A COMPARISON OF THREE-LEVEL WEB MENU NAVIGATION STRUCTURES

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This research addresses the topic of three-level menu structures, now commonly found in e-commerce web sites, by measuring the performance and preference effects of different menu location combinations. Two studies were conducted, each using 16 different participants. The first study compared combinations of left and top menu positions across three menu levels. The results indicated a benefit when the first (primary) menu level was located on the left side of the screen, and when second and third menu levels were grouped in the same plane, opposite from the primary menu. The second study included a comparison of right-side menus. The results confirmed the benefit of grouping the second and third menu levels in the same plane, and suggest the value of locating the primary menu level on the right side. Finally, users preferred primary menus that were located in the left or right planes rather than the top plane. The results have important implications for the design of multi-level web site menu structures and represent a first-step towards providing empirical-based guidelines to site designers.

INTRODUCTION

With the expansion of commerce web sites three-level menu structures have become increasingly common as a site navigation scheme. Even with the increase in the number of usability professionals working in the Web industry, and the sizeable literature discussing web usability and design, it is still the case that the usability of many web sites is sub-optimal, with poor navigation, high error and drop-out rates (Nielsen, 1999). Despite all the literature there are no clear, unified design guidelines for how to best configure multiple-level menus for web sites, nor is there a single design that is common within the Web industry.

An initial survey of 69 (57 e-commerce, 12 Human Factors related) web sites was conducted to determine the most commonly used three-level menu structures. Our survey revealed that most commercial sites favor what we term the TLL (Top-Left-Left) and LLL (Left-Left-Left) menu structures, in order of the primary, secondary and tertiary menus.

Much of the past menu research has focused on menus within software applications related to breadth vs. depth (Larson & Czerwinski, 1998) and menu hierarchy order (Giroux & Belleau, 1986). A small set of research has touched on the topic of schemas for web site menu location (Bernard, 2001) and primary menu location and preference (Gathman, Lee and Nader, 1998; Bernard and Hambin, 2003). Results of these studies show a preference for left menus, but better performance with top menus. However, these studies have primarily focused on a single menu level. No study has yet to empirically study the three-level menus common to most e-commerce sites.

This study aimed to determine the relative performance and preference benefits of different three-level web site menu structures. That is the structure(s) where the majority of users perform with the most accurate selections, have the least number of unnecessary clicks, navigate with the fastest task completion time, and are viewed as the most preferred. In doing so we ask: 1) should the primary menu be placed on the left, top, or right plane?, 2) should all levels be grouped together or should at least one level be split across two planes?, and 3) if menus are split across two planes, does performance and preference favor the primary-secondary, or secondary-tertiary grouping?

Based on the literature, human factors principles, and our analysis of common web site structures we do not have a clear hypothesis for the ideal location of the primary menu. However, we do hypothesize that the most advantageous menu structure is determined by whether or not the destination pages (tertiary menu level) are grouped with the secondary navigation menu. We therefore hypothesize that the best menu layout is afforded when the secondary and tertiary menus are grouped together, but separate from the primary menu (e.g., TLL, LTT, and RTT).

We addressed these issues through two experiments. The first study focused on comparing factorial combinations of vertical/left and horizontal/top layouts. The second study explored the concept of primary right-hand menu layouts.

STUDY 1

Method

A 2 x 2 x 2 factorial (with each level a factor of position, left or top) within-subjects design resulted in eight menu structure conditions. These conditions allowed us to compare the vertical/left and horizontal/top menu placement for each of the three menu levels. The presentation order of the eight site navigation conditions was counterbalanced across participants and within each session.

Participants. Sixteen undergraduate psychology students, self reported as intermediate web users with online shopping experience, were given course credit to participate in this study.

