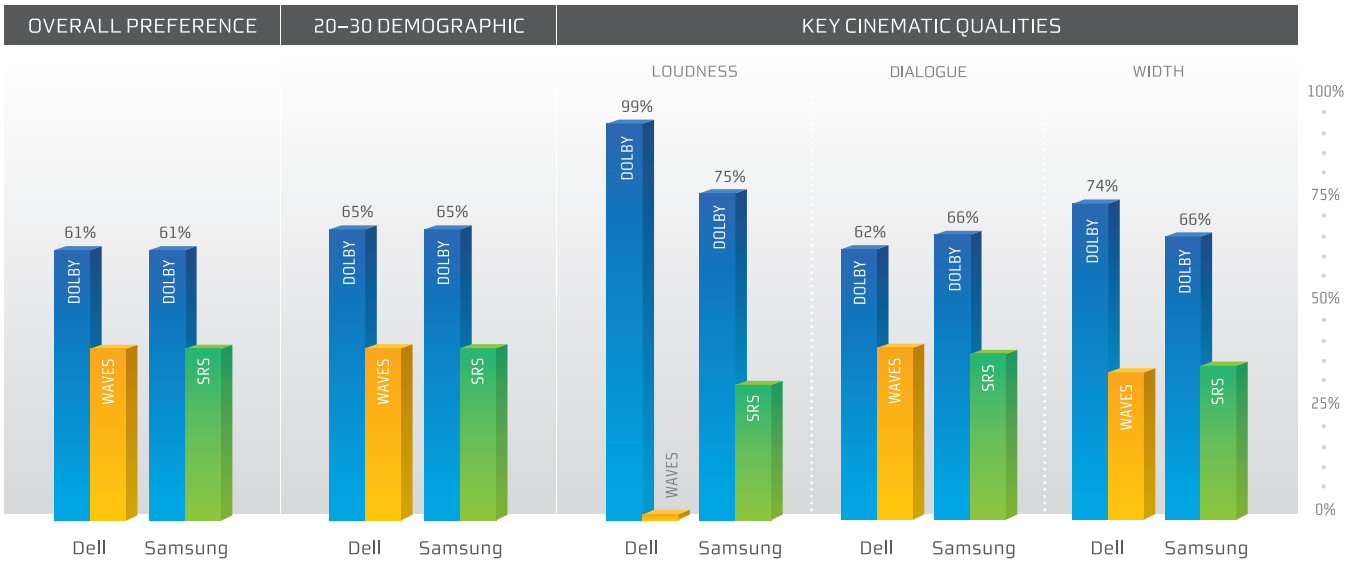
PC Postprocessing Technologies: A Competitive Analysis

Dolby Home Theater v4
SRS Premium Sound
Waves MaxxAudio 3

Abstract

In a scientifically rigorous analysis of audio postprocessing technologies for laptop computers conducted by one of the world's leading research and teaching institutions, based in the San Francisco Bay Area, consumers clearly preferred Dolby® Home Theater® v4 for overall sound. The preference was particularly strong in the 20–30 age bracket, and listeners in general cited better loudness, dialogue clarity, and spaciousness for the Dolby technology. The study, the most comprehensive ever done in this field, compared Dolby Home Theater v4 with Waves MaxxAudio 3 and SRS Premium Sound™ on identical laptop models from Dell and Samsung. A total of 78 listeners compared sound in the absence of postprocessing technologies, with the manufacturer's included postprocessing technology (SRS or Waves), and with Dolby Home Theater v4. Laptops under test were the Dell® XPS™ 15 and Samsung RF511. All audio was judged using each computer's built-in speakers. Listeners evaluated the sound using digital samples from movie soundtracks and music, and were asked to judge the audio for overall preference and several specific characteristics. Neither the laptop models nor the postprocessing technologies were identified at any time to the listeners, and all tests were performed with the computers placed behind an opaque, acoustically transparent screen.

