and attachment, or each may function independently, asymmetrically, or conjunctively to explain the outcome (e.g., brand loyalty), reflecting a complex relationship. Fuzzy-set qualitative comparative analysis (fsQCA) is deemed appropriate to assess these asymmetrical relationships. FsQCA is a configurational set theory-based method that relies on Boolean algebra and set theory principles (Ragin, 2000, 2006, 2008a). The method can be used to test how proposed factors (referred to as conditions in fsQCA) are configured through Boolean algebra to explain the outcome of interest for a specific population or a sample cohort. Drawing on complexity theory (Urry, 2005), fsQCA can generate asymmetrical relationships between proposed antecedent conditions and outcomes for the target population.

FsQCA reveals three core tenets: 1) asymmetry, 2) equifinality, and 3) causal complexity. The *asymmetry tenet* indicates that both high and low scores for the same simple antecedent condition (e.g., psychological needs) can appear in two different configurations, both of which indicate a high score in the outcome condition. A high score of a simple antecedent may be a necessary condition of the outcome but not sufficient to explain it (e.g., brand loyalty). This antecedent (e.g., psychological needs) must be configured with other conditions (e.g., consumer engagement and attachment) to predict the proposed outcome. The *equifinality tenet* indicates that an outcome (brand loyalty) can be reached by multiple paths or configurations (path, configuration, and recipe are used interchangeably in this study) of proposed antecedent conditions (psychological needs, consumer engagement, and attachment). The *causal complexity tenet* indicates that the same simple antecedent condition (e.g., consumer engagement) can appear in both positive and negative models for the same outcome condition, whereby the recipes indicating the negation of an outcome condition are not the mirror opposites of the recipes showing a positive response for the same outcome condition (Douglas & Prentice, 2019; Douglas et al., 2020; Prentice, 2020). Consistent with the foregoing discussion, we propose an asymmetrical relationship among psychological needs, consumer engagement, attachment, and brand loyalty. The following hypotheses are offered:

H4: Psychological needs (autonomy, competence, and relatedness), consumer engagement, and attachment to an IVA jointly account for consumer loyalty to the IVA associated brand.

H5: Psychological needs (autonomy, competence, and relatedness), consumer engagement, and attachment to an IVA form unique antecedent conditions of consumer loyalty to the IVA associated brand.

3. Method

3.1. Sample and measures

The data were collected from those who had used one of the IVA

brands in their daily lives. Amazon's Mechanical Turk (Buhrmester et al., 2016; Paolacci et al., 2010) was opted to reach the target respondents. The respondents from this venue tend to be younger and more educated (Aguinis et al., 2021) and, hence, may be more likely to engage with IVAs. To encourage participation, each participant was compensated with USD 3 to complete the questionnaire. To minimize response fatigue, the questionnaire was designed to ensure a completion time of less than 10 min.

The scales employed to measure the constructs of autonomy, competence, relatedness, attachment strength, and brand loyalty were adapted from Thomson (2006). The consumer engagement scale was adapted from So et al. (2016) and reworded to reflect engagement with IVAs. All items used to measure the study variables were evaluated using a 7-point Likert-type scale (1-completely disagree to 7-completely agree).

3.2. Data collection procedure

Prior to conducting the survey, the purpose of the study was explained to prospective respondents in the information sheet. The items in the questionnaire included choices and lengths of different IVAs they had. The questionnaire was developed to minimise recall and common method bias through the employment of memory message ("think about the IVA you own to answer the questions"), commitment reinforcement ("please answer conscientiously and anonymously"), and attention checks (e.g., "what is the colour of the sky? Make sure to select blue to let us know that you are paying attention"). The items of the same construct were positioned at a physical distance and were kept simple to avoid unfamiliar terms. The questionnaire was pilot tested with 15 consumers to ensure clarity of the items. Some minor amendments were made because of the pilot test.