Apparatus and stimuli. All participants interacted with a computer workstation running a standard web browser. Each condition was mocked up to exemplify a different fictitious store (e.g., toys, clothing, sports) with a three-level menu hierarchy (e.g., a toy store might have Educational>Science>Age as one menu path). Each site was a series of text links, with no graphics displayed until the user reached the third (end-product) level where six products were displayed on the page. A very basic web site design was employed to eliminate the confounding effects of higher order design factors.

Procedure. Participants were asked to complete a set of 12 navigation tasks for each of the eight sites without providing a verbal protocol to the experimenter. Each task was written to not reveal the optimal navigation menu order. Participants completed six tasks for each condition, followed by a short break, and then completed a second set of tasks in the reverse condition order. Next, participants drew out the menu structure they felt demonstrated to be the most usable layout, and ranked each condition among a number of usability dimensions.

Dependent measures. Dependent measures included navigation time (recorded using the Ergobrowser™ software), menu selection errors, cursor movement (frequency of cursor movement to a plane other than the correct plane), hesitation (frequency of explicit hesitation to move the cursor from one menu level to another), and overall preference. To determine
the optimal menu structure(s) an equal weight comparison of all measures was calculated using the final ranking of each condition across all measures.

Results

All measures were analyzed using a repeated measures analysis of variance. Refer to Table 1 at the end of this paper for means and standard deviations for each measure.

Navigation time. Overall, navigation time was faster when the primary menu was located on the left, $F(1,15) = 11.119$, $p \leq 0.05$. Similarly, navigation time was faster when the secondary menu was located on the left, $F(1,15) = 14.079$, $p \leq 0.05$. However, when the primary was located on the left, the navigation time between secondary menu locations (left or top) was equivalent. Finally, navigation performance was best when the (left or top) primary menu was split from the secondary and tertiary menus, $F(1, 15) =13.752$, $p \leq 0.05$.

Hesitation. There was less observed hesitation when the secondary and tertiary menu levels were grouped together, $F(1,15) = 9.732$, $p \leq 0.05$.

Cursor movement. Fewer cursor movements were exhibited by menu structures with a left primary menu, $F(1,15) = 13.058$, $p \leq 0.05$, menu structures that group the primary and secondary menu levels together on the same plane, $F(1,15) = 8.151$, $p \leq 0.05$, and menu structures that group the secondary and tertiary menus together on the same plane, $F(1,15) = 15.854$, $p \leq 0.05$.

Selection errors. Fewer selection errors occurred with a left primary menu, $F(1,15) = 16.453$, $p \leq 0.05$, and a left secondary menu, $F(1,15) = 19.863$, $p \leq 0.05$. Fewer selection errors also occurred when a left primary was placed with a left or top secondary menu, $F(1,15) = 15.546$, $p \leq 0.05$.

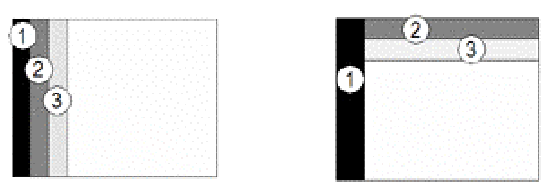
Preference. Participants preferred a left primary menu, $F(1,15) = 15.546$, $p \leq 0.05$. Grouping of primary and secondary menus placed together on the left, or at the top, $F(1,15) = 40.336$, $p \leq 0.05$, was preferred in addition to grouping secondary and tertiary menus on the same plane, $F(1,15) = 46.094$, $p \leq 0.05$. Finally, participants preferred all three menu levels grouped on the same plane, $F(1,15) = 9.367$, $p \leq 0.05$.

Measurement integration. An analysis of all measure ranks, based on equal measure weighting, revealed a significant main effect, $F(1, 7) = 3.97$, $p \leq 0.05$. Paired comparisons showed the TTL and TLT menu structure to be significantly the worst performing and preferred designs. All other comparisons were not significant ($p \leq 0.05$).

