ThunderBolt

NNJR “Trackside Classroom”

Car Control

May 24, 2021

Disclaimer

The techniques shown here have been compiled from experienced sources believed to be reliable and to represent the best current opinions on driving on track. But they are advisory only. Driving at speed at Thunderbolt, or any other track, requires skill, judgment and experience. These techniques assume the reader has high performance driving knowledge and applies them as applicable to their level of driving experience.

High-performance driving can be very dangerous, carries inherent risks and may result in injury or death. NNJR and PCA make no warranty, guarantee or representations as to the absolute correctness or sufficiency of any representation contained herein. Nor can it be assumed that all acceptable safety measures are contained herein or that other or additional measures may not be required under particular or exceptional conditions or circumstances.

Car Control

- What is car control?
  - Car does what I ask it to do; expect it to do
  - Remember: driver is “guiding not dictating” *
- Car “feels good”
  - What is that? What is feel?
  - No bad habits
  - Inspires confidence, not scary

** Dennis Macchio*

What is the car doing?

- Handling is
  - Balance,
  - Responsiveness, and
  - Overall grip
- There are tradeoffs
- Driver must have confidence in the car
  - Starts with “feel”

Ross Bentley: Speed Secrets Weekly 378

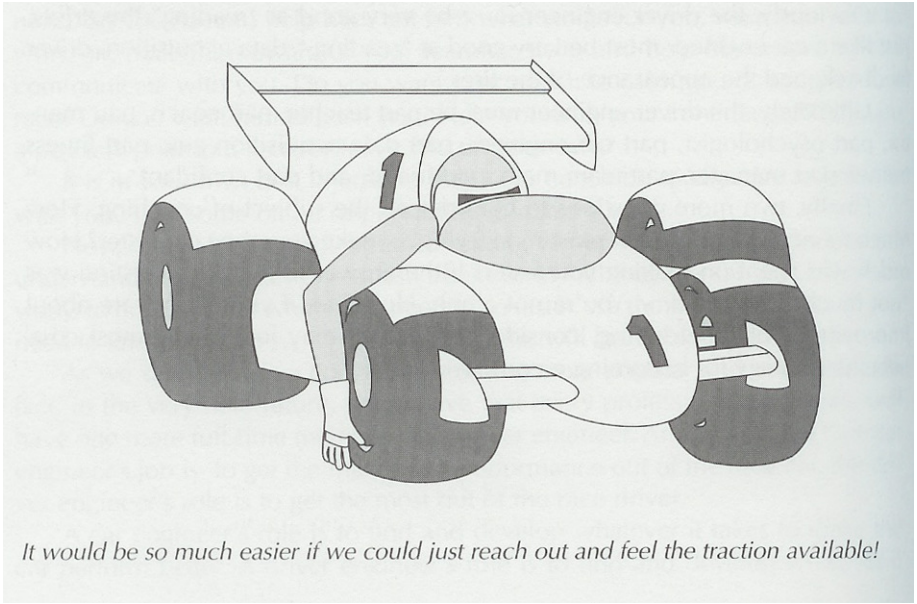
How to “feel” the car?

- Do you know if/when your car is understeering?
  - Oversteering?
  - Both (at different times)?
- Do you know when PSM intervenes??
- Sensing the car is a learned skill! *

** Ross Bentley*

How to develop “feel”?

- Sensory input sessions*
  - Sound
  - “Seat of the pants” (Kinesthetics)
  - Feel in the steering wheel
  - Vision: car’s path vs. intended path



It would be so much easier if we could just reach out and feel the traction available!

**Ross Bentley*

What are we Sensing?*

- Yaw (Body Slip Angle, Rotation)
- G-loads
- Weight (Load) transfer
- Steering effort/vibrations (steering is both output & input device)
- Visual picture
- Tire/wind/engine sound

**Ross Bentley*

Deliberate Practice*

- (Re)Learn the Track
  - Reference Points
  - Track Surface
  - Safety features
- (Re)Learn the Car
  - Brake Application
  - Brake Release
  - Throttle
  - Steering
- (Re)Learn the Traffic
  - Mirrors
  - What Would I Do If?
- Sensory Input
  - Vision
  - Kinesthetics
  - Hearing

* ***How*** **you practice is more important than** ***amount***

Do it in a focused way,
With clear goals,
Plan for reaching goals, and
A way to monitor your progress

Sources: Ross Bentley, Speed Secrets Weekly 322 and 370; Talent is Overrated by Geoff Colvin, and Peak. Secrets from the New Science of Expertise by Anders Ericsson and Robert Pool

Deliberate Practice for Car Control*

- (Re)Learn the Track
  - Reference Points
  - Track Surface
  - Safety features

2. (Re)Learn the Car
   - Brake Application
   - Brake Release
   - Throttle
   - Steering

- (Re)Learn the Traffic
  - Mirrors
  - What Would I Do If?

