The effects of gamma spaces on image quality with common image processing techniques

Make sure you have calibrated your display using Adobe Gamma or a third party calibration package.

Open Photoshop and USMTest.tif. (or run the 'build and save image' action)
This is a grayscale image with 4 squares on a background of level 128. The upper left square is white (255), the upper right square is black (0), the bottom left square is light gray (192) and the bottom right square is dark gray (64).

Experiment 1

Make sure the image is zoomed at 100%, so you will see the entire image without any distortion.

BTW - the Photoshop action file accompanying this document will also lead you through these steps if you run '** Run the Experiment **')

Now Filter->Sharpen->UnsharpMask...

amount:	100 %
radius:	10 pixels
threshold:	0 levels

Hit OK

Bring up Image->Histogram -- it should be pretty symmetrical.
The grays near the white square have decreased just as much as the grays near the black square have increased, and the grays near the two gray squares have changed equally as well.

This shows that the numerical effects of the UnsharpMask filter are symmetrical with respect to increasing and decreasing pixel values.

Let's try looking at that another way:

Go to the layers palette and duplicate the background layer.
Image->Adjust->Invert
Edit->Transform->Flip Horizontal
Change the layer blending mode to 'difference'
Merge the layers (Flatten)
open Image->Histogram

This shows that there is very little difference between the inverse of the effect applied to one gray square and the effect applied to it's opposite.

There is some difference -- this is because the background was set to 128, but the inverse of 128 is 127 (differs by 1) and there is some numerical rounding and quantization (the fact that the result has to fit in 8 bits) occurring during the filtering process.
If you bring up Image->Adjust->Levels and set it for 0,1.0,2 you can see the shape of those differences (BTW - these small numerical differences form the basis of several cool special effects tricks)

Once again, this shows that the numerical effects of the UnsharpMask filter are symmetrical -- they apply equally to increase and decrease values around edges.

Experiment 2

Up till now, your RGB or Grayscale setup hasn't mattered -- we were only looking at numbers.
But now let's look at the visual effects.

Revert the image to its original saved state and make sure it is zoomed to 100%.
Open Grayscale Setup and change it to RGB.
Open RGB Setup and change it to sRGB and make sure that 'display using monitor compensation' is turned on.
At this point the background gray should look like it is halfway between white and black.
If it doesn't, you need to recalibrate your display - something went wrong.

Now Filter->Sharpen->UnsharpMask...

amount:	100 %
radius:	10 pixels
threshold:	0 levels

Hit OK

Here we shouldn't have to look at the histogram -- the effects should be visually symmetrical.
This is because we are working in a gamma encoded colorspace that is close to visually uniform.

Now, open RGB Setup, make sure preview is turned on, and change the gamma to 1.0, leaving the dialog open and moving the dialog so you can see the image.
The background is now much lighter, and there is a change in the visual effect (but the numbers are still the same!).
We can see a darkening around the white square, but it is very difficult to see a change around the black square.
Similarly, we can see a big change inside the dark gray square but almost no change outside it, and almost no change inside or outside of the lighter gray square.
This is because we are working in a gamma space that is not uniform -- equal changes to the numbers don't produce equal visible changes.

In a gamma 1.0 color space, small values added to a pixel will produce big changes in the shadows, but small changes in the highlights. Also, adding a value will result in a much smaller visible change than subtracting from the same value.

Change the gamma to 1.25.
We can see a little change, but not much -- this gamma space is still far from uniform.

Change the gamma to 1.8.
This should give something that looks a lot closer, but still leans just a little toward dark.

Change the gamma to 2.2.
This gets us back where we started -- with visually symmetrical effects.

Color Images

How about color images you ask?
Well, that's why I included an actions file with this experiment -- so you can try several different color images and see what the effects look like. (and using adjustments means that you only have to download 1 image) You can run either the '** Run the Experiment **' action or just run the 'ColorTests' action with USMTest.tif already opened.

Conclusions

Many image editing operations are similar to UnsharpMask in that they add or subtract a small value to the existing pixel value. These functions assume that changes in either direction (lighter or darker) will have the same visual 'distance' (effect, but without regard to direction). If you are editing in a non-uniform colorspace (one with too small or too large a gamma), then common image editing functions will not work well. Editing in a visually uniform gamma space around 2.2 gives the most accurate and visually acceptable results.