

Mobile Web Stress

The Impact of Network Speed on Emotional Engagement and Brand Perception



SHARE THIS WHITEPAPER



Table of Contents

Executive Summary	3
Approach	4
Why EEG Testing?	5
Part 1. EEG Research: The Effect of Network Speed on Emotional Engagement.....	6
Approach and Methodology	6
Normal Speed: Frustration Levels	7
Normal Speed: Emotional Engagement Levels	7
500ms Delay: Frustration Levels	7
500ms Delay: Emotional Engagement Levels	9
Impact of Slow Connection Speed on Post-Test Brand Association	9
EEG Research Summary	10
Part 2. Implicit Response Test: Positivity vs. Negativity	10
Approach and Methodology	10
Positivity vs. Negativity: JohnLewis.com	11
Positivity vs. Negativity: Tesco.com.....	11
Positivity vs. Negativity Summary.....	12
Part 3. Implicit Response Test: The Effect of Loading Speed on Brand Perception.....	12
Approach and Methodology	12
Dimensions and Attributes	13
Implicit Pre-Test: Brand Mapping	13
Implicit Pre-Test: Purchase Intent	14
EasyJet (Slow): Impact on Each Dimension.....	14
EasyJet (Slow): Impact on Each Attribute.....	14
Ryanair (Slow): Impact on Each Dimension.....	14
Ryanair (Slow): Impact on Each Attribute	15
Brand Perception: Summary	15
Conclusion.....	15
Appendix: EEG Study Notes.....	16
Acknowledgements	17
About Radware.....	17
Sources.....	17

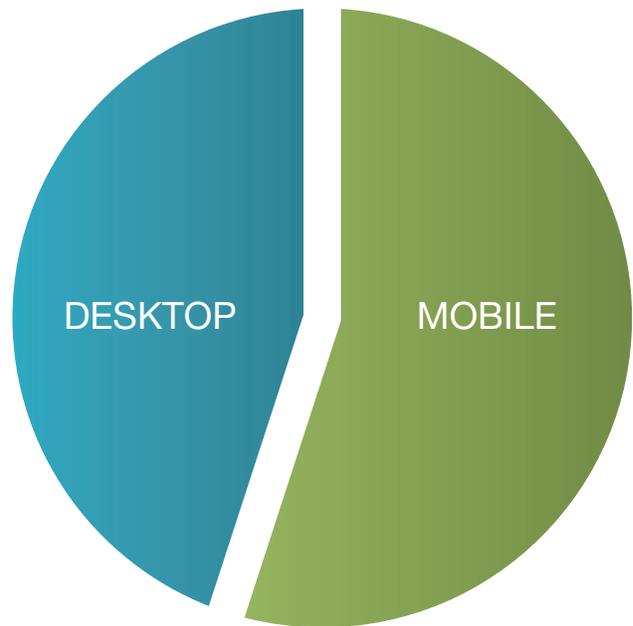
Executive Summary

Increasingly, it's a mobile-first world. Yet there is a marked disconnect between how much time people spend on their mobile devices and how much money they spend on their mobile devices. 55% of all time spent on retail websites takes place on a mobile device,¹ yet mobile commerce (mcommerce) accounts for only an estimated 16% of total online sales.² The explanation for this disconnect lies partially with how most sites perform on mobile devices.

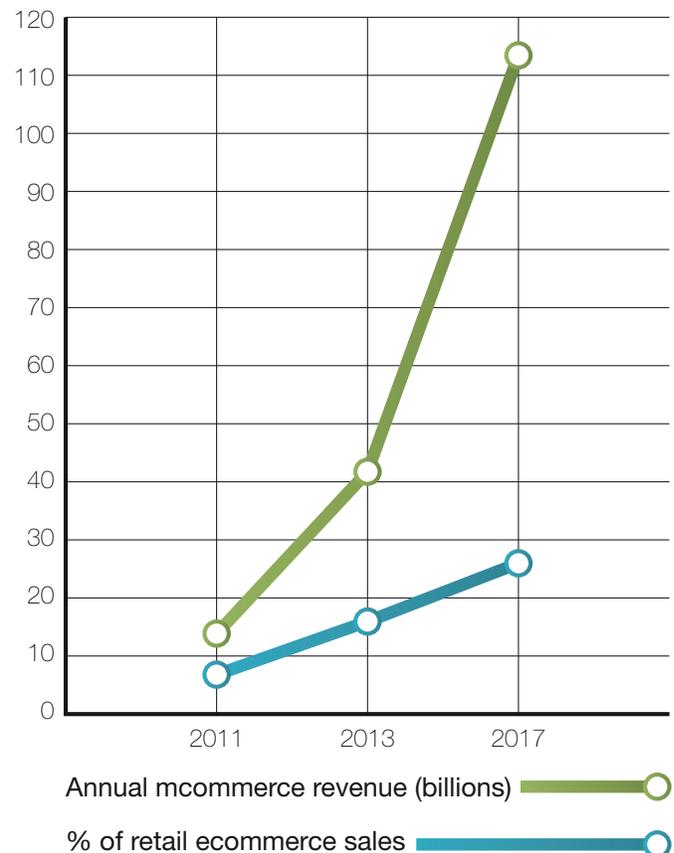
Slow pages are the number one issue that mobile users complain about – ranking even higher than site crashes. Two out of three smartphone users say they expect pages to load in 4 seconds or less, but most sites cannot deliver this level of performance. In a recent study of the top 100 retail websites found that only 2% of the top 100 ecommerce sites loaded in fewer than 4 seconds, while 20% took 10 seconds or longer to load. The median site loaded in 7.84 seconds.³

There is already consensus amongst mobile thought leaders that the performance of websites has a direct impact on the user experience, with consequent effects on business goals; however, the actual impact on users themselves from an emotional perspective is unknown. Abandonment of a website means the user is lost for that visit. An experience that affects a user negatively in emotional terms could mean that they never return.

Using a pioneering Emotional Engagement Measurement process – integrating electroencephalography (EEG) and eyetracking technologies with implicit response testing – we can begin to plug this gap in understanding.



55% of all time spent on retail websites takes place on a mobile device





Two-thirds of smartphone users expect sites to load in 4 seconds or less.

This study demonstrates that:

1. Mobile users are significantly affected by slow performance. A 500ms connection speed delay resulted in up to a 26% increase in peak frustration and up to an 8% decrease in engagement.
2. Slow sites can seriously undermine overall brand health – across both desktop and mobile platforms.
3. The nature and scale of the impact varies, depending on a number of factors (e.g., inherent strength/weakness of brand).
4. Brands with already fragile consumer affinity are at higher risk.
5. The greatest risk of page delays is to purchase intent.
6. These findings represent excellent opportunities to strengthen overall brand by investing in performance optimization.