After multiple assessments of data normality (e.g., missing values, inconsistency, or extreme outliers), 252 valid responses remained for analysis. Almost half of the participants (48 %) used Amazon's Alexa, followed by Apple's Siri (28 %), and Google Assistant (17 %). A large number (46,8%) had owned their personal voice assistants for more than two years. Additionally, 37.4 % used the device every day and 24.8 % used them 2 to 3 times a week. Only 6 percent of the respondents used IVAs for less than a month.

3.3. Common method bias

Common method bias (CMB) in the data was assessed prior to testing the hypotheses (Podsakoff et al., 2003). Harman's single-factor analysis was conducted. The analyses revealed all items loaded on one factor explained 37.85 % of the total variance. Second, a common method factor was added by including all items. The variances explained by the focal factor versus those by the method factor for each item were assessed. On average, the focal factors explained 81 % of items' variance, while the method factor explained only 1 % (a ratio of 67:1). Therefore, CMB was not a concern in this study.

4. Results

4.1. Measurement model

The study proposed both symmetrical linear and asymmetrical relationships between psychological needs, consumer engagement, attachment, and brand loyalty. Structural equation modelling was employed to test the symmetrical relationships, while fsQCA was used for the asymmetrical relationships. Prior to asymmetrical testing, confirmatory factor analysis (CFA) was performed to assess the reliability and validity of the measures used in this study. The model fit was acceptable: $\chi^2(979) = 2112.99$, CFI=.91, SRMR=.05 and all loadings were above 0.70. Reliability and average variance extracted (AVE) were also acceptable, supporting convergent validity (Table 1). The square

Table 1
Results for factor loadings, reliability, and AVE.

Variables and items	Loading	Alpha	CR	AVE
<i>Autonomy</i>		0.82	0.83	0.71
IVA makes me feel controlled (reversed).	0.78			
IVA makes me feel pressured to be certain ways (reversed).	0.90			
<i>Competence</i>		0.91	0.91	0.83
Generally, IVA makes me feel very capable.	0.92			
Generally, IVA makes me feel effective.	0.90			
<i>Relatedness</i>		0.92	0.92	0.86
IVA makes me feel cared about.	0.91			
I feel a lot of closeness with IVA.	0.94			
<i>Absorption</i>		0.96	0.96	0.79
When I am interacting with this IVA. I forget everything else around me.	0.91			
Time flies when I am interacting with this IVA.	0.93			
When I am interacting with this IVA I get carried away.	0.91			
When interacting with this IVA. it is difficult to detach myself.	0.85			
In my interaction with this IVA. I am immersed.	0.91			
When interacting with this IVA intensely. I feel happy.	0.82			
<i>Attention</i>		0.93	0.93	0.76
I like to learn more about this IVA.	0.83			
I pay a lot of attention to anything about this IVA.	0.92			
Anything related to this IVA grabs my attention.	0.92			
I like learning more about this IVA.	0.82			
<i>Enthusiasm</i>		0.95	0.95	0.79
I am heavily into this IVA.	0.90			
I am passionate about this IVA.	0.92			
I am enthusiastic about this IVA.	0.88			
I feel excited about this IVA.	0.88			
I love this IVA.	0.86			
<i>Identification</i>		0.96	0.96	0.85
When someone criticizes this IVA. it feels like a personal insult.	0.88			
When I talk about this IVA. I usually say “we” rather than “they”.	0.93			
This IVA’s successes are my successes.	0.92			
When someone praises this IVA. it feels like a personal compliment.	0.96			
<i>Interaction</i>		0.97	0.97	0.88
In general. I like to get involved in the IVA’s community discussions.	0.91			
I am someone who enjoys interacting with like-minded others in the IVA’s community.	0.95			
I am someone who likes actively participating in the IVA’s community discussions.	0.94			
In general. I thoroughly enjoy exchanging ideas with other people in the IVA’s community.	0.96			
I often participate in activities of the IVA’s community.	0.93			
<i>Experience with IVA</i>		0.93	0.93	0.82
The experience with IVA contributed very much to my happiness in life.	0.87			
The experience with IVA is very meaningful.	0.93			
The experience with IVA is very personally fulfilling.	0.92			
<i>Attachment strength</i>		0.92	0.92	0.75
I feel better if I am not away from or without IVA for long periods of time	0.80			
I miss IVA when I don’t have it with me	0.87			
If IVA was permanently gone from my life. I would d be upset	0.89			
Losing IVA forever would be distressing to me.	0.89			
<i>Brand loyalty</i>		0.94	0.94	0.63
I would say positive things about this IVA brand to other people.	0.74			
I would recommend this IVA brand to someone who seeks my advice.	0.82			