Dolby Dominance



Background

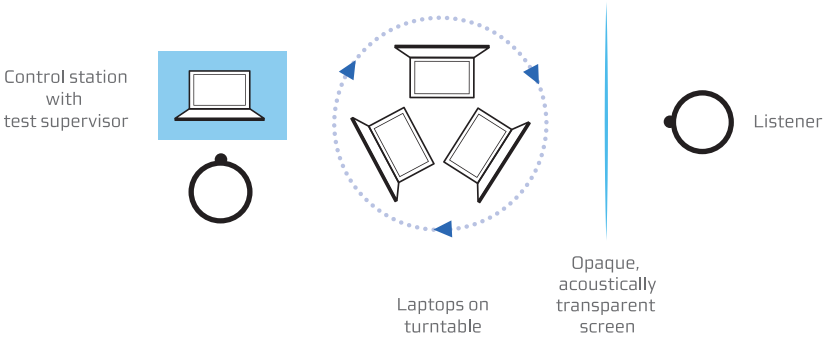
Today's PCs are not just productivity devices but often the primary entertainment device for consumers. While desktop PCs can be easily outfitted with third-party add-ons ranging from large-screen monitors to external speakers, laptops cannot be expanded without sacrificing the portability that makes them popular.

In addition, laptop designs limit the size of built-in speakers and the power of built-in amplifiers. Users on the go can watch movies on bright, sharp screens, but the audio quality often doesn't match.

Dolby Laboratories and other companies have developed postprocessing technology suites to address many of the laptop audio shortcomings. All of these make the same promises—realistic, cinema-style sound that immerses you in the onscreen action or music. At Dolby, however, we believe that our Dolby Home Theater v4 suite improves laptop audio more effectively than competing technologies.

We were confident enough in this belief to commission a research institution to conduct a comprehensive scientific analysis of Dolby Home Theater v4 and competing technologies. The institution compared popular laptops that use technologies from SRS and Waves, exactly as supplied by the laptop manufacturer, to identical machines with Dolby Home Theater v4. The institution also selected the participants, oversaw the setup, and ran the study independently on campus.

Test setup for laptop comparisons



Graphic 1: Listeners were seated at a normal working distance relative to the laptops but could not see or touch them.

The table below summarizes feature judgments made for music and movie content:

Test Parameter	Music	Movie
Overall Preference Instinctive choice independent of specific audio characteristics	X	X
Loudness Crucial to immersing the listener in the audio, especially on small portable consumer devices	X	X
Dialogue Clarity Vital to enjoying a movie soundtrack		X
Sound Width Gives a small laptop a large, spacious sound		X
Bass Enhanced low frequencies necessary for full-range music reproduction	X	
Spectral Naturalness Subjective sense of natural sound	X	X

Methodology

All tests followed a general paradigm that included an overall preference judgment and a multifeature comparison using a two-interval-forced-choice procedure (2IFC). We believe that the methodology used in this test is the most rigorous competitive analysis of consumer computer subjective audio quality. All studies were performed by an unbiased third party using untrained listeners from a broad sampling of age groups and listening expertise. Most important, the test was performed in a blind unbranded setting. The 2IFC procedure is a widely used psychophysical paradigm known for providing an unbiased measure of a judgment or performance. Presentation orders, presentation balancing, and content types were all randomized or controlled to ensure an unbiased robust result that was not indicative of a specific content or listening scenario. Timing between presentations and content durations also were all carefully controlled to optimize listener memory and minimize presentation ordering effects.

Testing involved six separate laptop PCs: two models, each with three separate laptop PCs per model. For each model, all three PCs included different audio implementations: (a) with all postprocessing technologies removed, (b) with the competitive technology (SRS or Waves) as shipped from the manufacturer, and (c) with Dolby Home Theater v4 installed as the postprocessing solution. The laptops with competing technologies were supplied to the testing institution directly by the manufacturer: Dell XPS 15 (with Waves MaxxAudio 3) and Samsung RF511 (with SRS Premium Sound). Dolby supplied identical models, one pair including Dolby Home Theater v4 technologies and one pair with postprocessing technologies disabled, as described above. All postprocessing technologies were played using the native profiles suggested for movie or music content as provided from the manufacturer.

