

Ehrenberg-Bass Institute Working Paper:

Remembering less, or needing less? Age-related differences in the purchase funnel

*This working paper, dated 5 June 2023, was subsequently published in **Marketing Letters**.*

To access the published version of this article see:

[Mecredy, P., Wright, M., Feetham, P., Stern, P. \(2023\). Remembering less, or needing less? Age-related differences in the purchase funnel. Marketing Letters](#)

Authors:

Dr Philip Mecredy - Massey University

Professor Malcolm Wright - Ehrenberg-Bass Institute, Massey University

Dr Pamela Feetham - Massey University

Professor Philip Stern - Ehrenberg-Bass Institute, University of Exeter



Remembering less, or needing less? Age-related differences in the purchase funnel

¹Philip Mecredy ^a, Malcolm Wright ^{a, b}, Pamela Feetham ^c, Philip Stern ^{b, d}

^a School of Communication Journalism and Marketing, Massey University, Dairy Flat Highway, Albany, Auckland 0632, New Zealand

^b Ehrenberg-Bass Institute for Marketing Science, University of South Australia, Adelaide, Australia

^c School of Communication, Journalism and Marketing, Massey University, Tennent Drive, Palmerston North 4410, New Zealand

^d University of Exeter Business School, Rennes Drive, Exeter EX4 4PU, United Kingdom

Abstract:

This study explores how age influences the stages of the brand purchase funnel (awareness, consideration, and purchase) and the mechanisms associated with any age-related differences. Aggregated analysis of survey data (n=1,862) across five markets and four age groups shows a reduction in the proportion of brands recognised that subsequently enter the consideration and purchase sets of older consumers. Subsequent individual-level GLS regression analysis using age as a continuous variable reveals an inverse-U shape for brand recognition and in some cases for brand recall and consideration. Peak cognitive performance occurs at age 56. There is a linear decline for purchase set size across age. Therefore, age-related differences in brand awareness and consideration, and the mechanisms driving these changes, do not greatly impact age-related increases in loyalty. Instead, findings suggest age-related increases in loyalty result from a combination of accumulated experience, development of purchase habits and declining category purchase rates.

Keywords: older consumers, age, brand purchase funnel, brand loyalty

Ethical Approval: This study was peer reviewed and assessed as low risk, notified to the Massey University Human Ethics Committee, and exempted from ethical approval in accordance with the Massey University Code of Ethical Conduct for Research Involving Human Participants.

Informed Consent: Informed consent was obtained from all individual participants included in the study.

Funding: This work was supported by Massey University; the MSA Charitable Trust; and the HOPE Foundation for Research on Ageing.

Declarations of interest: none

¹ Corresponding author.

E-mail address: p.mecredy@massey.ac.nz (P. Mecredy)

Remembering less, or needing less? Age-related differences in the purchase funnel

1.0 Introduction

Most national populations are rapidly ageing due to longer life expectancies, ageing baby-boomers, and declining birth rates (United Nations, 2015). One consequence is that older adults are becoming an ever increasingly valuable segment of active consumers. Baby-boomers (born 1943-1963) account for \$548 billion of annual spending in the United States, the greatest of any generational cohort (Epsilon, 2019).

Despite the financial importance of older consumers, little research has explored how age influences the size of brand awareness, consideration and purchase sets (see Lambert-Pandraud & Laurent, 2020), three important components of the brand purchase funnel (Shocker et al., 1991). The brand purchase funnel may operate differently for older consumers for several reasons including the effects of age-related loyalty, cognitive decline, purchase inertia, and accumulated experience. Therefore, it is important to determine whether age-related differences in awareness, consideration, and purchase sets exist. Should observable age-related differences occur, this would enable researchers to investigate the mechanisms responsible for these differences, and practitioners to consider different strategies to target older consumers. As it stands, marketers may, for example, be inadvertently targeting less productive stages of the brand purchase funnel for older consumers.

Research in this area to date is limited to a few prominent studies exploring how age influences the size of brand awareness (e.g. Lambert-Pandraud et al., 2017; Thoma & Wechsler, 2021), consideration (e.g. Cole & Balasubramanian, 1993; Lambert-Pandraud et al., 2005), and purchase (e.g. Lambert-Pandraud & Laurent, 2010; Lambert-Pandraud et al., 2005; Uncles & Lee, 2006) sets. This lack of knowledge when combined with conflicting results between high and low-involvement categories, highlights that until now the evidence of how age influences each stage of the brand purchase funnel is inconclusive. In particular, research examining the influence of age on brand awareness is rare (Lambert-Pandraud et al., 2018; Lambert-Pandraud et al., 2017) and does not determine how age-related differences in brand awareness subsequently influence consideration and purchase. To better understand the complex relationship between age and progression through the brand purchase funnel, more

evidence is required across a range of new contexts, including how age-related changes in awareness subsequently influence consideration and purchase.

To address this gap, the current study assesses the impact of age on brand awareness in new contexts (consumer goods, store choice, and services) and is also the first study to comprehensively examine how age-related changes to brand awareness are related to consideration and purchase. The results have important implications for marketers as they identify the stage in the brand purchase funnel most affected by age. These findings will indicate whether marketing strategies are needed to influence, for example, long-term and working memory to build brand awareness and consideration, or instead to penetrate the purchase set of older consumers by altering well-established habits.

2.0 Literature review

2.1 Possible mechanisms for age-related differences in the brand purchase funnel

Multiple mechanisms may underpin age-related differences in the brand purchase funnel. For example, older consumers typically have smaller household sizes and so buy from certain categories less frequently, resulting in smaller purchase sets (Uncles & Ehrenberg, 1990; Yang et al., 2005). Therefore, older consumers may appear to be more loyal than younger consumers simply due to their reduced category purchase rate. This highlights the importance of controlling for purchase rates across age groups when assessing loyalty.

Biological ageing involves declines in vision, hearing, and mobility, as well as the onset of age-related chronic conditions and diseases (Adams & White, 2004; Zniva & Weitzl, 2016). Declines in mobility may cause difficulty accessing retailers, while hearing or vision issues may impact the processing of new information about brands (Lambert-Pandraud & Laurent, 2020). These changes are most likely to occur in later life rather than developing steadily across an adult's lifespan.