Table 1 (continued)

Variables and items	Loading	Alpha	CR	AVE
I would refer this specific IVA brand to my friends and relatives.	0.82			
I would provide positive reviews for this IVA brand.	0.82			
I am most likely to reuse this IVA brand.	0.73			
High likelihood of repurchasing this IVA brand.	0.79			
I will repurchase this IVA brand even if the price increases.	0.74			
It is the best IVA brand I have ever used.	0.78			
I’m pleased to have used this IVA brand.	0.84			
It was a good idea to start using this IVA brand.	0.83			

CR=compositive reliability.

root of AVEs for each construct was higher than the correlation between the study variables, indicating the discriminant validity of the study variables (Table 2).

4.2. Hypothesis testing: Symmetrical relationship (H1-3)

Structural equations modelling was performed to test H1-3. As customer engagement is a multidimensional construct, the factor structure was assessed prior to hypothesis testing. Consistent with Prentice et al.’s (2021) procedures, both the first and second-order factor analyses were performed. The model fit indices for the second-order factor of customer engagement were acceptable: $\chi^2(248) = 864.35$, CFI=.92, SRMR=.06. The loading of items for first-order factors were all above 0.70. We then conducted CFA by calculating the average scores of the first-order factors to further examine the second-order factor structure. This approach had a better fit: $\chi^2(5) = 77.98$, CFI=.94, SRMR=.03 with all loadings above 0.70. Consequently, the latter approach was used in the hypothesis testing. The results show that autonomy ($\beta = 0.22, p < 0.001$), competence ($\beta = 0.17, p < 0.001$), and relatedness ($\beta = 0.63, p < 0.001$) were positively related to consumer engagement, supporting H1. Consumer engagement had a positive effect on attachment ($\beta = 0.85, p < 0.001$), which was positively associated with brand loyalty ($\beta = 0.53, p < 0.001$). Therefore, H2 and H3 were also supported.

4.3. Hypothesis testing: Asymmetrical relationship (H4)

FsQCA (Fiss, 2007; Ragin, 2008a) was used to perform the asymmetrical analysis. FsQCA involves three steps: calibration, defining a truth table, and counterfactual analysis (Olya and Altinay, 2016). The first step is to calibrate the data, converting the value of each variable to a range of 0 to 1. The calibrated score refers to the respondent’s membership. Three anchor points are used to represent full membership, the crossover, and full non-membership. Full membership refers to the selected cases with a membership score greater than or equal to the predetermined anchor point (normally ≥ 0.95 , or the 80th percentile); the cross-over represents neither in nor out cases ($=.50$, or the 50th percentile); full non-membership indicates the selected case has a score that is lower than the average value (normally ≤ 0.05 , or the 20th percentile) (Douglas and Prentice, 2020; Prentice, 2020; Prentice et al., 2021). The membership anchor points are determined by the study context and relevant theories (see Woodside et al., 2015). A truth table employing the Quine-McCluskey algorithm generates three solutions – complex, parsimonious, and intermediate. Parsimonious and intermediate solutions can be integrated to produce core and peripheral conditions (Fiss, 2007). We first calibrated our data into values between 0 and 1 following the direct approach before conducting fsQCA (Fiss, 2007; Ragin, 2008a). Table 3 presents the specific details for calibration in this study.

Table 2
Correlations and the square root of AVE (on diagonal).