For each trial, a listener sat behind an acoustically transparent but visually opaque screen. The laptops were mounted on a turntable to allow rapid placement in front of the listener in a

position identical to how they're typically used. Listeners first heard the unprocessed audio from either movie or music content. They then heard the same sample played on PCs with Dolby Home Theater v4 and the competing technology. The order of presentation for the processed audio was determined by randomization within the framework of a 50–50 split.

During each trial, listeners heard three identical sets of 10- to 15-second music or movie samples presented serially from both PCs under test. An approximately 1.5-second silence was included between each PC presentation. Following the first listening of all three audio implementations, each subject was asked to choose his or her overall listening preference for either of the postprocessing suites.

The second and third presentations of the content set followed completion of the preference ratings. Listeners were then asked to make similar 2IFC judgments, this time with respect to subjective parameters. Following the second listening, listeners were asked to judge the postprocessing suite that increased the loudness and maintained the spectral naturalness relative to the unprocessed audio for all content. Listeners were always instructed to make these judgments independently of preference and to strictly judge the feature at test. Listeners were also asked to judge low-frequency enhancement (bass) for music content and speech clarity for movie content.

On another repetition listeners were instructed to judge which presentation of the audio had the widest sound image (virtualization). This was measured using a 2IFC judgment, and was only tested for movie content.

Key Audio Characteristics Definitions and Results

Overall Preference

Respondents selected and orally reported the processed technology that sounded best to them. So as to obtain an instinctive preference, they were not asked to judge or identify any specific sonic characteristics.

Compared to Waves (Dell), 61 percent of the listeners preferred Dolby Home Theater v4. Listener preference for Dolby Home Theater v4 compared to SRS (Samsung) was also 61 percent. In the 20–30 age bracket, this overall preference for Dolby compared to both technologies rose to 65 percent.

Loudness

Respondents selected and orally reported the laptop presentation they perceived as louder. Loudness is a particularly important parameter for a postprocessing suite: If a laptop cannot achieve adequate volume, many of the other processing parameters will be inaudible in most listening situations. In addition, movie soundtracks require a wide dynamic range to deliver their full effects. The volume level was set to maximum for all laptops.

Compared to SRS (Samsung), 75 percent of the listeners perceived Dolby Home Theater v4 to be louder. The comparison with Waves (Dell) was even more definitive—99 percent perceived Dolby Home Theater v4 as louder. In the 20–30 age bracket, the results were similar: 74 percent selected Dolby versus SRS and 99 percent selected Dolby versus Waves.

Dialogue Clarity

Respondents selected and orally reported the laptop audio experience they perceived to have better speech quality in comparison to the unprocessed audio.

Compared to Waves, 62 percent of the listeners judged Dolby Home Theater v4 to deliver clearer dialogue. The figure rose to 66 percent compared to SRS.

Sound Width (Virtualization)

Respondents selected and orally reported the laptop presentation that sounded wider and more spacious. Sound width indicates how well a postprocessing technology delivers a spacious, enveloping, and surrounding sound. It's another key parameter, as the small sonic footprint of laptops that lack audio processing particularly detracts from the video-watching experience. A wide, involving audio experience more fully engages viewers and helps them forget they're watching on a small screen.

Compared to SRS, 66 percent of the listeners judged Dolby Home Theater v4 to provide a wider and more spacious sound, and 74 percent preferred Dolby over Waves. In the 20–30 demographic, these figures rose to 68 percent compared to SRS and 87 percent compared to Waves.

Additional Characteristics Judged

Bass

Respondents selected and orally reported the laptop presentation they perceived to be richer in low frequencies.

Spectral Naturalness

Respondents selected and orally reported the laptop audio experience they perceived to be the most natural. Although spectral naturalness is highly subjective, the aim was to understand how listeners perceived the processed transformation of the original sound and how consistent this feature was with a listener's overall preference.