Cognitive decline involves deteriorations in speed of processing, working memory, and long-term (semantic) memory (Drolet & Yoon, 2020; Park et al., 2002; Salthouse, 2012). Reductions in the speed of processing is one of the most well-documented and accepted phenomena of ageing and are manifested in age-related decreases in working memory (Salthouse, 1996) - the memory that holds information in mind in the short-term while it is

being processed (Anderson, 1983; Gutchess, 2011). These declines in processing speed and working memory also contribute to age-related reductions in long-term memory (Park et al., 1996) - the repository for facts and knowledge held over a longer period of time (Anderson, 1983; Cowan, 2008). Park et al. (2002) further highlight the closely connected relationship between processing speed, working memory and long-term memory by demonstrating that all three cognitive constructs decline relatively continuously across age from the 20s to 80s.

These inter-related cognitive constructs all impact the brand purchase funnel, although some will likely affect certain stages of the funnel more than others. For example, reduction in long-term memory is likely to cause declines in brand awareness (recall and recognition) sets. These long-term memory effects are likely to be larger for brand recall sets, as research has found older consumers perform worse on recall tasks compared to recognition tasks (Craik & McDowd, 1987). Declines in working memory may also impact brand awareness. This is because working memory affects the ability to process information on new brands and retrieve information on old brands from long-term memory (Gutchess, 2011; Park & Gutchess, 2004). Working memory is nonetheless likely to have a larger influence on consideration and choice than long-term memory as older adults seek to reduce their cognitive effort when making purchase decisions (Lambert-Pandraud et al., 2005).

However, older consumers are often able to compensate for declines in long-term and working memory through accumulated knowledge (“crystallised intelligence”) gained through past category experience (Salthouse, 2012). This accumulated knowledge can lead to the formation of habits where consumers repeatedly purchase a brand without a strong psychological connection (Wood & Neal, 2009). Habits are formed at any point in time through the repeated purchasing of a brand and lead to an automatic propensity to repeat the behaviour (Drolet et al., 2017; Lambert-Pandraud & Laurent, 2020), resulting in reduced purchase sets for a given level of category purchasing.

These mechanisms affect each stage of the brand purchase funnel differently. For example, if older consumers have smaller awareness sets than younger consumers and this flows through to smaller purchase sets (higher loyalty), this may suggest older consumers are more loyal due to cognitive decline and consequent changes in working or long-term memory. Whereas, if older consumers have similar awareness sets as younger consumers, but smaller purchase sets, this may suggest the greater loyalty is caused by accumulated experience and the formation of purchase habits rather than age-related changes to consumer

memory. In the next sections we provide a more detailed consideration of these mechanisms at each stage of the brand purchase funnel.

2.2 Age influence on the awareness sets

There is conclusive evidence that memory declines with age (Park & Festini, 2017; Park et al., 2002), with meta-analysis demonstrating that free recall tasks are more affected by age than recognition tasks (Rhodes et al., 2019). Despite substantial research on how age influences recall and recognition, there is little research within a consumer setting. Most recently, Thoma and Wechsler (2021) found that older consumers recall fewer brands than younger consumers, but no age-related differences were found for the number of brands recognised. A positive association was also found between the brands recalled from semantic memory and phenomenologically richer auto-biographical memories, with stronger links between semantic and episodic memory for older consumers (Thoma & Wechsler, 2021).

Two studies in the context of French radio stations discovered older consumers have smaller unaided brand recall and aided brand recognition (awareness) sets than younger consumers (Lambert-Pandraud et al., 2017) and spontaneously recall fewer ‘known’ radio brands (Lambert-Pandraud et al., 2018). For older radio brands, age had a direct positive impact on brand awareness up until consumers’ early 60s, with no significant direct impact afterwards. Whereas, for newer brands, age did not have a direct impact on brand awareness up until the early 60s, with a strongly negative direct impact afterward. This indicates that while older consumers are more aware of older radio brands (than newer brands), there is a clear inflexion point in the direct impact of age on the awareness of both older and newer brands once a consumer is sixty (Lambert-Pandraud et al., 2017).

The evidence to date suggests that the relationship between age and brand awareness is non-linear. Lambert-Pandraud et al. (2018) found that the relationship between age and brand recognition has an inverted-U shape, predicted by a quadratic regression, while Lambert-Pandraud et al. (2017) use an augmented spline regression to model this relationship due to a distinct turning point at 60 years of age. It is important to note that these studies focused on media choice and that age-related brand awareness patterns may differ for consumer-packaged goods, store choice, and services. Therefore, we address the following:

RQ1: How do the awareness sets (recognition and recall) of consumers vary with increasing age for consumer-packaged goods, store choice, and services?

2.3 Age influence on the consideration and purchase sets

Multiple studies indicate that older consumers consider fewer new car brands for purchase compared to younger consumers (Evanschitzky & Woisetschläger, 2008; Lambert-Pandraud et al., 2005; Lapersonne et al., 1995). However, the impact of age on consideration sets is not conclusive in low-involvement product categories. Prior research found that older people consider fewer cereal brands than younger consumers (Cole & Balasubramanian, 1993), yet insignificant relationships are witnessed for coffee (Gruca, 1989), toothpaste and laundry detergent (Campbell, 1969).

Studies in high-involvement categories (e.g. automobiles and perfume) found older consumers have smaller purchase sets than younger consumers as they tend to repurchase their previous brand more often (Evanschitzky & Woisetschläger, 2008; Lambert-Pandraud & Laurent, 2010; Lambert-Pandraud et al., 2005). Although older consumers also have smaller purchase set sizes in some low-involvement categories (Uncles & Ehrenberg, 1990; Yang et al., 2005), this is largely attributed to older consumers having smaller household sizes and thus buying from the category less frequently (Uncles & Ehrenberg, 1990).

In summary, the literature signals that older consumers tend to have smaller consideration and purchase sets than younger consumers, although this may vary by category, due to either real increases in brand loyalty or reduced category purchase rates. These studies are limited to a few contexts and infrequently investigate whether consideration and purchase sets also decline in a linear fashion. An exception is research by Evanschitzky and Woisetschläger (2008) that found a linear relationship between age and size of brand consideration sets. This limited prior research leads to further research questions:

RQ2: How do consideration sets vary with increasing age?

RQ3: How do purchase sets vary with increasing age?