	Autonomy	Competence	Relatedness	Engagement	Attachment	Brand loyalty
Autonomy	0.84					
Competence	0.30**	0.91				
Relatedness	0.57**	0.63**	0.93			
Engagement	0.63**	0.63**	0.86**	0.89		
Attachment	0.57**	0.60**	0.83**	0.85**	0.87	
Brand loyalty	0.09*	0.61**	0.46**	0.53**	0.53**	0.79

* $p < 0.01$, ** $p < 0.001$.

Table 3
Variable calibrations.

Variable	Descriptive Statistics	Calibrations (0.95, 0.50, 0.05)
<i>Demographic variable</i>		
Age	$\mu = 2.78, \sigma = 1.24, \text{min} = 1, \text{max} = 6$	(1,2,3)
Household size	$\mu = 1.93, \sigma = 0.85, \text{min} = 1, \text{max} = 3$	(1,2,3)
Technology experience	$\mu = 2.10, \sigma = 0.79, \text{min} = 1, \text{max} = 4$	(1,2,3)
Usage duration	$\mu = 2.31, \sigma = 0.73, \text{min} = 1, \text{max} = 3$	(1,2,3)
Usage frequency	$\mu = 3.70, \sigma = 1.30, \text{min} = 1, \text{max} = 5$	(2,4,5)
Autonomy	$\mu = 3.55, \sigma = 1.72, \text{min} = 1, \text{max} = 7$	(2.00,4.00,5.20)
Competence	$\mu = 4.89, \sigma = 1.41, \text{min} = 1, \text{max} = 7$	(4.00,5.00,6.00)
Relatedness	$\mu = 4.16, \sigma = 1.84, \text{min} = 1, \text{max} = 7$	(2.00,4.50,6.00)
Engagement	$\mu = 3.93, \sigma = 1.64, \text{min} = 1, \text{max} = 7$	(2.19,4.05,5.55)
Attachment	$\mu = 3.96, \sigma = 1.64, \text{min} = 1, \text{max} = 7$	(2.25,4.00,5.50)
Brand loyalty	$\mu = 5.12, \sigma = 1.11, \text{min} = 1, \text{max} = 7$	(4.46,5.30,6.00)

Notes: μ = mean, σ = standard deviation

4.4. Necessity analysis

Necessity condition analyses were performed prior to running a truth table. A value of 0.90 was used as the recommended consistency benchmark (Schneider & Wagemann, 2012). When the value of a variable (referred to as a condition or factor in fsQCA) is larger than 0.90, the variable is considered a necessary condition for the outcome. The results (Table 4) show that none of the proposed antecedent conditions were larger than 0.90 for brand loyalty, indicating the proposed factors were not independently necessary conditions for brand loyalty.

4.5. Truth table analysis

A truth table algorithm (Ragin, 2008b) was employed to identify solutions leading to brand loyalty, using a consistency benchmark of 0.80 as suggested by Ragin (2006). The results in Table 5 indicate that young males who frequently use IVAs, despite having limited technology experience, exhibited a high level of brand loyalty regardless of their education level. The results from testing H4 and H5 show that two models (paths) account for brand loyalty, with solution coverage of 23 percent and 17 percent respectively. In Model 1, high competence is a

Table 4
Results for necessary conditions testing.

Antecedents	Brand loyalty	
	Consistency	Coverage
Gender	0.49	0.47
Age	0.39	0.61
Household size	0.65	0.61
Technology experience	0.52	0.56
Usage duration	0.47	0.64
Usage frequency	0.64	0.65
Autonomy	0.62	0.57
Competence	0.75	0.75
Relatedness	0.69	0.69
Engagement	0.69	0.69
Attachment	0.67	0.69

core condition for brand loyalty, while Model 2 shows that all psychological needs, combined with intensive engagement explain brand loyalty. Interestingly, consumers' attachment to IVAs did not appear to be an important condition. To gain more insights into these configurations, symmetrical testing (SEM) with demographics as control variables was performed to assess the unique variance by each proposed antecedent condition in brand loyalty. The results in Table 6 show that usage frequency had a significant positive effect on brand loyalty. Autonomy ($\beta = -0.32, p < 0.001$) had a negative effect, while competence ($\beta = 0.37, p < 0.001$), engagement ($\beta = 0.42, p < 0.001$), and attachment ($\beta = 0.21, p < 0.05$) were all positively related to consumer loyalty. These findings show similarities in the role of competence but nuances in the effects of attachment and other psychological needs.