Approach

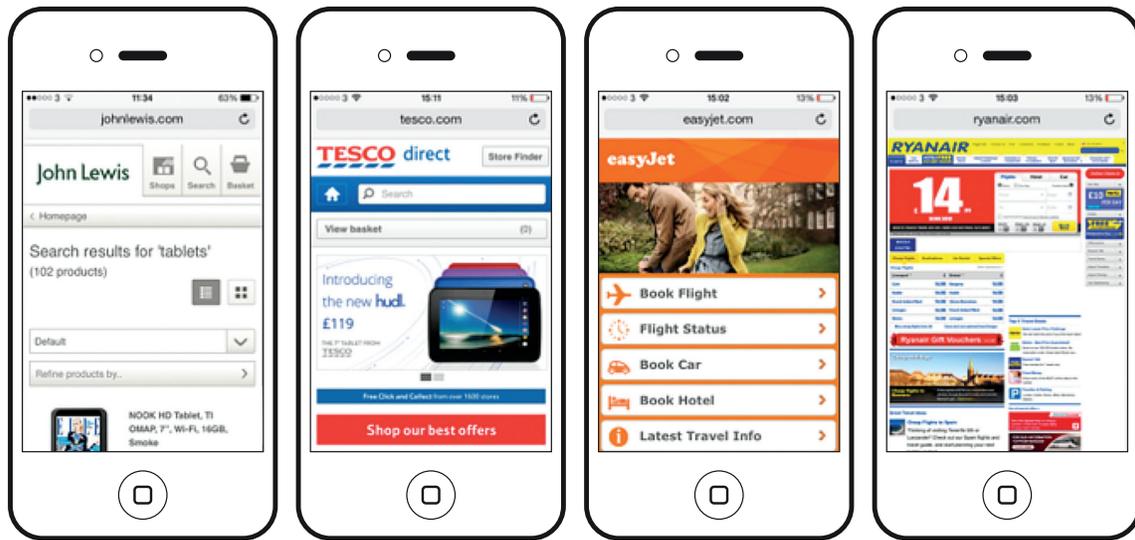
We used a science-led, evidence-based approach and blended three separate methodologies together:

1. EEG Emotional Engagement Study
2. Implicit Response Test: positivity vs. negativity study
3. Implicit Response Test: brand attribute impact study

We used software that allowed us to slow down the network speed on mobile devices by 500ms and compared the experience to a standard wireless network connection. Slow-loading sites were tested in a variety of ways using the latest consumer neuroscience techniques to elicit response patterns and emotional engagement at a non-conscious level. We selected this approach in order to better understand how consumers really feel, as opposed to what they say they feel.

To undertake the project, we assembled a team of global specialists from Seren (leaders in customer experience and service design), Neurosense (a global leader in implicit methodologies) and NeuroStrata (expert consultants in blending neuromarketing applications).

For a more detailed explanation of our approach, please see the appendix at the end of this document.



For this study, we selected two of the leading ecommerce retailers in the United Kingdom, JohnLewis.com and Tesco.com, as well as the top two airlines in the UK, EasyJet.com and Ryanair.com. These sites were selected based on the following factors:

- Existing brand recognition among test participants
- Comparability in terms of products and services
- Assumption that each site would have comparable investment in user experience and performance optimization

Why EEG Testing?

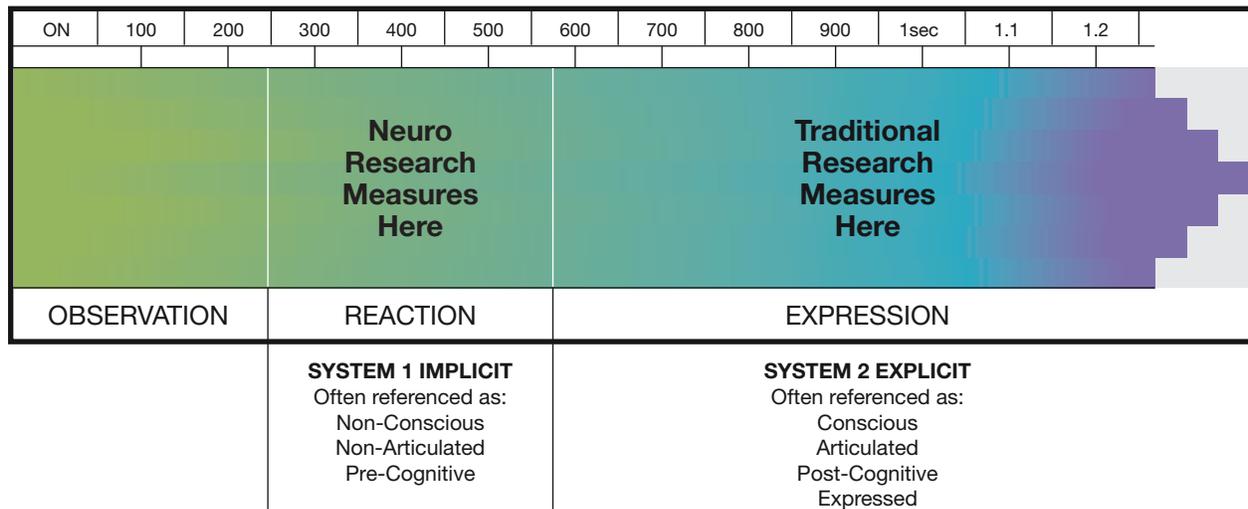
Neuroscientists agree that there are two different ways of thinking:

Implicit	Explicit
Unconscious	Conscious
Emotion	Reason
Limbic System	Pre-Frontal Cortex
Associative	Rule Following
Very Fast	Slow
Effortless	Effortful
Involuntary	Controlled
Here & Now	Future Plans
Non-Conscious	Conscious

According to Dr. Gerald Zaltman, Professor Emeritus at Harvard Business School, whose academic focus is on innovation, social change, and how we think, “95% of the consumer’s decisions are made at the subconscious level.”⁴ In fact, emotions play a critical role in decision-making. Patients with damage to emotional parts of the brain cannot make decisions despite having no change in IQ.⁵

There are five benefits of neuroscientific testing:

1. Evaluates think/feel (not say)
2. Quantified data, at deeper-than-Qual levels
3. Moment by moment interaction
4. Cause and effect triggers
5. Fresh, deeper insights



Part 1. EEG Research: The Effect of Network Speed on Emotional Engagement

Approach and Methodology

Using the latest lightweight, wireless EEG (Electroencephalography) technology, we were able to measure moment-by-moment responses. Linking the headset to the eye tracker allowed us to identify browsing behavior vs. checkout.

Users were given standardized shopping tasks on four sites: Ryanair, EasyJet, Tesco and John Lewis, using an iPhone. We studied users on these tasks, both at the normal site loading-speed over Wifi and also at a consistently slowed-down speed (500ms). From this we were able to extract measures of frustration and emotional engagement for the browsing and basket-filling stages of both the normal and slowed-down versions of all four sites.