2.4 Age and the entire brand purchase funnel

While past research has investigated the effect of age at various stages of the purchase funnel, no prior studies provide a comprehensive examination of age-related differences across its entirety. Exploring age effects in this context will provide evidence on how age-related changes in awareness sets subsequently affect consideration and purchase sets, and therefore provide important knowledge about the underlying mechanisms that govern brand choice. In fact, Lambert-Pandraud and Laurent (2020) stress that determining whether cognitive factors impact purchasing in contexts that rely more heavily on recognition (e.g. consumer-packaged goods) is an important question for future research. Such knowledge will also guide marketing strategies aimed at increasing the purchase propensity of older consumers. This guides us to the final research question:

RQ4: What impact do age-related differences in the awareness set have on consideration and purchase sets?

3.0 Methodology

3.1 Data collection

An on-line survey of the New Zealand public (n=1,862) was used to collect data on brand awareness, consideration, and purchase choice across three repertoire (toothpaste, fruit juice, and supermarket store choice) and two subscription (home broadband and electricity) markets. All participants were obtained from a commercial panel provider and were screened to ensure they participated in grocery shopping and were jointly or solely responsible for paying utility bills.

3.2 Survey Design

For each category, respondents began with an unaided brand recall question, followed by aided brand recognition and consideration questions. For unaided brand recall, only the category prompt was provided. For the aided brand recognition and consideration set questions, the names and logos of the competing brands were provided in a randomised tick list format (see Web Appendix A for more detail). Respondents were able to select multiple brands and enter the name of any brands not listed. Following this, the Juster scale (Juster,

1966), an eleven-point purchase probability scale, was used to assess purchase penetrations for the five leading brands and ‘any other’ brands for supermarket store choice, fruit juice and toothpaste (see Web Appendix B for more detail).

3.3 Analysis procedure

The analysis follows a two-stage process. First, we report model free insights for age-related patterns and test whether these differ significantly across aggregated age-groups. We do so by assessing brand purchase funnel metrics across four aggregated age groups (39 years and below, 40-59 years, 60-74 years, and 75 years and above) drawn from prior literature (e.g. Uncles and Lee, 2006; Lambert-Pandraud et al. 2005) thus allowing for cross-study comparisons. For simplicity, we focus on interpreting the overall pattern seen across the brand awareness, consideration, and purchase sets for each age group and category, supplemented by significance tests (Web Appendix C).

Second, we undertake regression at an individual-level for each of i) brand recognition, ii) brand recall, iii) brand consideration, and iv) brand purchase set size. Each variable is the number of brands identified by each individual for each category, except for purchase set size which is the sum of the purchase probabilities given by each individual for each category. Therefore, for each category, there is one observation per respondent for each stage of the purchase funnel.

Successive regressions include age and prior stage of the funnel as independent variables. Here age is measured as a continuous variable, with a quadratic term added to capture non-linear effects. Prior stage of the funnel is the observed value of the predictor from the previous regression, included as a control variable to ensure age effects can be discriminated from carryover effects at different stages of the purchase funnel.

Preliminary assessment shows that consistent with Lambert-Pandraud et al. (2018) models including both linear and quadratic age terms outperform a solely linear model (Web Appendix D). However, the models result in structural multicollinearity and autocorrelation due to the quadratic transformation, with Tolerance = 0.22 and VIF ranging from 44 to 47 for the age variables as well as autocorrelation as shown by inspection of residual plots and Durbin-Watson statistics significantly different from 2.0. We therefore adopt a GLS approach

implemented through the Statsmodels library in Python to ensure the assumptions of regression are appropriately met (Web Appendix E).

4.0 Results

4.1 Funnel comparisons across aggregated age groups – exploratory

Table 1 shows the average size of consumers' brand recognition sets (aided awareness) across age groups for each category. Brand recognition sets appear to grow across age groups until 75 years of age for supermarket store choice, broadband, and electricity, and 65 years of age for toothpaste and fruit juice, before declining.

To the right of table 1, the average number of brands recalled, considered, and purchased are reported as a proportion of the average number of brands recognised. This allows tracking of what proportion of brands recognised remain in each subsequent stage of the purchase funnel for each age group.

For brand recall, the proportion of brands recognised that are recalled is relatively stable across age groups for supermarket store choice, fruit juice, home broadband, and electricity, while increases are seen for toothpaste. Contrary to prior evidence, this demonstrates that free recall tasks do not appear to be more affected by ageing than recognition tasks in the categories examined.

Turning to brand consideration, declines in the proportion of brands recognised that are considered are seen in four out of five categories. This demonstrates a drop off in the number of brands from the brand recognition set entering the consideration sets for older age groups. A similar drop off is also witnessed for the proportion of brands recognised that enter the purchase set for the three repertoire markets examined. No purchase set analysis is undertaken for the subscription markets as consumers do not typically subscribe to more than one brand.

As the data are not normally distributed, we apply nonparametric Kruskal-Wallis tests to determine whether brand recognition, recall, consideration, and purchase vary between age groups. The results are significant for all metrics, rejecting the null hypothesis of no difference between age-groups. Comparing the proportions of brands recognised recalled, considered or purchased between younger and older age groups, we find that differences between the two younger and two older age groups are significant in all cases ($p < .001$), while

differences between the oldest age group and the three other age groups are significant in 11 out of 13 cases examined. See Web Appendix C for details.

This exploratory analysis shows that the proportion of brands recognised being recalled is similar across age groups, sometimes showing an increase in age, but usually with a drop off in the proportion of brands recognised that are considered or purchased. Declining consideration and loyalty seen here is consistent with prior studies in high-involvement categories that have compared consideration and purchase sets across age groups (e.g. Lambert-Pandraud et al., 2005). However, as discussed next, tracking all funnel metrics for the same customers provides additional insights by indicating that age-related declines in loyalty are enhanced by mechanisms affecting the last stage of the brand purchase funnel.