Discussion

While no single structure was consistently best across all performance and preference measures, there appears to be a benefit of placing the primary menu on the left side as well as grouping secondary and tertiary menu levels. Factoring all measures together the Left-Top-Top (LTT) and Left-Left-Left (LLL) menu structures were often the top performing and most preferred among the three-level menu structures studied across all measures (see Figure 1 below).

The results of this study would suggest that the LLL and LTT menu structures appear to be the best menu designs to apply taking all performance and preference measures into account, though the former has negative practical implications in terms of lateral screen real estate.



L-L-L L-T-T

Figure 1. *Examples of Left-Left-Left (LLL) and Left-Top-Top (LTT) three-level menu structures.*

STUDY 2

The objective of this exploratory study was to further examine the benefits of secondary and tertiary groupings, as well as to determine the benefits of a primary right-hand menu. Nielsen (1999) has made arguments for the right menu scheme in light of the fact that the scroll bar is typically located on the right side of the screen, though Kalbach and Bosenick (2003) found little difference in their study comparing left and right primary menus.

Method

A non-factorial within-subjects design compared the four conditions that paired secondary and tertiary menus from study 1 (LLL, TTT, LTT, TLL), with four structures that used a primary right menu (RRR, RRT, RTT, RTR).

Participants. A second set of sixteen undergraduate psychology students were given course credit to participate in this study.

Apparatus and stimuli. The same set up from Study 1 was used in Study 2. The set of right menu structures replaced those removed from Study 1.

Procedure. The same procedure from Study 1 was used to conduct Study 2.

Dependent measures. The same set of dependent measures collected in Study 1 were collected in Study 2.

Results

Refer to Table 2 at the end of this paper for means and standard deviations for each measure.

Navigation time. Navigation time was faster for a left primary menu over right and top primary menus, $F(1,15) = 6.458$, $p \leq 0.05$, and when secondary and tertiary menu levels were grouped together with the primary menu $F(1,15) = 6.221$, $p \leq 0.05$.

Hesitation. Hesitation was reduced with a left primary menu $F(1,15)= 5.468$, $p \leq 0.05$.

Cursor movement. Similarly, cursor movements were reduced with a left primary menu, $F(1\ 15) = 9.482$, $p \leq 0.05$. Grouping of primary and secondary menus on the same plane $F(1,15) = 77.308$, $p \leq 0.05$, and grouping secondary and tertiary menu levels on the same plane as the primary menu, $F(1,15) = 77.308$, $p \leq 0.05$, resulted in fewer cursor movement errors.

Selection errors. Selection errors show a primary left menu performing almost equal to a primary right menu, both significantly better than a primary top menu, $F(1,15) = 5.556$, $p \leq 0.05$. Grouping all three levels on left or right plane had fewer selection errors compared to the top plane, $F(1,15) = 6.240$, $p \leq 0.05$.

Preference. Participants preferred menu structures that grouped the primary and secondary menu levels on the same plane, $F(1,15)= 14.780$, $p \leq 0.05$, as well as those that grouped all three levels on a single plane, $F(1, 15) = 6.988$, $p \leq 0.05$.

Measure integration. An analysis of all measure ranks, based on equal measure weighting, revealed a significant main effect, $F(1, 7) = 3.46$, $p = 0.05$. Paired comparisons showed the RTR to be ranked lower than all other conditions ($p =0.05$), and the LLL menus structure to be ranked higher than the LTT menu structure ($p=0.06$). All other comparisons were not significant.

Discussion

As in Study 1, no single structure was consistently best across all performance and preference measures. The benefit of placing the primary menu on the left side (LLL or LTT) was again demonstrated in the second study. In addition, the concept of secondary-tertiary grouping (see Figure 2) were still supported, as these conditions generally outperformed the two non-grouped conditions (RTR and RRT). Further, the concept of a right-hand primary menu was supported as a viable design option by both performance and preference measures. Taking all measures into account LLL and RRR appear to be the best performing and most preferred three-level menu structures.