1. Sensory Input
   - Vision
   - Kinesthetics
   - Hearing

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Deliberate Practice Worksheets

Topics for Sensory Input Worksheets
Use these topics with your printed track map

Reference Points
- Not cones!
- Cracks, posts, seams, curbs, etc.
- BOB, TI, EOB, A, TO, in between

Track Surface
- Sealer, color change, etc.
- Elevation
- One new feature per lap

Safety
- How soon/far ahead can I see flag stations?
- Bail out area(s) for each corner
- Which curbs could I drive on? Not?
- Etc.

Brake Application
- Quick and hard enough? Too much?
- Does the car get upset?
- Totally consistent lap to lap?
- Get money in the bank early in the brake zone (Cass Whitehead)
- "On like a lion, off like a lamb" (Pobst)
- Etc.

Brake Release
- Modulating pressure thru brake zone properly?
- Beginning release at the right point?
- Right rate? Slow, medium, fast
- Totally consistent lap to lap?
- Come off the brakes politely (Peter Argetsinger)
- Etc.

Throttle
- Squeezing too soon? Too quickly? Not enough?
  - Pause between brake and gas?
- On floor until brake application?
- How are you using it (vs when)
- Use only the top half? (David Murry)
- Etc.

Steering
- Especially how you unwind on corner exit
- Is turn-in from track edge?
- Is turn-in crisp/flowing or gentle/progressive
  - Both correct, depends on corner
- Etc.

Mirrors
- Adjusted properly?
- How many cars behind?
  - End of back straight?
- Closing speed: is car in mirror closer or further away?
  - What color(s) is/are cars behind?
- Etc.

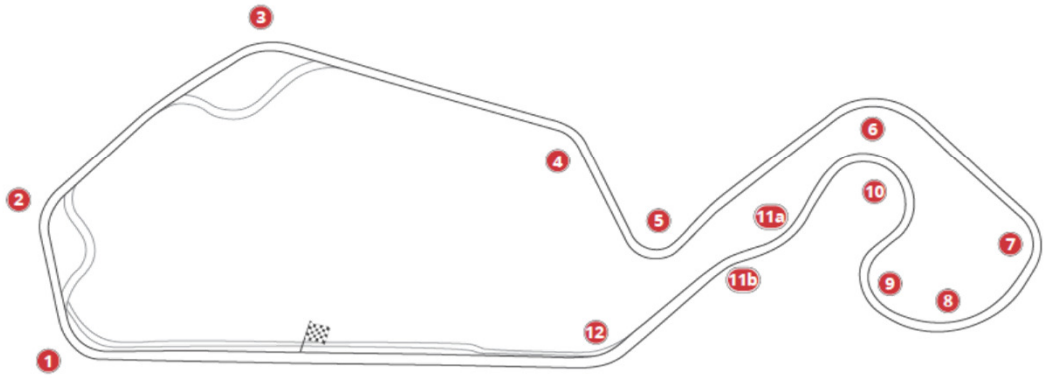
What Would I Do If
- I smell anti-freeze?
- Car in front swerves under braking?
- Brake pedal soft in middle of traffic entering bus stop? off camber?
- Two fast cars, you give one signal, can't see second one?
- Etc.

Vision
- Everything you can see on and off the track surface
  - Something new each lap
  - e.g. Horizon change during cornering
- How far ahead can you see?
- Etc.

Kinesthetics
- Steering wheel feedback
- How g-loads build; weight transfer
- Feel the track surface
- Etc.

Hearing
- Wind noise, tires, brakes
- Cornering vs. straight
- Different parts of track
- Etc.

NJMP - THUNDERBOLT



Remember: Capture learning right away: in the first 10 minutes
- Write down what you saw, heard, felt
- Before lap times, data, video, socializing

NORTHERN NEW JERSEY REGION PORSCHE CLUB OF AMERICA

Big Picture: “Principles”

- All cars have handling “issues”, but
  - If you don’t feel them, focus on driving (it’s not the car)
  - You can’t judge them unless you are (very) consistent
  - If you feel them, start with a diagnosis
- If you are going to change the car
  - Balance is more important than overall grip
  - Avoid pre-conceived ideas
  - Copying an adjustment from someone else rarely works