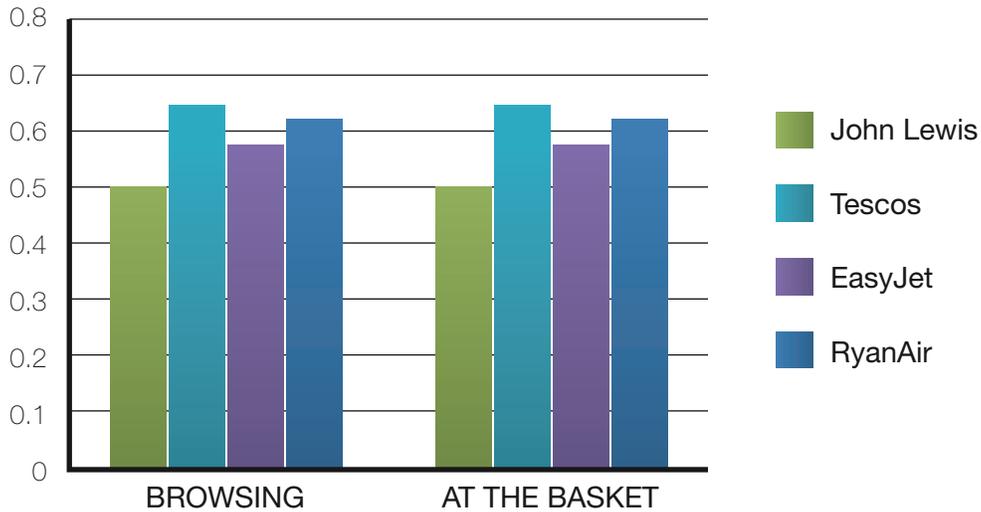
In the results, we focused on two metrics that were affected the most by a slowed-down connection speed: maximal level of frustration and average engagement. We did not include metrics that did not show a significant change. We extracted measures of frustration and emotional engagement for the browsing and basket-filling stages of both the normal and slowed-down versions of all four sites.

Benefits of EEG Brain-Response Testing:

- Users can get on with the task as they would in everyday life whilst we passively monitor their responses.
- There are no interruptions to the experience, asking them to rate it, or reflect on it (which can sometimes change their feelings about the experience!)
- As we are measuring brain activity directly, there are no biases from person to person from differences in how they express themselves, or how they rate an experience.

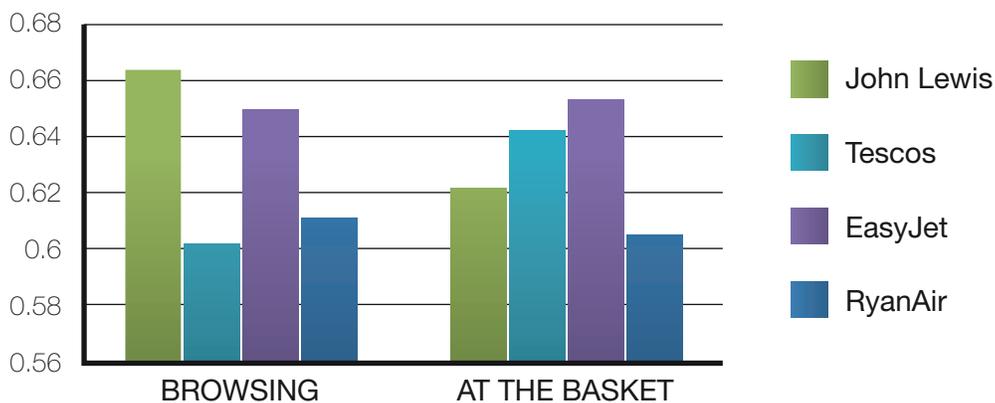
Normal Speed: Frustration Levels

Overall the Ryanair and Tesco sites were the most frustrating at normal speed, with EasyJet being moderately frustrating, particularly at the basket. John Lewis was the least frustrating. As Ryanair does not have a mobile-optimised site, and therefore requires users to either scroll or pinch-and-zoom, it is not surprising that it had the most frustrating site, even at normal speed.



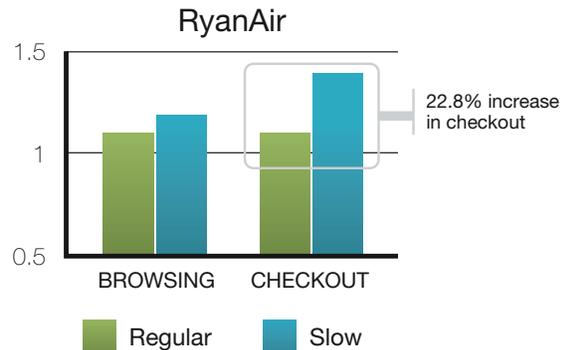
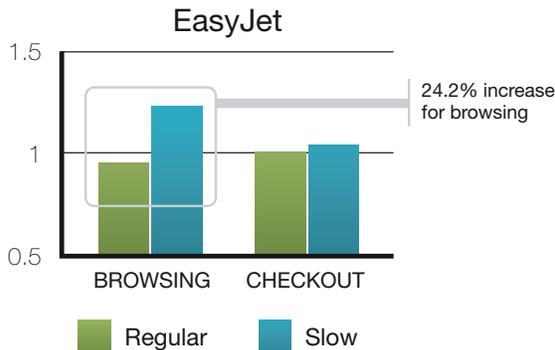
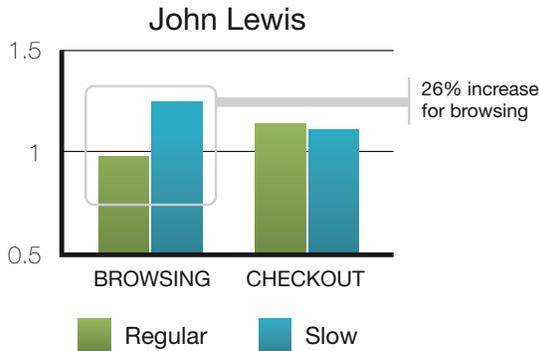
Normal Speed: Emotional Engagement Levels

During the browsing phase, John Lewis and EasyJet were the most emotionally engaging at normal speed, with Tesco and Ryanair showing low levels of engagement. John Lewis's basket-filling section was less emotionally engaging, but Tesco's improved at that point. Ryanair still had low levels of emotional engagement across both sections.



500ms Delay: Frustration Levels

Three out of the four sites saw increased frustration peaks when the site was slowed down. In general, John Lewis and EasyJet had higher frustration peaks during browsing when the site was slowed down, while Ryanair had higher frustration in the checkout phase.



There are two primary tasks users perform on an ecommerce site: decision-making (browsing) and form-filling (checkout). Decision-making is the more cognitively demanding, and therefore leaves users more vulnerable to becoming frustrated if other elements (such as page loading) slow them down. The browsing stage is where most of the decision-making occurs, therefore it is not surprising that this was where we were most likely to see increases in frustration.