Table 1. Awareness, consideration, and purchase set size across age groups

Age Group	n	Ave. # of brands recognised	Ave. # of brands recalled	Ave. consideration set size	Ave. purchase set size	Ave. recall ratio	Ave. consideration ratio	Ave. purchase ratio
						<i>Reported as a proportion of the number of brands recognised</i>		
<i>Supermarket (next 4 weeks)</i>								
<40yrs	416	5.0	3.4	2.4	2.9	0.68	0.49	0.59
40-59yrs	484	5.4	3.6	2.4	2.6	0.67	0.44	0.47
60-74yrs	503	5.6	3.9	2.2	2.3	0.70	0.40	0.41
>74yrs	459	5.4	3.7	2.1	2.2	0.69	0.39	0.41
Average		5.4	3.7	2.3	2.5	0.68	0.43	0.46
<i>Toothpaste (next 3 months)</i>								
<40yrs	416	4.9	2.0	2.3	2.6	0.41	0.47	0.54
40-59yrs	484	4.9	2.2	2.2	2.3	0.45	0.46	0.46
60-74yrs	503	4.1	2.2	1.9	1.7	0.55	0.47	0.42
>74yrs	459	3.6	2.0	1.7	1.5	0.56	0.49	0.43
Average		4.4	2.1	2.0	2.0	0.49	0.47	0.46
<i>Fruit Juice (next 4 weeks)</i>								
<40yrs	416	5.1	2.1	2.9	2.5	0.42	0.57	0.50
40-59yrs	484	5.5	2.3	2.9	2.1	0.43	0.53	0.39
60-74yrs	503	5.0	1.9	2.3	1.4	0.37	0.46	0.28
>74yrs	459	4.4	1.7	2.1	1.3	0.38	0.48	0.30
Average		5.0	2.0	2.5	1.8	0.40	0.51	0.36
<i>Home Broadband</i>								
<40yrs	416	6.4	2.5	2.3	N/A	0.39	0.36	N/A
40-59yrs	484	7.3	2.9	2.5	N/A	0.40	0.34	N/A
60-74yrs	503	7.4	2.8	2.3	N/A	0.38	0.31	N/A
>74yrs	459	6.5	2.5	2.1	N/A	0.38	0.32	N/A
Average		6.9	2.7	2.3	N/A	0.39	0.33	N/A
<i>Electricity</i>								

<40yrs	416	5.0	2.2	2.3	N/A	0.44	0.46	N/A
40-59yrs	484	6.0	3.1	2.5	N/A	0.52	0.42	N/A
60-74yrs	503	6.3	3.3	2.2	N/A	0.52	0.35	N/A
>74yrs	459	5.8	3.0	2.0	N/A	0.52	0.34	N/A
Average		5.8	2.9	2.2	N/A	0.50	0.38	N/A

4.2 Regression analysis across age – individual-level

Table 2 displays the results of the GLS regression for each category and each stage of the brand purchase funnel. The regressions are conducted using individual-level data where age is reported as a continuous variable. The fit statistics reported include R^2 , F statistic and p-value (Sig. F), as well as linear impact of age (β_1), quadratic impact of age (β_2), prior stage of the funnel (β_3), and a constant term (β_4). The Durbin-Watson statistics, all being non-significantly different from 2, indicate application of the GLS approach has also successfully addressed autocorrelation present in the OLS regressions.

For brand recognition, all linear age parameters are significant and positive and all quadratic age parameters are significant and negative. This confirms the relationship between age and brand recognition follows an inverse-U shape with the number of brands recognised increasing across age before reaching a turning point and declining. From the estimated parameters, the average peak age for brand recognition is 52 years.

Turning to brand recall, only fruit juice and home broadband show significant results for both age parameters. For brand consideration, a similar result is found, with only home broadband and electricity showing consistently significant age parameters. Each of these four cases has a positive linear parameter and a negative quadratic parameter, confirming the inverse-U shape found for brand recognition stage of the brand purchase funnel. That is, the number of brands recalled or considered increases across age before reaching a turning point (at age 65 for brand recall, and age 58 for brand consideration) and then declining. The six other cases show minimal age-related changes. In contrast, the parameters for the prior stage of the funnel are consistently positive and significant with comparatively higher t-values. These results indicate considerable momentum from the prior stage of funnel compared to a relatively smaller effect for the age parameters in the middle stages of the brand purchase funnel. Across the first three stages of the funnel, where both age parameters are significant, the estimated average peak age for the studied effects is 56 years.

Lastly, for brand purchase, the linear parameters are significant and negative for supermarket store choice and toothpaste, while the quadratic parameters are not significant in any of the cases. These findings demonstrate a linear decline between age and purchase set size for two out of the three repertoire markets examined, although these effects are again much less than the momentum from the prior stage of the funnel. No purchase set analysis is

undertaken for the subscription markets as consumers do not typically subscribe to more than one brand.

Overall, the results show consumers tend to recognise, recall and consider more brands as they age until their fifties or sixties, at which point a minor decline sets in. These effects are relatively small and operate most consistently and strongly for brand recognition, the first stage of the purchase funnel. Conversely, brand purchase repertoires do tend to show a decline with age. In later stages of the brand purchase funnel the incremental age effects are found in about half the studied cases but are generally small effects compared to the momentum from participation in the prior stage of the funnel.

Table 2. GLS Regression fit statistics for the impact of age on brand awareness, consideration, and purchase sets