5. Discussion and implications

The study draws upon complexity, self-determination, and assemblage theories to examine the symmetrical and asymmetrical relationships among psychological needs, consumer engagement with and attachment to an IVA, and brand loyalty to the IVA-associated brand. Psychological needs refer to the need for autonomy, competence, and relatedness. Personal attributes were integrated into the analysis including age, gender, household, technology experience, IVA use duration, and frequency. The symmetrical testing shows a significant and positive linear relationship between the proposed factors. However, the asymmetrical testing generates some contrasting finding. The discussion of the study findings is as follows.

5.1. Symmetrical relationships

The results from SEM supported H1-H3. First, the needs for autonomy, competence, and relatedness positively impact consumer engagement. Second, consumer engagement is positively related to attachment, which ultimately leads to brand loyalty. These findings are consistent with those reported by Li et al. (2020). When psychological needs, consumer engagement, and attachment were included in the regression model with demographics as control variables, competence, engagement, and attachment had positive effects on brand loyalty. However, the need for autonomy had a negative effect. This finding is rather unique in consumer behaviour and branding research.

Regarding demographic variables, the SEM results showed that only usage frequency and usage duration had positive effects, and the effect of usage duration became insignificant after adding psychological needs, engagement, and attachment. Therefore, our results indicate that only usage frequency plays an important role in developing loyalty. Such results are consistent with the literature, which shows that consumers are likely to continue to use branded apps with higher usage frequency (Stocchi et al., 2020).

5.2. Asymmetrical relationships

When examining the configurations of psychological needs, consumer engagement, and attachment for brand loyalty, the results showed that two models with different antecedent conditions explained brand loyalty. The models presented rather different conditions as

Table 5
Configurational solutions of brand loyalty.

Model	Configurations	Raw	Unique	Consist.
A: Brand loyalty = F (gender, age, household size, education, technology experience, usage duration, usage frequency)				
1	Gender*~Age*Education*~TechnologyExperience*UsageDuration*UsageFrequency	0.14	0.09	0.79
2	Gender*~Age*HouseholdSize*~Education*~TechnologyExperience*~UsageDuration*UsageFrequency	0.10	0.04	0.78
Solution coverage: 0.19 Solution consistency: 0.77				
B: Brand loyalty = F (autonomy, competence, relatedness, engagement, attachment)				
1	~Autonomy*Competence*~Relatedness*~Engagement*~Attachment	0.23	0.13	0.82
2	Autonomy*Competence*Relatedness*Engagement*~Attachment	0.17	0.07	0.83
Solution coverage: 0.30 Solution consistency: 0.79				

Note: * indicates logic and, ~ indicates negation.

Table 6
Results for symmetrical testing between the proposed antecedents and brand loyalty as the outcome variable.

	Brand loyalty	Brand loyalty
Autonomy		-0.32***
Competence		0.37***
Relatedness		-0.12
Engagement		0.42***
Attachment		0.21*
<i>Demographic variables</i>		
Gender	-0.04	-0.02
Age	0.01	-0.01
Household size	0.02	0.01
Education	0.04	0.05
Technology experience	-0.003	0.10
Usage duration	0.28***	-0.01
Usage frequency	0.24***	0.18**
R ²	0.20	0.54

* p < 0.05, ** p < 0.01, *** p < 0.001

shown in the following:

*Model 1: Brand loyalty < low autonomy*competence*low relatedness*low engagement*low attachment.*

Model 2: Brand loyalty < autonomy competence* relatedness*engagement*low attachment.*

The fsQCA testing showed that, in one model, only the need for competence was an important condition of brand loyalty. In Model 2, a high level of psychological needs combined with intensive engagement with IVAs explained brand loyalty, regardless of whether consumers attached to the IVA or not. However, the need for relatedness did not have a significant effect on brand loyalty in SEM testing.