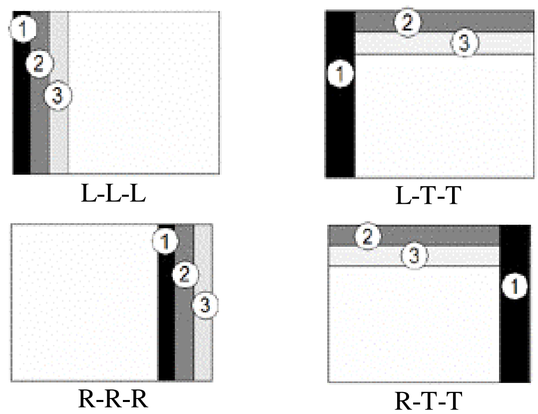


Figure 2. *Examples of Left-Left-Left (LLL), Left-Top-Top (LTT), Right-Right-Right (RRR), and Right-Top-Top (RTT) three-level menu structures.*

GENERAL DISCUSSION

The results of these studies show consistency of a left primary menu benefit, and a potential positive effect for a primary right menu. We encourage further research on the right hand menu placement.

Across both studies, the best performing menu structures were those that grouped all three levels together, or the secondary and tertiary menus separate from the primary menu, over those that group primary and secondary menus separate from the tertiary menu. In addition, we witnessed a tradeoff between faster navigation time and more selection errors, increased inappropriate cursor movements and more hesitation. Menu structures that grouped all menus together (LLL, RRR, and TTT) reduced hesitation, selection and cursor movement errors, but did not result in the fastest navigation time. In contrast, menu structures that split the primary menu from secondary and tertiary menus (e.g., LTT) allowed for faster navigation time, but slightly worse selection performance. Participant preference favored placing all menu levels on the left or right planes. However, implementing such nested designs may not appeal to either web designers or users in that they take up so much lateral display space that requires constantly scroll laterally or vertically.

PRACTICAL IMPLICATIONS

Although our findings often support the LLL or RRR menu structures (all levels grouped on a single plane) we feel such a design only benefits a site when the content of the menus may require more attention to navigation between primary menus rather than focusing more on the destination content (tertiary menu level). Developers should make use of such menu structures when the menu structure consists of a limited menu set, otherwise menus may appear below the fold of the screen, and users may be forced to scroll to use the navigation.

We recommend that designers consider the use of the LTT and RTT menu structures (splitting the primary menu on the left or right from the secondary and tertiary menus) when a user needs to focus on the comparison of destination content/products (tertiary menu level), such as represented by the sites in this study. These menu structures make better use of the available screen real estate and allow developers to present a larger set of persistent menus on the screen at a time, compared to structures that group all menus on the same plane.

CONCLUSION

The objective of these studies was to determine the relative importance of menu location and grouping in the context of a 3-tier menu design for e-commerce sites. Based on our findings we conclude that 1) no single menu structure consistently performed or was preferred across all measures, 2) the LLL and RRR structures (all menu levels grouped on a single plane) reduced cursor movements to the wrong plane, hesitation, selection errors, and were consistently preferred over all other menu structures, yet we feel the overall design of these three-level menu structures is not optimal given the increased likelihood for scrolling with large menu sets and the value placed on making use of screen real estate, and 3) based on the results of our studies and our practical perspective as human factors professionals we recommend use of the LTT and RTT menu structures (splitting the primary menu on the left or right from the secondary and tertiary menus) given their benefits in navigation time, advantages for reducing vertical and horizontal scrolling, and better use of screen real estate.

The results of these studies have important implications for the design of multi-level web site menu structures and represent a first-step towards providing empirical-based guidelines to site designers.