				Linear impact of age			Quadratic impact of age			Prior step of funnel			Constant			D-W
	Adj R ²	F	Sig. F	β 1	t (β 1)	Sig (β 1)	β 2	t (β 2)	Sig (β 2)	β 3	t (β 3)	Sig (β 3)	β 4	t (β 4)	Sig (β 4)	
Brand recognition set																
Supermarket store choice	0.037	36.6	0.000	0.072	7.164	0.000	-0.058	(6.381)	0.000	n.a			3.355	13.280	0.000	2.000
Toothpaste	0.040	39.7	0.000	0.079	5.348	0.000	-0.085	(6.354)	0.000	n.a			3.590	9.679	0.000	2.000
Fruit juice	0.134	145.4	0.000	0.051	4.223	0.000	-0.073	(6.607)	0.000	n.a			4.079	13.325	0.000	1.997
Home broadband	0.033	33.0	0.000	0.165	8.117	0.000	-0.149	(8.006)	0.000	n.a			2.841	5.540	0.000	1.998
Electricity	0.058	58.3	0.000	0.145	8.859	0.000	-0.117	(7.831)	0.000	n.a			1.739	4.203	0.000	1.999
Brand recall set																
Supermarket store choice	0.177	134.6	0.000	0.015	1.711	0.087	-0.010	(1.199)	0.231	0.371	18.752	0.000	1.167	5.164	0.000	1.999
Toothpaste	0.243	200.0	0.000	0.005	0.518	0.605	-0.009	(1.041)	0.298	0.358	23.059	0.000	0.249	0.979	0.328	2.000
Fruit juice	0.161	120.3	0.000	0.030	3.705	0.000	-0.019	(2.566)	0.010	0.279	18.186	0.000	-0.113	-0.531	0.595	2.000
Home broadband	0.145	105.9	0.000	0.036	2.567	0.010	-0.034	(2.735)	0.006	0.261	16.795	0.000	0.120	0.348	0.728	2.000
Electricity	0.072	49.0	0.000	0.018	1.293	0.196	-0.026	(2.025)	0.043	0.214	11.066	0.000	0.891	2.568	0.010	1.999
Brand consideration set																
Supermarket store choice	0.044	29.7	0.000	-0.002	-0.251	0.802	-0.006	(0.0695)	0.487	0.170	7.744	0.000	1.995	8.701	0.000	2.000
Toothpaste	0.124	89.1	0.000	-0.002	-0.147	0.883	-0.011	(0.951)	0.342	0.352	13.388	0.000	2.352	7.303	0.000	1.998
Fruit juice	0.088	61.0	0.000	-0.008	-0.846	0.397	-0.005	(0.535)	0.593	0.250	9.898	0.000	2.147	8.874	0.000	2.000
Home broadband	0.035	23.2	0.000	0.040	2.671	0.008	-0.040	(2.917)	0.004	0.169	7.239	0.000	1.001	2.691	0.007	2.000
Electricity	0.108	75.9	0.000	0.106	8.374	0.000	-0.081	(6.959)	0.000	0.184	8.891	0.000	-0.643	-2.014	0.044	1.999
Brand repertoire set																
Supermarket store choice	0.166	124.3	0.000	-0.023	-3.192	0.001	0.009	1.395	0.163	0.247	13.571	0.000	2.871	15.725	0.000	2.000
Toothpaste	0.211	166.4	0.000	-0.033	-3.338	0.001	0.011	1.241	0.215	0.251	14.443	0.000	2.670	10.453	0.000	1.998
Fruit juice	0.316	287.2	0.000	-0.013	-1.681	0.093	-0.004	(0.579)	0.563	0.403	22.177	0.000	2.088	10.476	0.000	1.995

5.0 Discussion

5.1 Main findings

Model free insights show age-related variations across the stages of the brand purchase funnel. For differing age group categories, similar proportions of brands recognised are being recalled. However, the results show an initial increase followed by a drop-off in the proportion of brands recognised that subsequently enter the consideration and purchase sets of older consumers. Cognitive changes to long-term and working memory do not appear to greatly impact brand loyalty as older consumers generally recognise and recall more brands than younger consumers. Additionally, there tend to be slight increases in brand recognition, recall and consideration sets, as a proportion of the number of brands recognised, until the 60-74 age group.

Evidence of different age-related patterns is further validated through the individual-level regression analysis of the stages of the brand purchase funnel. The results show that brand recognition follows an inverse-U quadratic pattern with recognition sets increasing in size across age before peaking and then declining. For brand recall and consideration, similar patterns are found in four of the 10 cases studied. Overall, where age-related effects were detected in the cognitive stages of the purchase funnel, they peaked at age 56, on average. This provides further evidence that working memory and the cognitive effort required to consider multiple brands are not greatly impacting age-related loyalty. Conversely, a linear decline is found for purchase sets in repertoire markets, implying the mechanisms that underlie age-related increases in brand loyalty impact the purchase stage rather more than the cognitive stages of the brand purchase funnel. This research clearly demonstrates that the purchase stage of the brand purchase funnel is most affected by age. Biological changes are expected later in life and therefore present a plausible explanation for the declines in awareness set size seen between the two oldest age groups studied (60-74 years, and 75 years and above). However, the declines in consideration and purchase set size do not accelerate across these age groups, reaffirming the minimal impact of age-related differences in brand awareness on consideration and purchase. So, what mechanisms cause increases in brand loyalty across age? Declining category purchase rates and formation of purchase habits through the accumulation of category experience provide the most plausible explanations for higher loyalty among older consumers, indicating a potentially fruitful avenue for further research.

5.3 Practical Implications

Older consumers continue to recognise and recall a large number of brands, with increases in brand awareness until at least the mid-fifties. While declining category purchase rates and formation of purchase habits over time cause declines in consideration and purchase sets, the results clearly show that after peak brand awareness, consumers aged 60-74 years still have the cognitive capacity to recognise and recall as many or more brands than consumers below 40 years of age. This finding can be expected to apply to new brands as well, as research demonstrates older consumers still buy new brands (Phua et al., 2020). Marketers should therefore attempt to build brand awareness among older consumers in the same way as younger consumers, through advertising, deepening the network of associations consumers have with the brand and strengthening category entry points.

To overcome the effects of well-established purchase habits and declining category purchase rates, marketers will need to adjust strategies to challenge the habitual repeat purchase behaviour of older consumers and encourage variety seeking and product trial. Marketers should nonetheless be encouraged that increases in age-related brand loyalty appear to be largely driven by purchase rates and habits as these can be altered with effective marketing, whereas cognitive decline and biological ageing are less subject to intervention.

5.4 Limitations and future research directions

The present research addresses a clear need to understand how age influences each stage of the brand purchase funnel. While this study provides insights in repertoire and subscription markets, the study is limited to five categories and one geographic region. Future research could replicate this study in new product categories and countries.

The results also provide an indication of plausible mechanisms that may cause awareness, consideration, and purchase sets to differ across age groups. Future research could adopt alternative measures of cognitive and biological age to determine if they are associated with greater age-related declines in awareness, consideration, and purchase sets than chronological age.