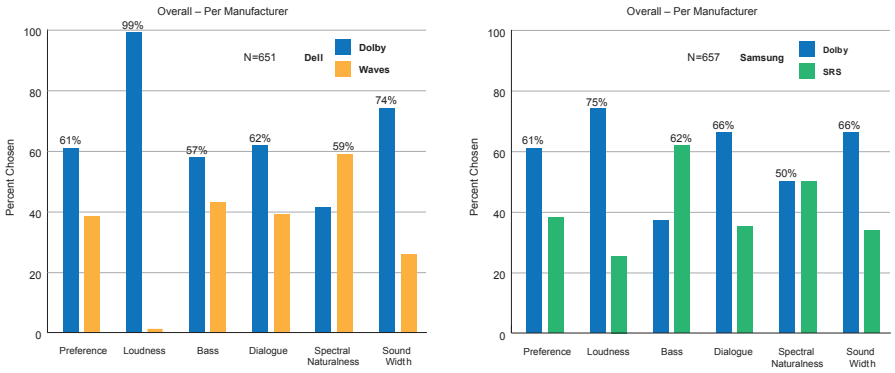
Note that the term "spectral naturalness" can actually represent many dimensions of a sound's quality. Listeners were not given a definition of the term, nor were they asked to provide one. The primary intent was to understand how listeners' judgments of this subjective quality related to their overall preference for each of the tested postprocessing technologies and how consistent this judgment was with the other tested features: loudness, bass, dialogue clarity, and sound width. It was entirely expected that this variable would have different meanings from person to person.

Complete Results

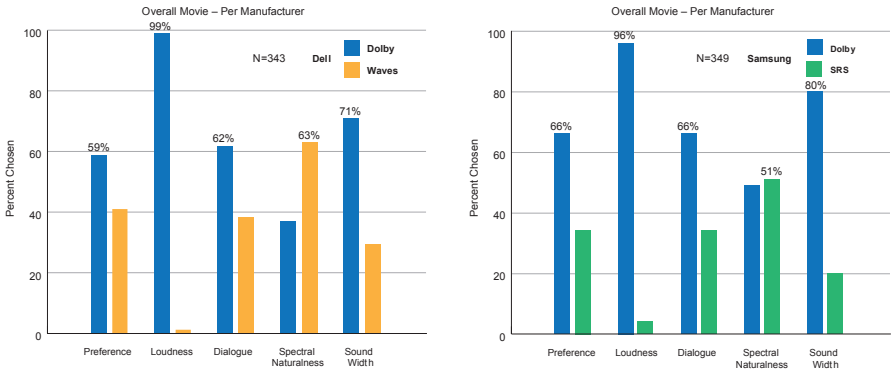
The described study generated extensive data comparing computer audio technologies. In addition to the aggregate results and device types, we also broke out results for three different age groups (20–30, 30–40, 40–55), and two content types (music or movie).

To determine the statistical significance of the results (all primary results discussed were found to be highly significant, $p<0.01$), a nonparametric test of randomization was performed using common statistical resampling methods including bootstrapping and Monte Carlo simulation methods. This test and these techniques are extremely robust metrics that are conservative in falsely identifying statistical significance.

The graphs following provide the complete breakdowns:



N = Number of trials included in overall PREFERENCE rating represented in each graph.



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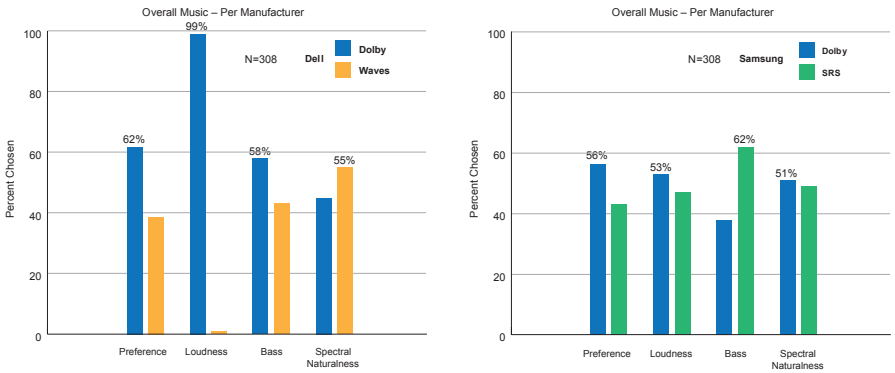