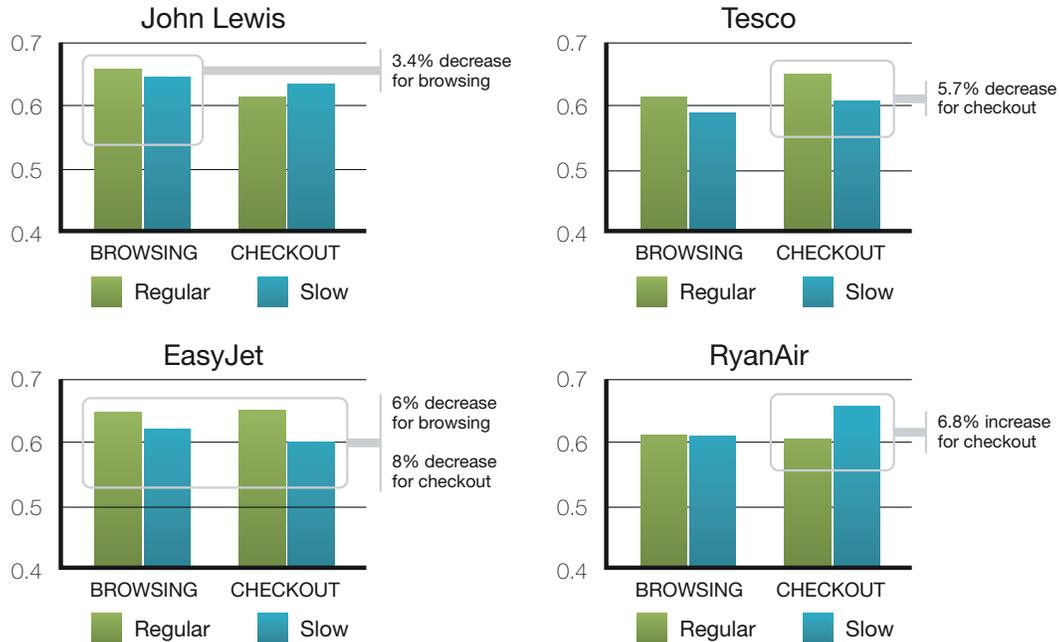
The exception was Ryanair, which saw a higher increase in frustration at the checkout; however, Ryanair’s checkout has a much higher than normal number of extra decisions it requires users to make, therefore increasing user frustration when pages load more slowly. Also, there may be added frustration at Ryanair’s basket due to the long decision-making process, as this extends the anxiety that you may miss reserving your place on the flight. Also, the more decisions the user makes, the greater the potential worry on each page-load that the site might lose their answers and force them to go back and fill them out again.

Tesco, being an early entrant into the online FMCG (fast-moving consumer goods) shopping arena, has undoubtedly become one of its most sophisticated players. The company has clearly invested a great deal of effort in optimizing its site, possibly assuming low connection speeds for mobile (particularly given Tesco’s more “budget” profile in comparison to John Lewis’s).

Also, while a search for tablets resulted in a far higher number of products on Tesco than John Lewis (493 versus 102), they were broken down over a larger number of pages (25 versus 2). Therefore, with only an average of 20 items per page rather than 51, the Tesco browsing pages were shorter and hence even faster loading.

500ms Delay: Emotional Engagement Levels

Three out of the four sites saw a decrease in average engagement when the site was slowed down. John Lewis customers were slightly less likely to engage with the browsing experience while the Tesco site was more affected during the checkout phase. Both browsing and checkout were affected on the EasyJet site.



While the small increase in emotional engagement at the basket on the Ryanair site may seem surprising, it is possibly just a reflection of high levels of frustration: the user is emotionally engaged, but in a frustrated way.

Impact of Slow Connection Speed on Post-Test Brand Association

We conducted exit interviews with every tester after each of the tests, and then poured all the adjectives from the interviews into a word cloud generator. Note that the only differentiator was speed and, because this was a blind study, the testers were not consciously aware of the speed difference. The results suggest that slower page speed affects the brand on a more global level.

For example, the words associated with Tesco shift from mainly easy-to-use (in the first word cloud) to a range of negative associations (in the second word cloud) purely because of the connection speed. After the slower user experience (500 ms of latency) on the Tesco website, users reported that the site seemed “boring”, “inelegant”, “clunky”, “tacky” and “hard to navigate”.

In other words, the perception of slowness affected non-performance issues such as brand, visual design, and ease of navigation. Also note that while both word clouds contain negative adjectives, the one for the slower site contains almost three times more negative adjectives than the faster site.

Normal Speed



500ms Delay



EEG Research Summary

Using EEG for our first test, and comparing live interaction across retail and airline sites, we detected how emotional engagement and frustration levels are triggered by slow-loading mobile sites versus normal loading speed. We established that both the peak levels of frustration throughout the experience was evidenced, as well as the average level of engagement becoming more pronounced. We also explored how different sites trigger stark emotional shifts at different phases of the experience (e.g. browsing versus checkout).

Part 2. Implicit Response Test: Positivity vs. Negativity

Approach and Methodology

This is a groundbreaking new methodology, which deploys the neuropsychology behind Implicit Reaction Speed Testing, but with a moment-by-moment readout (every 2 seconds).

Respondents undertake an attribute priming test while exposed to a recorded consumer interaction on two different websites. Attributes represent different facets of negativity and positivity to provide a robust measure of how it tracks throughout the website interaction task.



Positive Attributes

Easy
Clear
Intuitive
Fast
Efficient



Negative Attributes

Frustrated
Confused
Irritated
Discouraged
Resentful

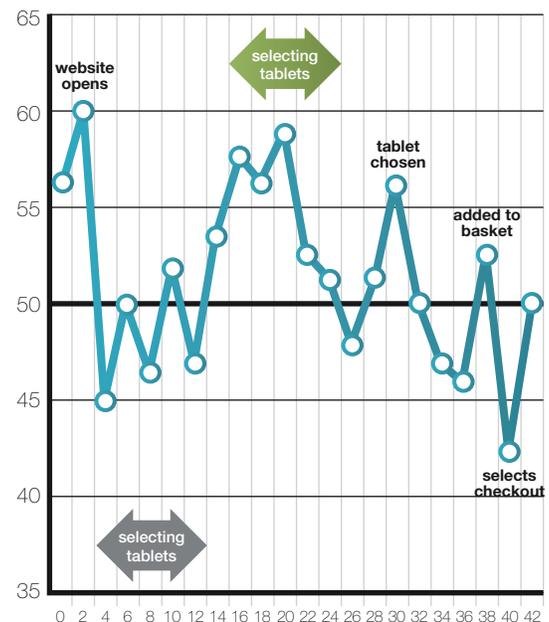
The video task shows the entire transaction process (searching, browsing, comparison, selection, and purchasing) of shopping for a tablet PC on the Tesco and John Lewis websites. For each retailer, there were two conditions: normal and slow. The slow version was manipulated with buffering to artificially prolong the website response post-certain clicks.

The results provide a measure of the % of respondents who felt positive or negative at every 2-second interval. This highlights how response levels are affected by slower page loads.