6.0 References

- Adams, J. M., & White, M. (2004). Biological ageing: a fundamental, biological link between socio-economic status and health? *The European Journal of Public Health*, 14(3), 331-334. <https://doi.org/10.1093/eurpub/14.3.331>
- Anderson, J. R. (1983). Retrieval of information from long-term memory. *science*, 220(4592), 25-30. <https://doi.org/10.1126/science.6828877>
- Campbell, B. M. (1969). *The existence of evoked set and determinants of its magnitude in brand choice behavior* [Doctoral Dissertation, Columbia Graduate School of Business, Columbia University].
- Cole, C., & Balasubramanian, S. (1993). Age differences in consumers' search for information: Public policy implications. *Journal of consumer research*, 20(1), 157-169. <https://doi.org/10.1086/209341>
- Cowan, N. (2008). What are the differences between long-term, short-term, and working memory? *Progress in brain research*, 169, 323-338. [https://doi.org/10.1016/S0079-6123\(07\)00020-9](https://doi.org/10.1016/S0079-6123(07)00020-9)
- Craik, F. I., & McDowd, J. M. (1987). Age differences in recall and recognition. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 13(3), 474-479. <https://doi.org/10.1037/0278-7393.13.3.474>
- Drolet, A., Bodapati, A. V., Suppes, P., Rossi, B., & Hochwarter, H. (2017). Habits and free associations: Free your mind but mind your habits. *Journal of the Association for Consumer Research*, 2(3), 293-305.
- Drolet, A., & Yoon, C. (2020). *The Aging Consumer: Perspectives from Psychology and Marketing*. Routledge. <https://doi.org/10.4324/9780429343780>
- Epsilon. (2019). *Age matters: A guide to cross-generation marketing*. <https://us.epsilon.com/resources/cross-generational-marketing>
- Evanschitzky, H., & Woisetschläger, D. (2008). Too old to choose? The effects of age and age related constructs on consumer decision making. *Advances in Consumer Research*, 35, 630-636.
- Gruca, T. S. (1989). Determinants of choice set size: an alternative method for measuring evoked sets. *NA-Advances in Consumer Research*, 16.
- Gutchess, A. H. (2011). Cognitive psychology and neuroscience of aging. In *The ageing consumer: perspectives from psychology and economics* (pp. 3-23). Routledge. <https://doi.org/10.4324/9780203852941>
- Juster, F. T. (1966). Consumer buying intentions and purchase probability: An experiment in survey design. *Journal of the American Statistical Association*, 61(315), 658-696. <https://doi.org/10.1080/01621459.1966.10480897>
- Lambert-Pandraud, R., & Laurent, G. (2010). Why do older consumers buy older brands? The role of attachment and declining innovativeness. *Journal of Marketing*, 74(5), 104-121. <https://doi.org/10.1509/jmkg.74.5.104>
- Lambert-Pandraud, R., & Laurent, G. (2020). Impact of age on brand choice. In *The Aging Consumer: Perspectives from Psychology and Marketing* (2nd ed., pp. 163-181). Taylor & Francis Group. <https://doi.org/10.4324/9780429343780-11>
- Lambert-Pandraud, R., Laurent, G., & Gourvennec, B. (2018). Investigating Brand Verbal Fluency: When known brands do not come to mind. *International Journal of Market Research*, 60(3), 304-315. <https://doi.org/10.1177/1470785318757172>
- Lambert-Pandraud, R., Laurent, G., & Lapersonne, E. (2005). Repeat purchasing of new automobiles by older consumers: empirical evidence and interpretations. *Journal of Marketing*, 69(2), 97-113. <https://doi.org/10.1509/jmkg.69.2.97.60757>

- Lambert-Pandraud, R., Laurent, G., Mullet, E., & Yoon, C. (2017). Impact of age on brand awareness sets: a turning point in consumers' early 60s. *Marketing Letters*, 28(2), 205-218. <https://doi.org/10.1007/s11002-016-9407-0>
- Lapersonne, E., Laurent, G., & Le Goff, J.-J. (1995). Consideration sets of size one: An empirical investigation of automobile purchases. *International journal of research in marketing*, 12(1), 55-66. [https://doi.org/10.1016/0167-8116\(95\)00005-m](https://doi.org/10.1016/0167-8116(95)00005-m)
- Park, D. C., & Festini, S. B. (2017). Theories of memory and aging: A look at the past and a glimpse of the future. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, 72(1), 82-90. <https://doi.org/10.1093/geronb/gbw066>
- Park, D. C., & Gutchess, A. (2004). Long-term memory and aging: A cognitive neuroscience perspective. In *Cognitive neuroscience of Aging: Linking cognitive and cerebral aging* (pp. 218-245). Oxford Press. <https://doi.org/10.1093/acprof:oso/9780195156744.003.0009>
- Park, D. C., Lautenschlager, G., Hedden, T., Davidson, N. S., Smith, A. D., & Smith, P. K. (2002). Models of visuospatial and verbal memory across the adult life span. *Psychology and Aging*, 17(2), 299. <https://doi.org/10.1037/0882-7974.17.2.299>
- Park, D. C., Smith, A. D., Lautenschlager, G., Earles, J. L., Frieske, D., Zwahr, M., & Gaines, C. L. (1996). Mediators of long-term memory performance across the life span. *Psychology and Aging*, 11(4), 621-627. <https://doi.org/10.1037/0882-7974.11.4.621>
- Phua, P., Kennedy, R., Trinh, G., Page, B., & Hartnett, N. (2020). Examining older consumers' loyalty towards older brands in grocery retailing. *Journal of Retailing and Consumer Services*, 52, 1-7. <https://doi.org/10.1016/j.jretconser.2019.101893>
- Rhodes, S., Greene, N. R., & Naveh-Benjamin, M. (2019). Age-related differences in recall and recognition: A meta-analysis. *Psychonomic Bulletin & Review*, 26(5), 1529-1547. <https://doi.org/10.3758/s13423-019-01649-y>
- Salthouse, T. (2012). Consequences of age-related cognitive declines. *Annual review of psychology*, 63, 201-226. <https://doi.org/10.1146/annurev-psych-120710-100328>
- Salthouse, T. A. (1996). The processing-speed theory of adult age differences in cognition. *Psychological review*, 103(3), 403-428. <https://doi.org/10.1037/0033-295x.103.3.403>
- Shocker, A. D., Ben-Akiva, M., Boccara, B., & Nedungadi, P. (1991). Consideration set influences on consumer decision-making and choice: Issues, models, and suggestions. *Marketing Letters*, 2(3), 181-197. <https://doi.org/10.1007/bf02404071>
- Thoma, D., & Wechsler, J. (2021). Older and more personal: Stronger links between brand-name recall and brand-related autobiographical memories in older consumers. *Psychology & Marketing*, 38(9), 1384-1392. <https://doi.org/10.1002/mar.21533>
- Uncles, M., & Ehrenberg, A. S. (1990). Brand choice among older consumers. *Journal of Advertising Research*, 30(4), 19-22.
- Uncles, M., & Lee, D. (2006). Brand purchasing by older consumers: An investigation using the Juster scale and the Dirichlet model. *Marketing Letters*, 17(1), 17-29. <https://doi.org/10.1007/s11002-006-3756-z>
- United Nations. (2015). *World population aging 2015*. http://www.un.org/en/development/desa/population/publications/pdf/ageing/WPA2015_Report.pdf
- Wood, W., & Neal, D. T. (2009). The habitual consumer. *Journal of Consumer Psychology*, 19(4), 579-592. <https://doi.org/10.1016/j.jcps.2009.08.003>
- Yang, Z., Zhou, N., & Chen, J. (2005). Brand choice of older Chinese consumers. *Journal of International Consumer Marketing*, 17(4), 65-81. https://doi.org/10.1300/j046v17n04_04

Zniva, R., & Weitzl, W. (2016). It's not how old you are but how you are old: A review on aging and consumer behavior. *Management Review Quarterly*, 66(4), 267-297.
<https://doi.org/10.1007/s11301-016-0121-z>

Web Appendix

Web Appendix A: Questionnaire

Below is a summary of the survey questions used to derive age, as well as the funnel metrics used in this study – please note that we only provide the funnel metric questions for one category to avoid repetition.

