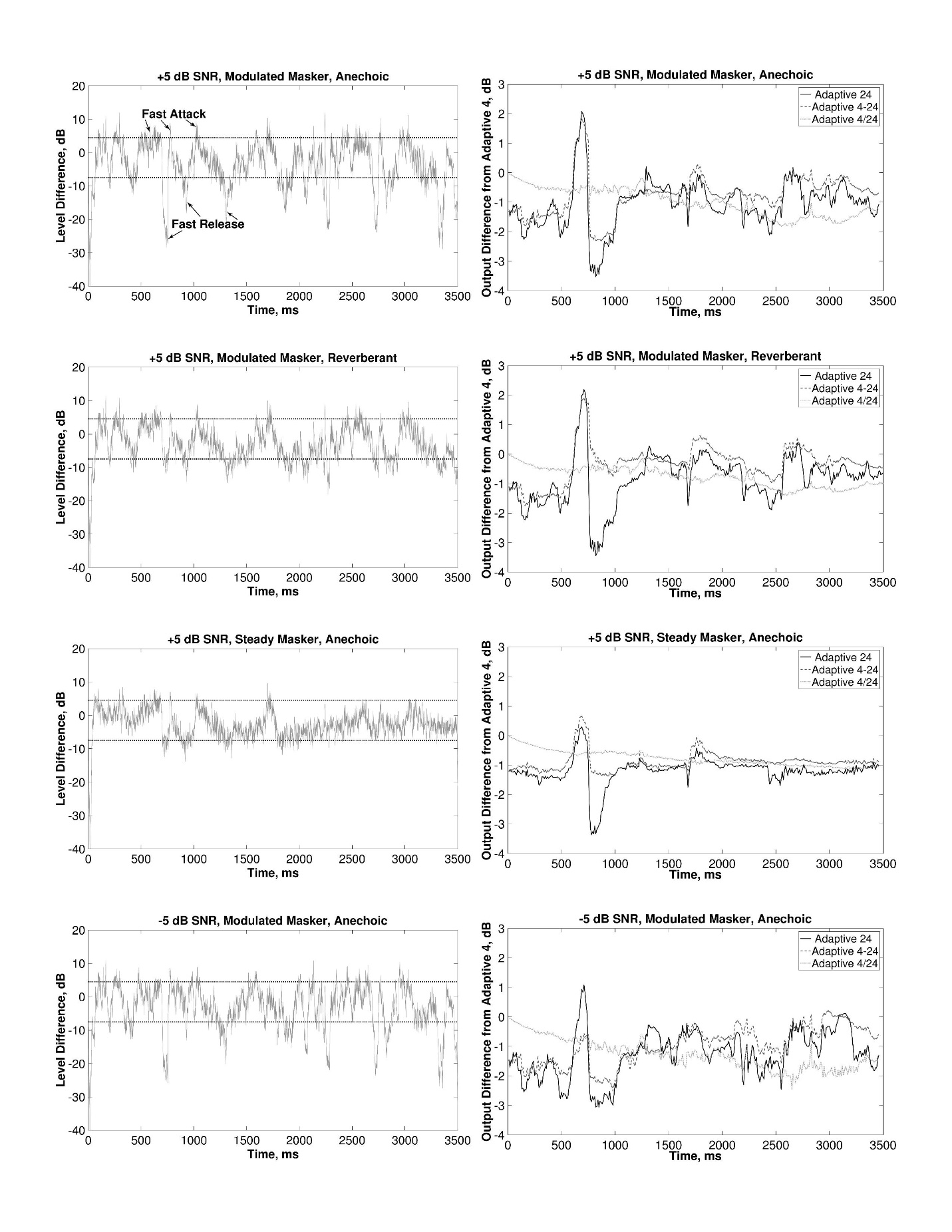
**Appendix A**

The adaptive compression method used in the current study is based on a commercial algorithm known as ‘Speech Guard E’ (Oticon A/S, Smørum, Denmark; Neumann, 2003). Key features of this method include a ‘time constant controller’ (TCC) that selects the attack and release times based on the difference between two level detectors. One level detector operates on the input signal and has fast time constants that are fixed. The other level detector controls the gain applied to the output signal and has variable time constants that are determined by the TCC. The level of the output signal is subtracted from the input level estimated by the fast detector. The difference between the two indicates the change in signal level. If it is a large negative value (the current input segment has a lower level than the previous output segment), level is rapidly decreasing and a fast RT is applied to keep the signal audible. If it is a large positive value, level is rapidly increasing and a fast attack time is applied to keep the signal comfortable. If the difference is close to zero, level is constant and slow time constants are applied to keep the signal as linear as possible and free from distortion.