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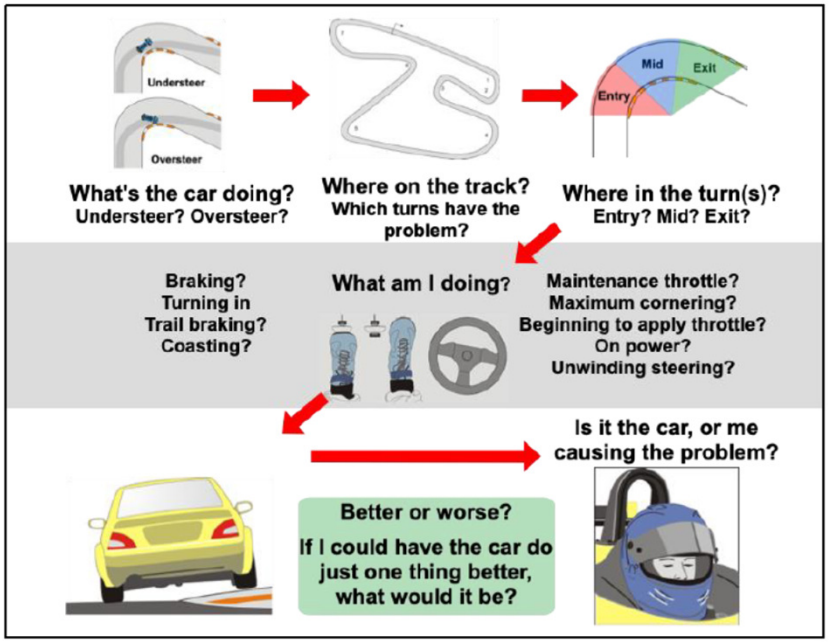
How to Focus on Handling?

- See Appendix for detailed Handling Debrief



Get Started: Handling Debrief

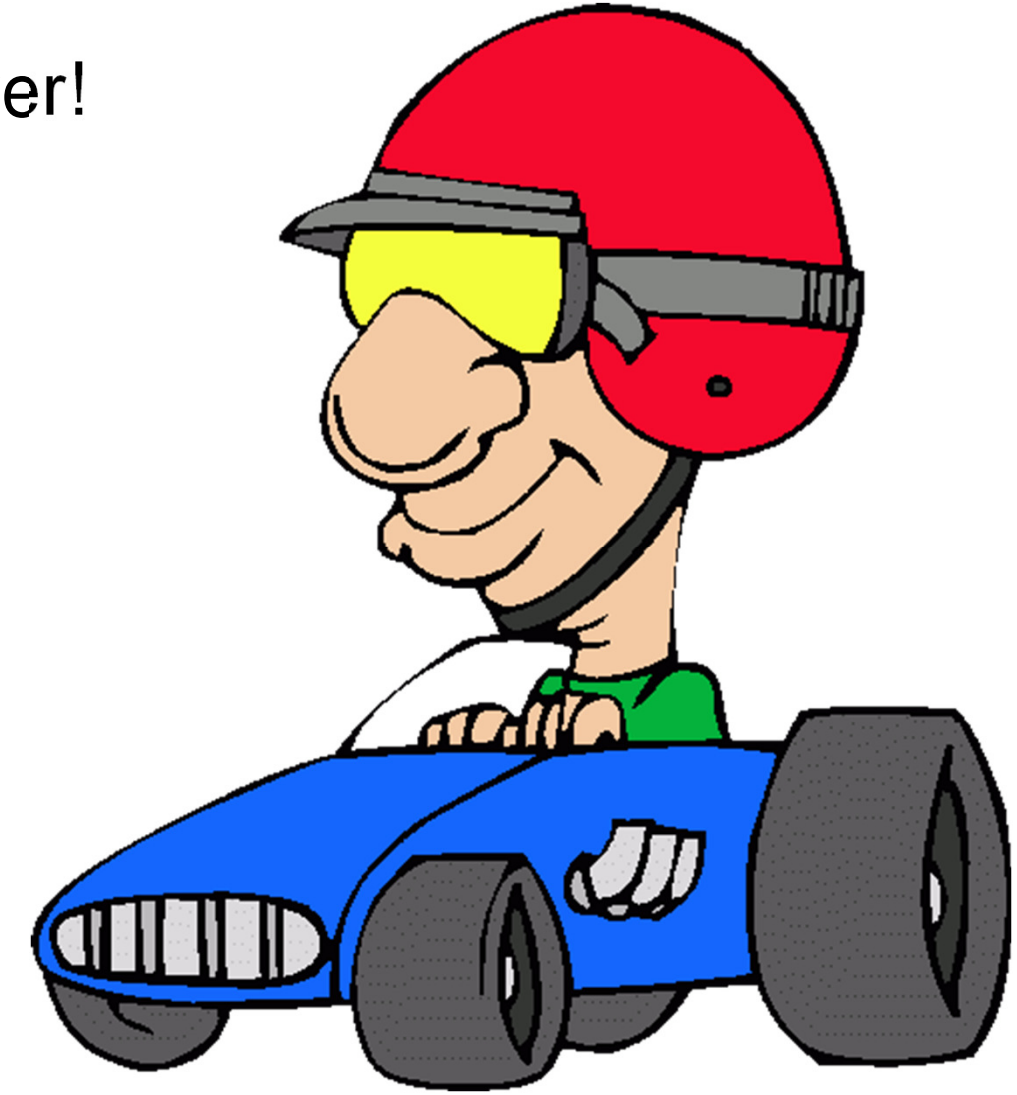
- Quick Debrief
  1. Better or worse? Was car's handling better or worse than before the change?
  2. If I could have the car do just one thing better, what would it be?