AGE

What **year** were you born?

SUPERMARKET STORE CHOICE

When you think of **supermarkets** operating in New Zealand, what **grocery chains come to mind**?

Please list all supermarket in the order they come to mind. If no supermarkets come to mind, please leave blank.

1st Supermarket _____

2nd Supermarket _____

3rd Supermarket _____

4th Supermarket _____

5th Supermarket _____

Any other supermarket _____

And from the list below, what supermarket brands do you **recognise**?

Please select all that apply

New World

Countdown

PAKn'SAVE

Four Square

Fresh Choice

SuperValue

Farro Fresh

Other, please specify: _____

Assuming you were purchasing groceries today, what supermarkets would you **seriously consider shopping at**?

Please select all that apply

New World

Countdown

PAKn'SAVE

Four Square

Fresh Choice

SuperValue

Farro Fresh

Other, please specify: _____

Now we would like to move from shopping today to thinking about the supermarkets you will shop at over the next four weeks. We will use a special scale to help you state the chances of shopping at each supermarket. You can think of the scale as chances out of ten.

If you are certain, or practically certain that you would shop at the supermarket then you should choose the answer '10'. If you think there is no chance or almost no chance of shopping at the supermarket, the best answer would be '0'. If you are uncertain about the chances, choose an answer as close to '0' or '10' as you think it should be.

Now, taking everything into account, what are the chances that you would purchase groceries from each of the following **supermarkets** sometime in the next **four weeks**?

Purchase of brands that are not specifically named should be included under "any other"

	Supermarket Brands					
	Countdown	New World	PAKn'SAVE	Four Square	SuperValue	Any other
10 Certain, practically certain (99 in 100)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
9 Almost sure (9 in 10)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
8 Very probable (8 in 10)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7 Probable (7 in 10)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6 Good possibility (6 in 10)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5 Fairly good possibility (5 in 10)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4 Fair possibility (4 in 10)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3 Some possibility (3 in 10)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2 Slight possibility (2 in 10)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
1 Very slight possibility (1 in 10)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
0 No chance, almost no chance (1 in 100)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Web Appendix B: Juster Scale

The Juster scale is validated as a purchase measure through a range of tests and applications (Day et al., 1991; Gabor & Granger, 1972; Wright & MacRae, 2007), with meta-analysis demonstrating that it provides accurate and unbiased demand estimates for established products and services (Wright & MacRae, 2007). Juster purchase probabilities were estimated over the next four weeks for supermarket store choice and fruit juice, while a three-month time period was used to account for the lower category purchase rate for toothpaste. Average purchase set size was then calculated as the sum of the average probability of purchase for each brand in the category, for that age group (e.g. purchase probabilities of 0.9

for Brand A, 0.6 for Brand B, and 0.3 for Brand C would give a purchase set size of $0.9+0.6+0.3 = 1.8$ brands).

Web Appendix C: Statistical tests for cross-group comparisons of awareness, consideration, and purchase set size

Results of the nonparametric Kruskal-Wallis test are reported to determine whether significant differences between one or more age groups ($p < .05$) exist for brand recognition, recall, consideration and purchase set size. The Kruskal-Wallis test is used as the assumptions of normality and homogeneity of variance required for a parametric test are violated by the data.

Age-related differences are apparent for aided recognition with the number of brands recognised growing across age groups until 75 years of age for supermarket store, broadband, and electricity, and 65 years of age for toothpaste and fruit juice, before declining. Results of Kruskal-Wallis tests confirm statistically significant differences between one or more age groups for supermarket store choice $\chi^2(3) = 44.051$, $p = 0.000$, toothpaste $\chi^2(3) = 267.058$, $p = 0.000$, fruit juice $\chi^2(3) = 75.911$, $p = 0.000$, broadband $\chi^2(3) = 61.716$, $p = 0.000$, and electricity $\chi^2(3) = 75.144$, $p = 0.000$.

Brand recall sets follow a similar trend, increasing across age until reaching a turning point and declining from 60 years of age for fruit juice and broadband, and 75 years of age for supermarket store choice, toothpaste, and electricity. Kruskal-Wallis tests confirm statistically significant differences between one or more age groups for supermarket store choice $\chi^2(3) = 50.361$, $p = 0.000$, toothpaste $\chi^2(3) = 20.550$, $p = 0.000$, fruit juice $\chi^2(3) = 58.983$, $p = 0.000$, broadband $\chi^2(3) = 18.208$, $p = 0.000$, and electricity $\chi^2(3) = 107.520$, $p = 0.000$.

The number of brands considered decline after the 40-59 year-old age group for all repertoire and subscription markets. Prior to these declines, consideration set size increases for the two subscription markets and remains stable for the three repertoire markets between the under 40 year-old and 40-59 year-old age groups. Results of Kruskal-Wallis tests confirm statistically significant differences for consideration set size between one or more age groups for supermarket store choice $\chi^2(3) = 22.134$, $p = 0.000$, toothpaste $\chi^2(3) = 56.293$, $p = 0.000$,

and fruit juice $\chi^2(3) = 73.810$, $p = 0.000$, broadband $\chi^2(3) = 9.107$, $p = 0.028$, and electricity $\chi^2(3) = 14.089$, $p = 0.003$.

Purchase sets decline steadily across the age groups examined. This decline occurs at a faster rate across than the decline in consideration sets sizes across age groups. Results of Kruskal-Wallis tests confirm statistically significant differences between one or more age groups for supermarket store choice $\chi^2(3) = 128.249$, $p = 0.000$, toothpaste $\chi^2(3) = 235.060$, $p = 0.000$, and fruit juice $\chi^2(3) = 234.454$, $p = 0.000$.