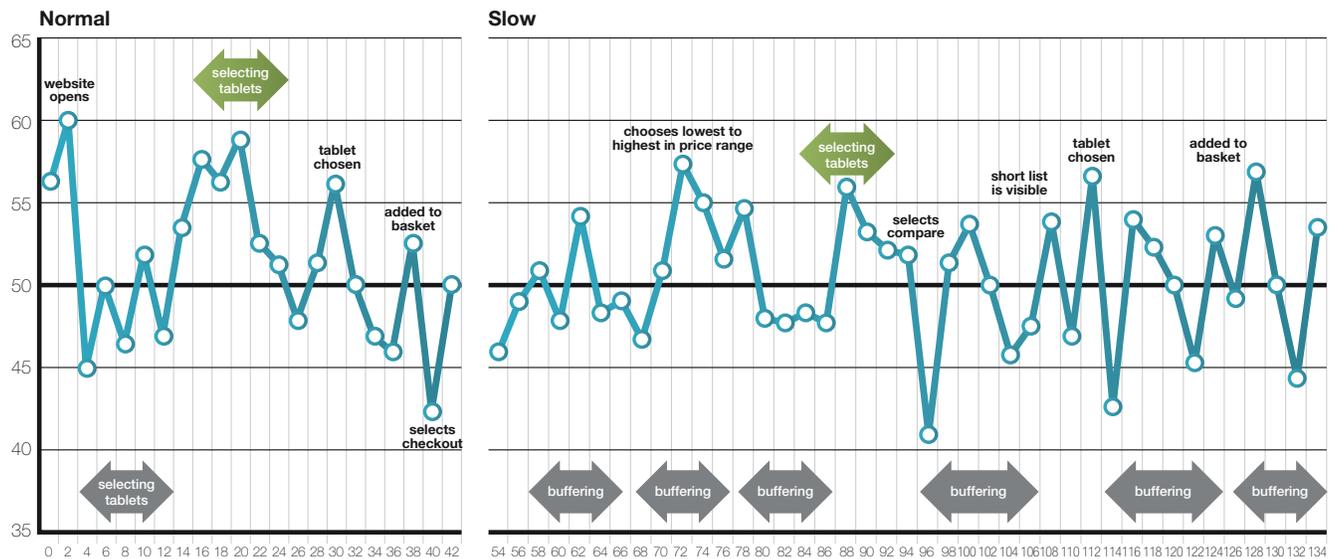
The phases are characterized as follows:

- Optioning: negative
- Browsing: mostly positive
- Selection: a marked positive peak
- Basket add: a positive peak
- Checkout: marked negative trough

As a generality, here browsing itself is a positive experience, but the closer one gets to purchasing, the more negative it becomes. Under normal speeds, the interaction is punctuated by three key positive peaks and three to four bouts of negativity.



Positivity vs. Negativity: JohnLewis.com

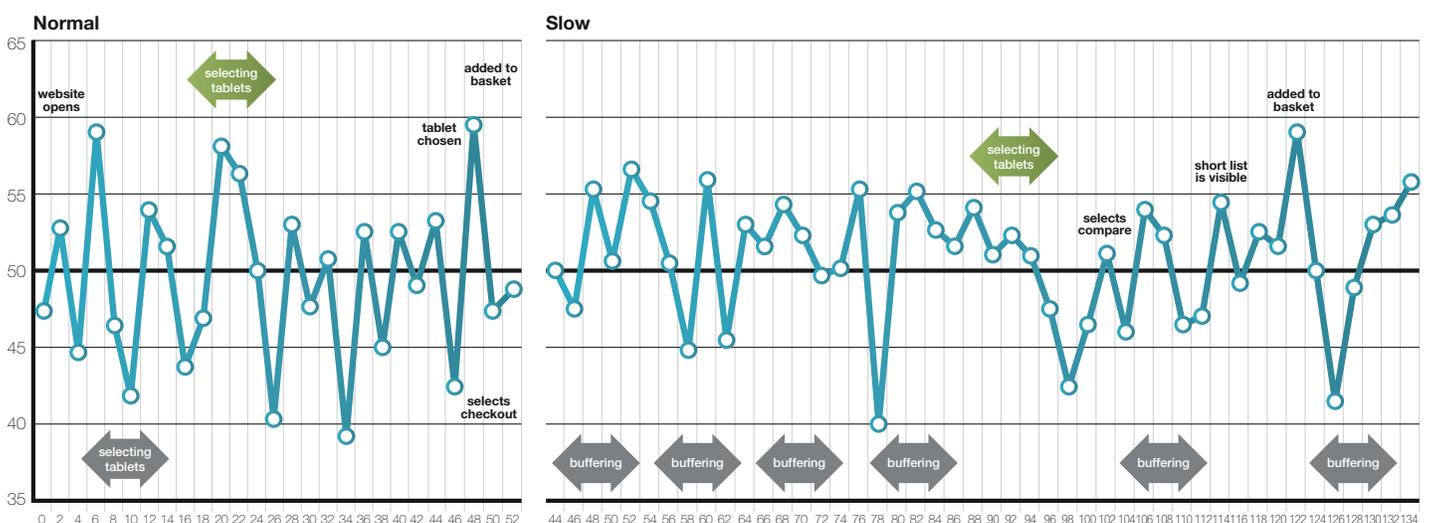


At slower speed, buffering had the following impact:

- Overall, the experience is much more of a rollercoaster of positive and negative.
- Less impact in browsing phase, but more pronounced impact closer to purchase
- On this site, the buffering does not appear to have a cumulatively negative impact; there is rapid recovery from it.
- The scale of buffering impact is similar to other triggers of peaks and troughs.
- The browsing experience for slower John Lewis site appears still to be a positive phase, despite the buffering experience.
- The purchasing phase is rather more volatile and less positive than for the normal site.

The net impact is an increase in negativity and, overall, a less balanced profile compared with the normal site.

Positivity vs. Negativity: Tesco.com



At slower speed, buffering had the following impact:

- The slowing of the Tesco site suppresses some of the positive peaks in the more positive browsing phase.
- The Tesco purchasing phase exhibits somewhat less positivity than the slow John Lewis site.

Positivity vs. Negativity Summary

In a second study, we used a brand new and highly innovative form of Implicit Reaction Speed testing, which allowed us to examine how on a moment-by-moment basis, an array of positive and negative emotions are triggered.

We found that buffering on PC sites evokes not dissimilar swings towards negative emotions and frustration than what we saw with slow-loading mobile sites. We also discovered that buffering can transform a normal web interaction experience into a far more frenetic, rollercoaster of a ride; and ultimately a more negative one.

The test also highlighted how the impact of buffering can disproportionately affect different phases of interaction. We found that with the John Lewis and Tesco sites, the negative impact during browsing and selection was less discernible and less concerning, but the closer to the purchasing and checkout phases, the greater the volatility – not surprising, as the emotional tension one feels will be heightened at that stage.

Measuring this moment-by-moment impact is registering the fleeting responses as the user navigates and interacts throughout the experience; this is invaluable for understanding how and where to focus optimization. However, we also recognize that the overall experience will create a residual impact in the mind of the user about not just the site, but about the broader Brand.