In the case of demographic variables, the results of fsQCA differed from those of SEM testing. While frequency of use presents in both configurations, other demographic variables also played important roles. Specifically, although gender and age did not have significant effects in SEM results, young males could develop high loyalty to the IVA brand when they had low technology experience but high frequency of use, along with other conditions in education, use duration, and household. These results indicate that there can be different paths for consumers from different backgrounds to develop brand loyalty.

The findings that the negation of attachment appears in both models indicate that personal attachment to the IVA is not necessarily related to their loyalty to the IVA brand. Marketers should direct their initiatives toward consumer engagement, focusing on identifying and addressing the appropriate psychological needs to attract consumers. For some consumers, it is their psychological needs in conjunction with engagement with the IVA that explains their brand loyalty. Conversely, other consumers remain loyal to the brand simply because of the effectiveness of using the IVA.

5.3. Theoretical implications

The study employed both symmetrical and asymmetrical analyses to

understand how psychological needs, consumer engagement, attachment, and brand loyalty are related in the case of IVAs. Several theories including self-determination, assemblage, and complexity systems were used to form hypotheses for the proposed relationships. Consequently, the study makes several contributions to consumer behaviour and branding research.

First, the nuances and similarities within the findings of this study regarding the influence of self-determination on brand attachment and loyalty indicate that symmetrical testing in prior research did not capture the totality of consumers' intrinsic-driven relationships with a brand. The case-based fsQCA method, with its asymmetrical testing, provided greater insights into brand loyalty and revealed the complex relationships between the antecedent conditions and outcomes of interest.

Second, the approach to configuring consumers' psychological needs, engagement, and attachment is novel to consumer behaviour and branding research. Self-determination theory has been widely used to describe brand loyalty. The configuration approach by fsQCA shows that psychological needs are not adequate to explain consumer behaviour on their own. These needs, combined with their engagement experience, form unique antecedent conditions of brand loyalty. This finding indicates that the variable-based symmetrical approach by linking two variables fails to reveal a holistic picture of the antecedent – outcome relationships, as shown in Gilal et al. (2020) and Yang et al. (2022). The case-based method of fsQCA revealed sufficient conditions, equifinal paths, and combined relationships for different population cohorts.

Third, most brand loyalty research is focused on attracting customer loyalty by identifying appropriate organisational offerings such as premium service quality (e.g., Rather and Camilleri, 2019), tiered pricing (e.g., Prentice, 2013), and complimentary services and loyalty programs (e.g., Prentice & Wong, 2015). This study approached the subject from the perspective of consumers' psychological needs and their personal engagement experience to assess brand loyalty. This approach provides a cost-effective avenue for customer loyalty research. The study also responds to the suggestion from Prentice and Loureiro (2018) that researchers and organisations should identify non-organisational endeavours that incur minimal organisational expenditure to address customer relationships with a brand.

Fourth, the finding that personal attachment to an IVA is significantly related to brand loyalty confirms the halo effect in the context of product-brand relationships. The halo effect in the branding literature is often used to describe the relationship between brand perception and brand equity. This study approached from a consumer perspective to understand how a consumer's relationship with one product extends to the associated brand. The findings reflected a relationship extension from personal experience to brand loyalty. In particular, understanding the factors of brand attachment informs the conditions for brand loyalty.

Finally, whilst attachment is significantly related to brand loyalty in the symmetrical testing, fsQCA shows a contrasting result that attachment to an IVA is irrelevant to brand loyalty. The differences are not reflective of contradiction but rather the complexity of the study context. As fsQCA is a case-based method, the findings indicate that the majority of IVA users develop loyalty to the IVA brand through their

psychological needs and engagement experience. The contrasting findings endorse the complexity theory in explaining consumer-brand relationships.