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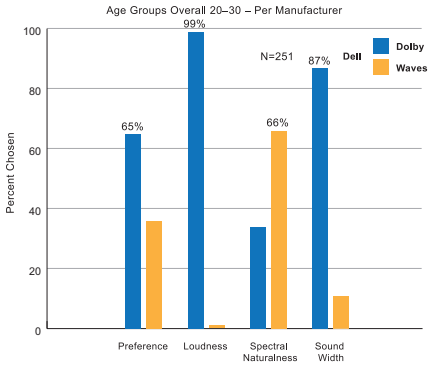

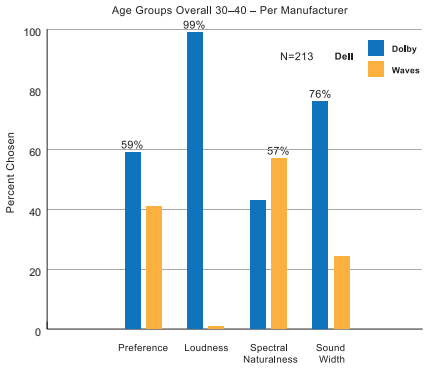

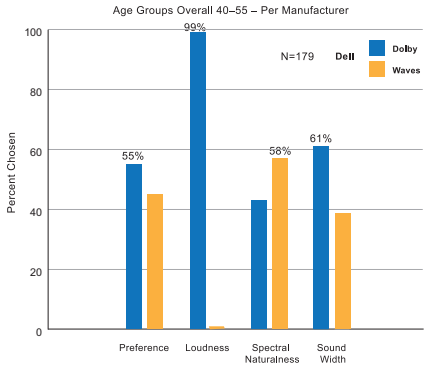

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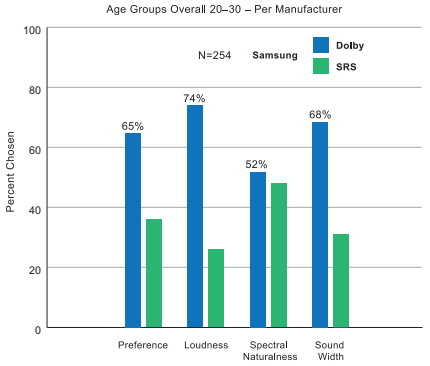

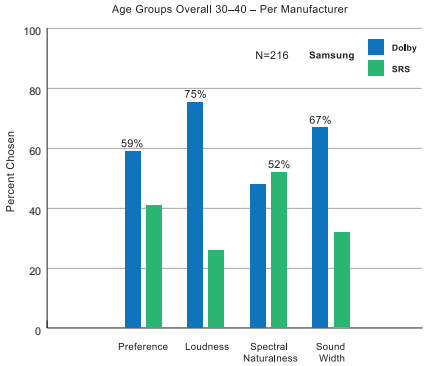

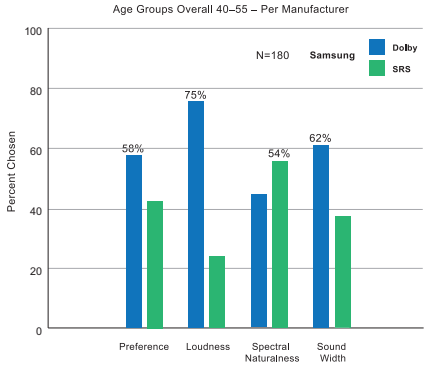

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