Part 3. Implicit Response Test: The Effect of Loading Speed on Brand Perception

Approach and Methodology

The third test in our study was a computer-based psychometric test that deployed Implicit Reaction Speed Testing, a universally validated methodology that, by capturing the speed of response to attributes in the form of primes, enables us to evaluate the relative strength of association of the stimulus with that attribute.

Implicit Reaction Speed Testing is based on two well-established findings in neuroscience:

1. Whenever we are presented with a stimulus, concepts are triggered or primed in our non-conscious mind, ready to become active. (For example, if you buy a new car, suddenly you are primed to see that model everywhere.)
2. When we are presented with two matching ideas, we can react to them faster than when presented with mismatched ideas.

Implicit response tests prime participants to trigger associations, then measure the strength of those associations by asking them to react when paired with the brand or stimuli. The faster the response time, the more closely associated is stimulus and prime.

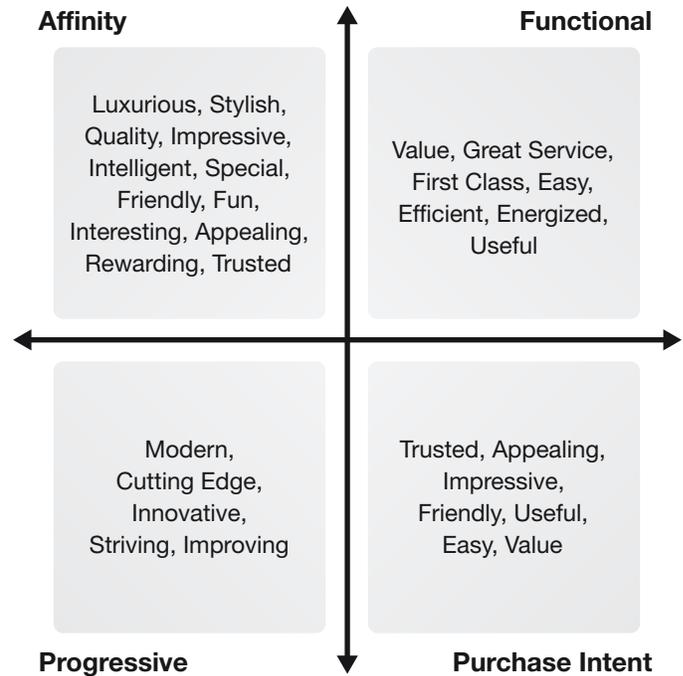
In our test, two brands – EasyJet and Ryanair – were measured against 24 word attributes (pre-test). The attributes were wide-ranging and include those relating to brand attractiveness, efficiency, warmth/friendliness, progressiveness and brand consideration.

Participants then viewed a video depicting relatively simple flight selection/ booking processes. Each brand's website was run at two speeds: normal or slow (slowed down by 500ms). The brand was measured again against the 24 word attributes (post-test). The difference between slow and normal indicates the effect of speed on brand perception.

Dimensions and Attributes

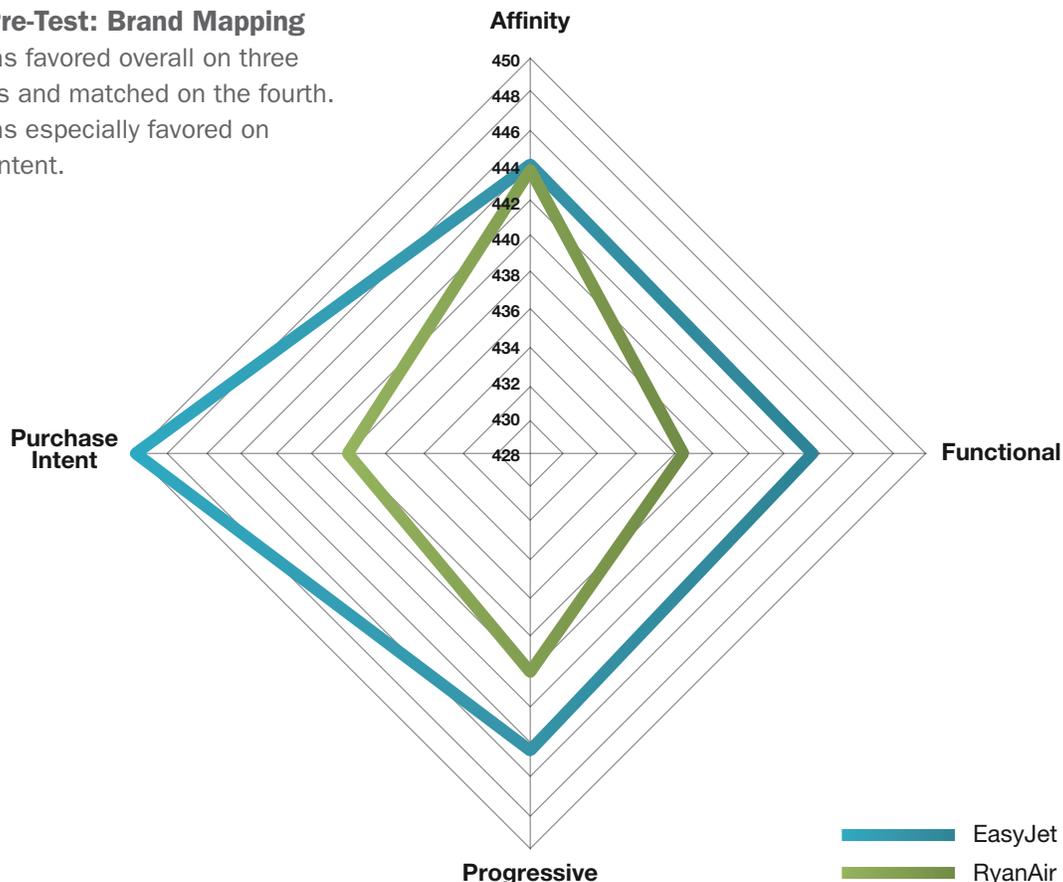
Attributes were selected on the basis of dimensions that are closely related to brands with personalities linked to many different consumer touch points.

- **Affinity attributes** are drawn from brand image/emotionally based attributes that are commonly used to relate to brand personality.
- **Functional attributes** are associated with the delivery of the service or brand and, again, are commonly used examples.
- **Progressive attributes** are terms often associated with brands from categories where high tech or keeping up to date with technology is important.
- **Purchase intent attributes** are commonly used attributes that, taken together, help predict propensity to shift consideration levels. Cognitive psychologists argue that attributes relating to trust, reward, desirability, ‘closeness’, simplicity – together with measures of ‘perceived high quality’ and value – have higher than average validity in influencing purchase.



Implicit Pre-Test: Brand Mapping

EasyJet was favored overall on three dimensions and matched on the fourth. EasyJet was especially favored on purchase intent.