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Table 1. Study 1 Means and Standard Deviations for All Measures by Rank

Study 1 Navigation Time				Study 1 Hesitation				Study 1 Cursor Movement			
Condition	M	SD	Rank	Condition	M	SD	Rank	Condition	M	SD	Rank
LTT	104.63	19.66	1	LTT	0.38		1	LLL	0.75	0.77	1
TLL	111.77	30.49	2	TLL	0.94		2	TTT	1.00	1.37	2
LLT	114.32	29.02	3	TTT	1.00		3	LLT	1.19	1.42	3
TLT	115.46	28.15	4	LLL	1.19		4	LTT	1.38	1.09	4
LLL	121.84	42.32	5	LLT	1.25		5	TLL	1.81	1.72	5
LTL	123.25	35.04	6	TLT	1.44		6	LTL	2.44	1.79	6
TTT	142.08	37.45	7	TTL	1.63		7	TTL	2.56	2.34	7
TTL	166.07	81.77	8	LTL	1.75		8	TLT	3.13	1.75	8

Study 1 Selection Errors				Study 1 Preference				Study 1 Measure Integration			
Condition	M	SD	Rank	Condition	M	SD	Rank	Condition	M	SD	Rank
LTL	0.31	0.60	1	LLL	11.56	8.68	1	LTT	2.6	1.81	1
LLL	0.63	1.54	2	TTT	13.44	8.76	2	LLL	2.6	1.52	1
LLT	0.69	1.30	3	LTT	17.93	6.19	3	TLL	3.4	1.34	3
LTT	1.25	1.88	4	TLL	20.44	7.68	4	LLT	3.8	1.10	4
TLL	1.25	9.04	4	LLT	20.69	9.67	5	TTT	4.2	2.59	5
TLT	1.44	2.22	6	TTL	26.06	6.58	6	LTL	5.8	2.86	6
TTT	5.38	4.84	7	TLT	31.50	8.66	7	TLT	6.2	1.48	7
TTL	8.06	9.04	8	LTL	35.81	5.62	8	TLL	7.2	0.84	8

Table 2. Study 2 Means and Standard Deviations for All Measures by Rank

Study 2 Navigation Time				Study 2 Hesitation				Study 2 Cursor Movement			
Condition	M	SD	Rank	Condition	M	SD	Rank	Condition	M	SD	Rank
LTT	101.03	15.70	1	LTT	0.06	0.25	1	LLL	0.12	0.34	1
RRT	106.74	30.95	2	LLL	0.19	0.40	2	RRR	0.19	0.54	2
TLL	107.15	14.70	3	RRR	0.19	0.54	2	TTT	0.19	0.40	2
RTT	111.33	21.60	4	RTT	0.19	0.54	2	LTT	0.81	0.98	4
LLL	111.47	20.92	5	TLL	0.25	0.45	5	TLL	1.00	0.97	5
RRR	115.77	29.73	6	TTT	0.31	0.60	6	RRT	1.13	1.15	6
RTR	122.51	19.56	7	RRT	0.44	0.63	7	RTT	1.56	1.32	7
TTT	128.11	33.54	8	RTR	1.19	0.83	8	RTR	2.44	1.21	8

Study 2 Selection Errors				Study 2 Preference				Study 2 Measure Integration			
Condition	M	SD	Rank	Condition	M	SD	Rank	Condition	M	SD	Rank
LLL	0.06	0.25	1	RRR	15.63	11.13	1	LLL	2.20	1.64	1
RRR	0.13	0.34	2	LLL	16.25	9.53	2	RRR	2.60	1.95	2
LTT	0.31	0.87	3	TTT	19.69	10.59	3	LTT	3.00	2.12	3
RRT	0.56	1.41	4	RTT	21.63	7.09	4	RTT	4.40	1.81	4
TLL	0.75	1.18	5	RRT	23.13	9.91	5	RRT	4.80	1.92	5
RTT	0.75	1.44	5	LTT	23.94	7.89	6	TLL	5.00	1.41	6
RTR	0.88	1.36	7	TLL	24.75	8.72	7	TTT	5.40	2.79	7
TTT	2.13	2.28	8	RTR	35.00	6.12	8	RTR	7.60	0.55	8