Tests of proportion difference show that differences in brand recall, consideration and purchase sets between older and younger consumers are mostly significant. Two sets of tests are conducted; one for the two older versus the two younger age groups, and one for the oldest versus the other three age groups. Results below confirm differences are almost all significant, with just two non-significant comparisons for the oldest group highlighted in grey (Appendix Table 1).

Appendix Table 1: z tests of proportion differences (two tailed)

Two older (n=962) versus two younger (n = 900) age groups			
	Recall	Consideration	Purchase
Supermarket store choice	$z = 3.128$, $p = .002$	$z = 5.819$, $p = .000$	$z = 7.790$, $p = .000$
Toothpaste	$z = 8.085$, $p = .000$	$z = 2.654$, $p = .008$	$z = 6.016$, $p = .000$
Fruit Juice	$z = 4.979$, $p = .000$	$z = 6.313$, $p = .000$	$z = 9.105$, $p = .000$
Home Broadband	$z = 2.695$, $p = .007$	$z = 4.075$, $p = .000$	n/a
Electricity	$z = 4.225$, $p = .000$	$z = 6.920$, $p = .000$	n/a
Oldest (n = 459) versus other (n = 1403) age groups			
	Recall	Consideration	Purchase
Supermarket store choice	$z = 1.478$, $p = .139$	$z = 4.288$, $p = .000$	$z = 5.260$, $p = .000$
Toothpaste	$z = 5.705$, $p = .000$	$z = 2.882$, $p = .004$	$z = 3.765$, $p = .000$
Fruit Juice	$z = 3.010$, $p = .003$	$z = 3.633$, $p = .000$	$z = 5.602$, $p = .000$
Home Broadband	$z = 1.856$, $p = .063$	$z = 2.308$, $p = .021$	n/a
Electricity	$z = 2.899$, $p = .004$	$z = 4.974$, $p = .000$	n/a

Web Appendix D: Comparison of linear and quadratic regressions

The relationship between brand recognition and age is better fitted by a quadratic regression in all categories as the Adjusted R^2 is consistently higher and standard errors are lower in three cases and equivalent in two cases. For Toothpaste and Home broadband the linear regression is non-significant whereas the quadratic regression is significant (Appendix Table 2).

Appendix Table 2: comparison of linear and quadratic regressions

	Adj R ²		S		F		Sig. F	
	Linear	Quad.	Linear	Quad.	Linear	Quad.	Linear	Quad.
Brand recognition set								
Supermarket store choice	.016	.022	1.13	1.13	30.831	22.274	0.000	0.000
Toothpaste	.000	.012	1.07	1.06	1.415	12.772	0.234	0.000
Fruit juice	.018	.025	1.36	1.36	34.554	25.081	0.000	0.000
Home broadband	.000	.015	1.79	1.77	.074	15.417	0.786	0.000
Electricity	.042	.071	1.59	1.56	82.027	71.585	0.000	0.000
Brand recall set								
Supermarket store choice	.178	.190	1.12	1.12	201.881	146.109	0.000	0.000
Toothpaste	.250	.259	1.37	1.37	310.776	217.966	0.000	0.000
Fruit juice	.242	.252	1.59	1.58	298.426	210.298	0.000	0.000
Home broadband	.142	.160	2.32	2.30	155.082	119.314	0.000	0.000
Electricity	.300	.307	1.72	1.71	399.743	276.049	0.000	0.000
Brand consideration set								
Supermarket store choice	.059	.059	1.06	1.06	59.726	39.796	0.000	0.000
Toothpaste	.126	.126	1.14	1.14	135.537	90.351	0.000	0.000
Fruit juice	.188	.188	1.48	1.48	216.918	144.621	0.000	0.000
Home broadband	.097	.098	1.73	1.73	101.239	68.195	0.000	0.000
Electricity	.070	.072	1.66	1.66	71.488	49.156	0.000	0.000
Brand repertoire set								
Supermarket store choice	.166	.167	.853	.853	186.304	124.931	0.000	0.000
Toothpaste	.321	.321	.934	.934	440.948	293.907	0.000	0.000
Fruit juice	.210	.210	1.21	1.21	248.739	166.386	0.000	0.000

A similar result is witnessed for brand recall with consistently higher Adjusted R^2 for the quadratic compared to the linear regression, lower standard errors for the quadratic compared to the linear regression in three cases, and equivalent standard errors in two cases. In this case however, all linear and quadratic regressions are significant. For brand consideration and brand repertoire, there are no meaningful differences between the linear and quadratic regressions.

Web Appendix E: Generalized least squares (GLS) approach

We employ the Generalized Least Squares (GLS) model to account for violations of the assumptions of OLS regression. The GLS model relaxes OLS assumptions that error terms have constant variance and are uncorrelated.

Assumptions of the GLS model include:

1. Linearity: The relationship between the independent and dependent variables is linear.
2. Independence: Observations are independent of each other.
3. Normality: The error terms are normally distributed.
4. Errors have a known covariance structure: The errors may exhibit heteroskedasticity and/or autocorrelation, but their covariance structure is known or can be estimated.

To account for the autocorrelation in the GLS model, we regressed the OLS residuals on their lagged values to estimate the autocorrelation coefficient (ρ). Next, we created a covariance matrix (σ) using the estimated ρ and the Toeplitz function. The Toeplitz function generates a symmetric matrix with constant values along each diagonal. Finally, we estimated the GLS model using the constructed covariance matrix and obtained parameter estimates. These estimates are more efficient and unbiased compared to the OLS estimates.

In summary, the GLS model allowed us to obtain more efficient and unbiased estimates in our study by accounting for potential violations of the OLS assumptions arising from the use of a quadratic transformation. This approach provided a more reliable basis for understanding the relationships between age, brand recognition, recall, consideration, and purchase in our analysis.

References

- Day, D., Gan, B., Gendall, P., & Esslemont, D. (1991). Predicting purchase behaviour. *Marketing Bulletin*, 2(5), 18-30.
- Gabor, A., & Granger, C. (1972). Ownership and acquisition of consumer durables: Report on the Nottingham consumer durables project. *European Journal of Marketing*, 6(4), 234-248. <https://doi.org/10.1108/eum0000000005145>
- Wright, M., & MacRae, M. (2007). Bias and variability in purchase intention scales. *Journal of the Academy of Marketing science*, 35(4), 617-624. <https://doi.org/10.1007/s11747-007-0049-x>