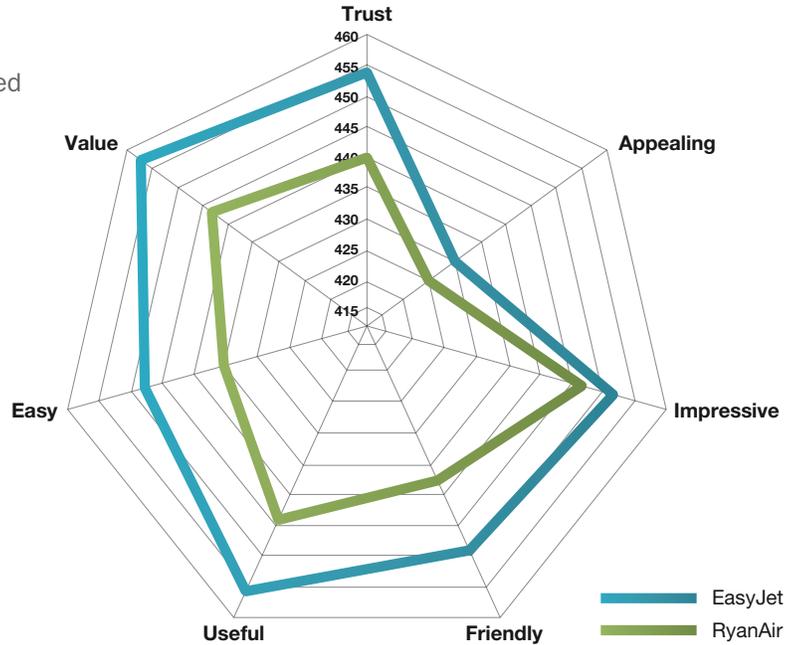
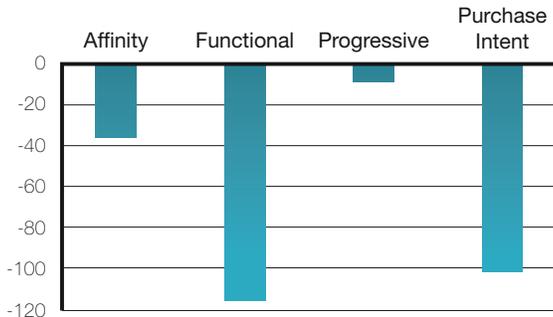


Implicit Pre-Test: Purchase Intent

EasyJet was favored on each prime attribute related to Purchase Intent.

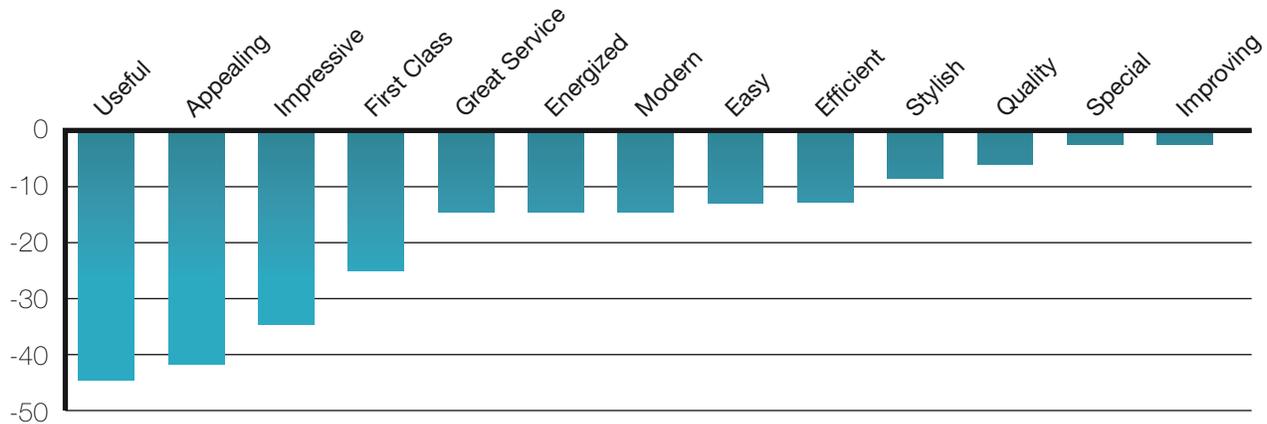
EasyJet (Slow): Impact on Each Dimension

Each dimension was negatively affected, but the biggest hits were to the functional and purchase intent dimensions.



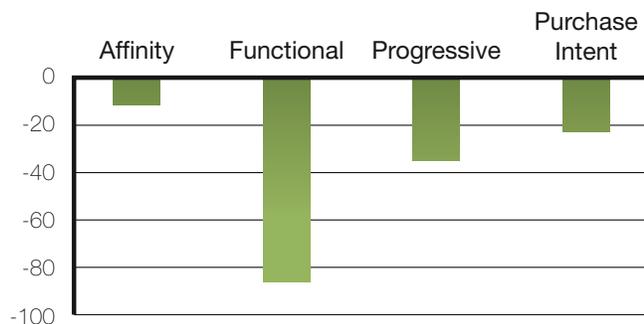
EasyJet (Slow): Impact on Each Attribute

Slowed-down interaction seriously undermined EasyJet brand perception across a wide array of attributes. The biggest risk is the commercial ramifications of undermining intent to purchase.



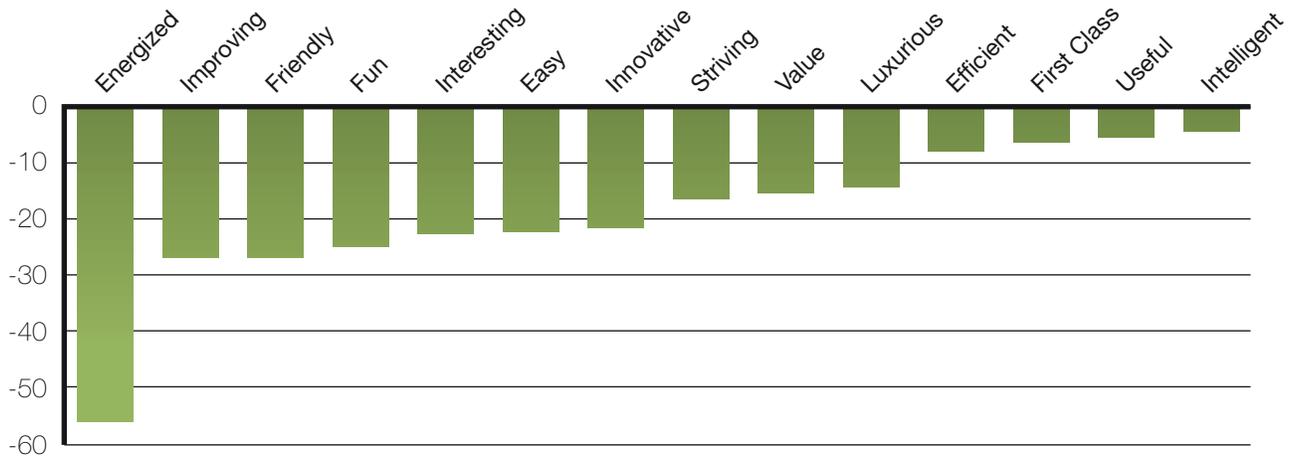
Ryanair (Slow): Impact on Each Dimension

The impact to Ryanair was also substantial, but overall not quite as damaging as for EasyJet. Each dimension was undermined, particularly functional values. Purchase intent for Ryanair, while negatively affected, was relatively more resilient than for EasyJet.