**Figure A1**

Figure A1 shows a functional comparison across the adaptive compression methods using some of the stimuli from the present study. In these examples, the signal is the sentence ‘A large size is stockings is hard to sell.’ The panels on the left show the input to the TCC (the difference between the two level detectors described earlier) for the 1484-3672 Hz channel in the underlying 4-channel architecture. As indicated in the top row, fast attack times are applied when the difference exceeds the upper criterion of the window (shown by the horizontal dotted lines) because this indicates that input segments have progressively higher levels than the previous output segments. Fast release times are applied when the difference exceeds the lower criterion of the window. The window is negatively skewed in order to protect the listener from high-level sounds. Within the window, slower compression time constants are applied.

The panels in the first row were presented at 5 dB SNR with a simulated anechoic room. The noise was a two-talker babble referred to as ICRA noise (see Methods). As can be seen in the left panel, this example has numerous instances where the level difference exceeds the window, thereby triggering the fast-acting component. The variability in signal level is due to the amplitude modulation of the masker used in this example.

The panels on the right show the differences in output levels for the 1/3-octave band centered at 3150 Hz for the three experimental compression methods compared to Adaptive 4, the original method in the commercial devices. In each row, the relatively smooth line corresponding to the Adaptive 4/24 method (gray dotted line) indicates that its dynamic behavior is almost the same as that of the Adaptive 4 method. This occurs because Adaptive 4/24 is the same as Adaptive 4 when the level differences going into the TCC exceed the window criteria and because slow time constants are applied when the levels difference are within the window, which tends to keep the gain linear.

On the other hand, the right panels show that the dynamic behaviors of Adaptive 24 (solid black line) and Adaptive 4-24 (dashed black line) are more variable and tend to be more similar to each other and more different from the other two methods. Compared to the first two methods that apply fast time constant across 4 channels, these two methods apply fast time constants across 24 channels. Like conventional WDRC algorithms, having narrower channels will make the compressors in each more responsive to level changes in their own local frequency neighborhood. This may explain the greater variability in gain, hence output level, for the Adaptive 24 and Adaptive 4-24 methods. The biggest differences in output levels between the methods occur around the 600-1100 millisecond time interval. The upper left panel shows that during this interval a fast release time is abruptly followed by a fast attack time, and again by a fast release time. The effects of these rapid gain adjustments are seen in the upper right panel where, relative to the fast-acting 4-channel methods, the output levels for the fast-acting 24-channel methods rapidly increase, then rapidly decrease, and then increase again.

The second row of panels show the effects of reverberation. As discussed in the Introduction, reverberation will tend to flatten the temporal changes in level. Compared to the anechoic condition in the first row, the level differences in the reverberant condition exceed the window about as frequently, but the size of their excursions are less extreme. Except for the Adaptive 4-24 method, the effect on the output levels shown in the right panel are minimally affected. The biggest difference is seen right after the fast attack mode is engaged around 700 milliseconds. In the anechoic condition (first row), the Adaptive 4-24 method showed a drop in level between 800-1100 milliseconds that was similar to the Adaptive 24 method. In the reverberant condition (second row), the level for the Adaptive 4-24 method returns to the same level as the other methods during this time interval. This may have occurred because the time constants for this method are based on 4 wide channels so that even though gain is applied independently to 24 narrow channels, the amount of energy in the wide channel that triggered the compression may have been relatively constant due to the reverberation which would have prevented gain from dropping too quickly.

The third row shows the effects of a steady masker. Compared to the first row, which was processed under otherwise identical conditions, there are less frequent and smaller excursions beyond the level difference window in the left panel. Consequently, the output levels are almost the same among all of the methods, with the one exception for the Adaptive 24 method around the 600-1100 millisecond time interval.

The last row shows the effects of SNR. It was processed under identical conditions as the first row, except the noise level was 10 dB higher. As shown in the left panel, the excursions beyond the level difference window are as frequent and about as large as those in the first row. Compared to the other conditions (all with +5 dB SNR) shown on the right, the dynamic behaviors of the adaptive compression methods relative to the Adaptive 4 method are more variable as indicated by small, rapid fluctuations along the lines. In addition, the rapid changes in level for the Adaptive 24 and Adaptive 4-24 methods around the 600-1100 millisecond time interval are smaller compared to the first row and are more similar in magnitude to the steady masker condition shown in the third row.