5.4. Practical implications

Given the research context and the application of SEM and fsQCA, the study findings have practical implications for relevant practitioners. The findings that psychological needs are significantly related to consumer engagement in symmetrical testing indicate that engaging consumers does not necessarily require organisational resources or expensive marketing offerings. IVA organisations should adopt a consumer psychological perspective to understand why consumers engage with the brand or product. Whilst consumer engagement is well recognised as an antecedent of brand loyalty, in the case of IVAs, consumers often develop attachment to these AI gadgets and subsequently become loyal to the parent brand. Marketers should not overlook the power of consumer attachment in brand loyalty.

In asymmetrical testing, the study shows that young males without technology experience use IVAs frequently, tend to be more attached to IVA devices and show loyalty to associated brands. This finding has a range of implications. First, for manufacturers, IVA design must be user friendly, especially for those who are not technology savvy or are reluctant to engage with complex designs. Second, attachment to IVA gadgets may have social and marketing implications. In some cases, consumers may prefer to engage with digital assistants over interacting with service representatives; for instance, using an IVA to order food rather than picking up a phone to call a restaurant. These findings can be used to develop marketing segmentation to target the appropriate market, adding more insights into the IVA target market.

The truth table analysis shows that the need for competence appears in both paths of explaining brand loyalty. The need for competence indicates the user’s effectiveness in interacting with an IVA. This finding has implications for IVA developers, suggesting that technical and functional features should be designed to enable consumers to achieve a sense of competence. IVA manufactures need to design devices that empower consumers to feel competent. IVAs come in a variety of designs within the market. Rather than adopting a push strategy, a pull approach, where IVAs are customized to suit consumer cohorts, may enhance sales and loyalty behaviour. Indeed, over last few years, IVA companies such as Apple and Amazon have been constantly upgrading

the functionality of Siri and Alexa. For instance, Apple offered iOS 17 to enable the use of Siri without saying “Hey Siri” (Mellon, 2023). These technological advancements enhance the effectiveness of interaction with IVAs, eliciting a sense of competence in consumers. As a result, Siri users stay loyal to Apple and do not switch to Amazon.

5.5. Limitations and future research directions

A few limitations must be acknowledged in this research. First, the study was conducted in the USA, thus the findings may not be generalised to other regions. Culture may play a role in consumer behaviours associated with IVAs. Future studies should replicate this research in other countries, especially emerging markets such as China and India. Second, the study utilized Amazon’s Mechanical Turk for data collection, which has merits given greater access to more diverse respondents than other approaches (Buhrmester et al., 2016; Paolacci et al., 2010). However, this method has received criticism due to the potential for biased sampling (see Lowry et al., 2016). Future research should include other qualitative and quantitative methods to mitigate potential common method bias. Third, the cross-sectional design of the study does not establish causal relationships between independent and dependent variables. Nevertheless, as fsQCA is a case-based approach that tests configurations with Boolean algebra and conjunctive relationships for the proposed conditions and outcomes, the findings are less affected by a cross-sectional design (see Prentice, 2020). Conducting comparative studies, however, may yield more insightful information. The study approached the issue from a user’s perspective to examine psychological needs and engagement experience. Future research should incorporate business initiatives, such as marketing promotions, to provide deeper insights into consumer relationships with IVA brands.

CRediT authorship contribution statement

Wei He: Writing – review & editing. **Catherine Prentice:** Writing – review & editing, Writing – original draft, Validation, Supervision, Resources, Project administration, Methodology, Formal analysis, Data curation, Conceptualization. **Xuequn Wang:** Formal analysis.

Data availability

Data will be made available on request.

