Parent functions:

- **Quadratic**
  \[ F(x) = x^2 \]

- **Cubic**
  \[ F(x) = x^3 \]

(Graph using transformations)

- **Transformations**: can slide, stretch, shrink

  - **Vertical transformations**: happening outside the parent function
    
    \[ g(x) = x^2 - 4 \]
    
    P.f. \( f(x) = x^2 \)

  - Adding or subtracting on the outside (shifts up/down)

  - **Vertical stretch/shrink**: multiply P.f. by a \( \neq 1 \)
    
    - (pulls the graph towards the y-axis)
    
    \[ g(x) = 3\sqrt{x} \]
    
    P.f. \( f(x) = \sqrt{x} \)
    
    \[ h(x) = \frac{1}{2}\sqrt{x} \]
    
    (pulls the graph closer to the x-axis)

D: \((-\infty, \infty)\)
R: \([-4, \infty)\)
**Vertical Reflection**

\[ F(x) = x^2 \quad g(x) = -x^2 \]

*Reflection has to happen first.*

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**Horizontal Transformations:***

- Do the opposite
  - Left \( \rightarrow \) add
  - Right \( \rightarrow \) subtract

- \( \text{add/sub} \)
  \[ g(x) = \sqrt{x-2} \quad h(x) = (x+3)^2 \]
  \[ \text{Pf: } f(x) = \sqrt{x} \quad \text{Pf: } h(x) = x^2 \]

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**Horizontal stretch/shrink**

- \text{(stretch)} \( \times \) multiply \( x \) by a \( \# \), where \( 0 < \# < 1 \) (closer to the \( x \)-axis)
- \text{(shrink)} \( \times \) multiply \( x \) by a \( \# \), where \( \# > 1 \) (closer to the \( y \)-axis)

\[ g = \sqrt{2x} \quad g = \sqrt{\frac{1}{2}x} \]

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**Horizontal Reflection**

*flip over the \( y \)-axis*

\[ g(x) = -\sqrt{-x} \quad f(x) = \sqrt{x} \]