Ryanair (Slow): Impact on Each Attribute

Slowed-down interaction undermined Ryanair’s brand perception across a wide array of attributes, especially those relating to functionality and warmth/friendliness. The biggest risk is the potential ratcheting up of tension in customer relations and further stretching of passenger goodwill. Sustained spells of a slow performance could thus potentially trigger more direct impact on purchase intent.



Brand Perception: Summary

Overall, across the 24 attributes, EasyJet enjoyed a more positive brand perception and a stronger purchase intent than Ryanair. The slowing of each site triggers marked downward shifts in brand perception for each brand. In general, the impact on EasyJet was greater than that for Ryanair.

The impact of slow sites varied across different attributes for each brand. The slow EasyJet site affected those attributes most closely related to purchase intent as well as functional attributes. On the other hand, Ryanair was affected more on warm/friendliness dimensions, which are often linked to customer interaction.

A slow site can cause substantial damage to each brand, not just to the reputation of the site itself. EasyJet has more to lose, as the downshifts are more likely to affect purchase intent directly. For Ryanair the implication is that a slow site will exacerbate consumer perceptions of customer service and ultimately could lead to greater negative commercial impact through dampening purchase intent.

Conclusion

Slow websites can significantly undermine brand health. The impact is not just on damaging perception of the website, but on the core brand itself. Collateral damage can be readily triggered implicitly across a wide array of feelings, values, functions and benefits in brand aspects that, at first sight, are quite unrelated to website interaction.

The **scale** of the impact varies from brand to brand and is likely to depend on factors including:

- The robustness and inherent strength of the brand
- The weight of importance that the site plays in the overall relationship with the brand
- The importance of speed for usage experience, e.g., relaxed browsing versus time-dependent transactions
- The expectations of optimal website speed

The **nature** of the impact will vary across different brands depending on factors including:

- The fragility of the overall brand
- The relative strength of each attributes
- The contribution each attribute is perceived to provide to the site experience and brand experience

At high risk will be those brands with a fragile consumer affinity and/or a site representing a critical touch point for brand experience or transaction. The greatest risk of all is the reduction in Purchase Intent triggered by the negative brand response.

The corollary is that a great opportunity exists to strengthen and build overall brand perceptions by investing in optimizing the speed of website interactions.

Appendix: EEG Study Notes

Twenty-four participants (12 men, and 12 women) between the ages of 21 and 54 were fitted with an EEG braincap that passively monitored their responses whilst surfing websites on a mobile phone (iPhone 4). Once fitted with the braincap, participants soon forget they are wearing it (it just feels like wearing a hat), so it allows them to get on with using the phone as they would in every-day life, without interruption, whilst we unobtrusively monitored their responses in real-time.

The experiment involved each participant completing a shopping task on four different websites, two retail (Tesco.com and JohnLewis.co.uk) and two airlines (EasyJet.com and Ryanair.com). The participants had two of the sites remotely slowed down by the experimenter controlling the phone's wi-fi access remotely using specialised software. Which sites were slowed down was controlled for across participants, so that each participant experienced two sites at slow speed and two at normal speed, and also the order of the sites used was controlled for. Participants were not told that any of the sites they were using were being slowed down.

EEG (electroencephalography) is a measure of electrical brain activity that allows us to track responses from second-to-second. Every moment of the day, as we go about different tasks like surfing a website, the top part of our brains – the cortex – is pulsing with electromagnetic patterns which are different depending on how much attention we're paying, and how emotionally engaged we are.

We made recordings from a series of sensors built into a lightweight, wireless headcap. Each of the sixteen sensors records 100 data-points per second, allowing us to track the three key features of brain activity:

- **Rhythm:** The speed of the activity. Different forms of brain activity involve large groups of neurons (brain-cells) pulsing at different speeds. Each speed, or combination of speeds, is associated with different types of activity. For example, very focused forms of thinking tend to involve fast frequencies, whereas relaxed states and deep (non-dreaming) sleep tend to involve lower frequencies.
- **Power:** EEG can also pick up how powerful these rhythms are. To use a musical analogy, if the rhythm is like a musical note, the power is like the volume of that note.
- **Location:** With sensors positioned across the whole head, the EEG braincap can determine the location of the signals it's recording. Different parts of the brain are responsible for different types of activity. For example, the front area of the cortex (the frontal lobes) are responsible for motivating and co-ordinating our behaviour, whilst the back area of the cortex (the occipital lobes) are responsible for our visual processing.

By measuring these three sources of data, the EEG software can apply algorithms to search for patterns that correlate to mind-states like frustration, excitement, boredom and engagement. As it can measure responses second-by-second without the need to ask participants questions, EEG recordings can reveal responses that can be difficult or impossible to capture using more traditional methodologies such as surveys, questionnaires or focus groups. For example, oftentimes we experience fleeting emotions or changes in our levels of engagement of which we either aren't aware, or that we can't accurately describe while they are happening (because thinking about an experience can change the experience), or can't describe afterwards (as they are hard to accurately recall). Also, EEG measures can shed light on experiences that are hard for people to accurately rank or rate, or which they don't have the vocabulary to accurately express.

Acknowledgements

Tammy Everts, Radware

Sven Krause, Seren

Darren Bridger and Thom Noble, NeuroStrata

Additional technical assistance provided by SMI (SensoMotoric Instruments)

Radware FastView is a best-in-class solution that accelerates websites and web-based applications. Our advanced front-end optimization (FEO) technology is the only solution that optimizes performance for both fixed and mobile clients. [Contact us to learn more about FastView.](#)

About Radware

Radware (NASDAQ: RDWR), is a global leader of application delivery and application security solutions for virtual and cloud data centers. Its award-winning solutions portfolio delivers full resilience for business-critical applications, maximum IT efficiency, and complete business agility. Radware's solutions empower more than 10,000 enterprise and carrier customers worldwide to adapt to market challenges quickly, maintain business continuity, and achieve maximum productivity while keeping costs down. For more information, please visit www.radware.com.

Sources

- ¹ comScore. 2013 Social & Mobile Commerce Report. October 2013
- ² eMarketer. Mobile Devices to Boost US Holiday Ecommerce Sales Growth. September 5, 2013
- ³ Radware. 2013 State of the Union: Mobile Ecommerce Performance. November 2013
- ⁴ Zaltman, Gerald. How Customers Think: Essential Insights into the Mind of the Market. February 2003
- ⁵ Damasio, A.R. Descartes' Error: Emotion, reason, and the human brain. 1994