Appendix A. Summary of the relevant literature

Studies	Independent variable	Dependent variable	Summary
Fernandes and Oliveira (2021)	Functional elements (perceived ease of use, perceived usefulness, subjective norms); social elements (perceived humanness, perceived social interactivity, perceived social presence); relational elements (trust and rapport)	Acceptance	Perceived usefulness, perceived social presence, trust, and rapport enhance acceptance.
Guha et al. (2023)	Natural speech; social cues; task range; accuracy	Evaluation	More natural speech and social cues increase artificiality, while greater task range and accuracy increase intelligence. Lower artificiality and higher intelligence enhance evaluations.
Jiménez-Barreto et al. (2021)	Self-determined interaction (competence, autonomy, relatedness); customer experience (sensory, intellectual, affective, behavioural, social)	Attitude and satisfaction with chatbot	Self-determined interaction and customer experience positively influence attitude and satisfaction.
Lee et al. (2021)	Personal innovativeness; technology anxiety	Continuance intention; intention to recommend	Perceived innovativeness and technology anxiety influence confirmation, which ultimately influence intentions.
Loureiro et al. (2021)	IVA attachment (self-connection, prominence); perceived value (quality, price, emotional and social value)	Relationship quality (satisfaction, commitment, trust)	Perceived value increases relationship quality.
Malodia et al. (2023)	Convenience; status seeking; usage barrier; risk barrier	Behavioural intention	Convenience, status seeking, and risk barrier influence trust, which then increase behavioural intention.
McLean and Osei-Frimpong (2019)	Utilitarian benefit; hedonic benefits; symbolic benefits; social presence; social attraction	Usage	Utilitarian benefits, symbolic benefits, social presence, and social attraction enhance usage.

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Studies	Independent variable	Dependent variable	Summary
McLean et al. (2021)	Social presence; perceived intelligence; social attraction; perceived ease of use; perceived usefulness; utilitarian benefits; hedonic benefits; distrust	Brand usage intention; purchase intention	Social presence, perceived intelligence, social attraction, perceived ease of use, perceived usefulness, and utilitarian benefits increase brand engagement, which in turn lead to brand usage intention.
Poushneh (2021)	Functional intelligence; sincerity; creativity	Satisfaction; continuance intention	Functional intelligence, sincerity, and creativity influence perceived control, which ultimately increases satisfaction and continuance intention.
Tassiello et al. (2021)	Involvement; Psychological condition of power	Willingness to purchase	Consumers are more likely to purchase low involvement via voice assignment, especially with high-power states.
This study	Psychological needs (competence, autonomy, relatedness); engagement experience (absorption, attention, enthusiasm, identification, interaction)	Attachment strength; brand loyalty	Psychological needs and engagement experience form unique and combined configurations of consumer attachment and brand loyalty.

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Dr He Wei is an Associate professor of marketing at School of Management and Economics, University of Electronic Science and Technology of China. His research interests include social media marketing and advertising.

Professor Catherine Prentice is a Professor of Marketing, Head of Marketing Discipline, at University of Southern Queensland, Australia. Over last 10 years She has published more than 100 articles in Q1 marketing and management journals, and three solo-authored research books, and given numerous keynote speeches, seminars, workshops in international conferences and institutions. Professor Prentice was named the leading researcher in Marketing and Strategic Management in The Australian's 2023 Research Magazine. Her main research interests include artificial intelligence, robotics, emotional intelligence, service research, consumer psychology, consumer behaviours, branding, services and relationship marketing, tourism, hospitality and gambling studies. She currently serves as Regional Editor of International Journal of Contemporary Hospitality Management (Q1); Associate editor of Service Industries Journal (Q1), Journal of Hospitality and Marketing Management (Q1), Tourism Review (Q1), and Journal of Global Scholars of Marketing Science (Q1) and an editorial member of over a dozen of Q1 journals.

Xuequn (Alex) Wang is a Senior Lecturer in the School of Business and Law, Edith Cowan University. He received his Ph.D. from Washington State University (US). Alex has taught different modules of Management Information Systems in various universities, including Washington State University (US), Dongbei University of Finance & Economics (China), and Murdoch University. Alex's research interests include social media, privacy, and human-computer interaction. His research has appeared in various Australian Business Deans Council (ABDC) A*/A-ranked journals, such as MIS Quarterly, Decision Sciences, Information Systems Journal, Information & Management, Tourism Management, and Journal of Business Ethics. He also serves as reviewer and editorial board members for different international journals and conferences.