- Use with Deliberate Practice

Ross Bentley: How to Turn Your Car's Handling

The Biggest Cause of Handling "Issues"

- The driver!



Driver Causes of Understeer

- Corner entry too fast: exceed traction limit of front tires
- Steering input too rapid or too much steering angle
- Insufficient weight on front tires due to:
  - Abrupt brake release (on entry)
    - e.g. Turn 5
  - Too aggressive throttle (on exit)
    - e.g. Turns 1, 5, 9, 10
  - Not releasing the wheel/steering angle on exit

How to Fix Understeer

PREVENT (early, mid-corner)

- Slower Corner Entry
  - Brake earlier and/or harder
- More/longer trail braking (maybe)
- Smoother (more progressive) Turn-In
- Slightly later turn in
- Mid-corner: wait to go to the gas
- PATIENCE!

COMPENSATE

- Straighten the steering
  - Opposite of instinct!
- Slow down / lift (carefully)
- Brake (maybe)

Ross Bentley Speed Secrets Weekly 389

Manage corner entry understeer with more or less trail braking?

We all know that more load on the front tires results in them having more traction. We also know that the front tires can only do so much, and too much load will overload them (leading to them sliding too much).

So, picture this: You're approaching your favorite near-180-degree, 2nd-gear corner. You're in top gear as you get to the brake zone, and you know that getting a good exit out of it onto the next straightaway is critical. Given that, you have two separate goals in mind:

1. Getting the car rotated so you can get back to full throttle early.
2. Carrying speed through the corner so you begin accelerating from as high a speed as possible.

In other words, you want it all. Welcome to the greedy world of performance driving!

As you turn into the corner, the front end starts to push. Understeer. The front tires are just not gripping the way you want, to be able to carry entry speed and get the car's direction changed enough so you can accelerate early out of the corner. What do you do?

You have two options:

1. Trail brake more to keep load on the front tires.
2. Trail brake less to give the front tires the ability to generate cornering grip.

So, the solution to understeer is to either trail brake more or less. How do you know which to do?

Let's zoom in on what you do from the turn-in point to the apex.

Let's zoom in on what you do from the turn-in point to the apex.

You begin to release the brakes as you turn in. You're fine-tuning your corner entry speed, while managing the load on the front tires. As you ease off the brakes, one of two things happen:

1. You notice the front of the car feeling more responsive, turning more.
2. You notice the front of the car feeling less responsive, turning less.

If, as you begin to release pressure off the brake pedal, you feel the front of the car gripping more, then continue to ease off. But if you feel the understeer getting worse as you ease off the brakes, just stop releasing them for a brief moment – hold the pressure there, and then slowly continue to release them. Doing this, you're managing the amount of load on the front tires, controlling the amount of grip the front tires have for changing the direction of the car. Of course, you're also controlling your corner entry speed. Therefore, if you feel you're over-slowing, ease up a little more off the brakes; if you're carrying too much entry speed, hold that pressure for a moment.

You only have two options to focus on: releasing the brake pressure slower, or releasing it more quickly. By doing so you're managing the load on the front tires, as well as your corner entry speed.

That's a lot to sense and process in the fractions of a second you have entering a corner, isn't it? I'm sure you can imagine Lewis Hamilton, Colin Braun, or Scott Dixon being able to do this, but you're wondering whether you can. Or maybe you're convinced you can't do that. I disagree.

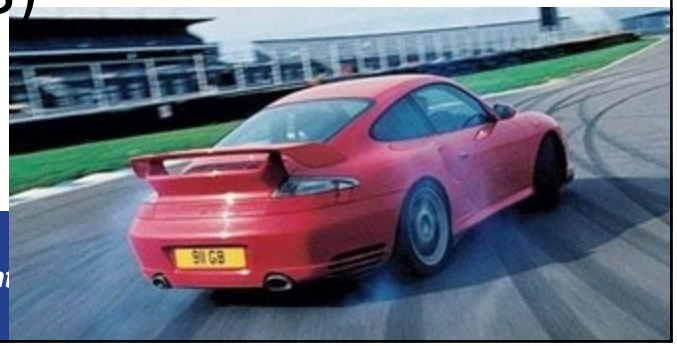
You can. But it takes practice, deliberate practice.

First, go back to imagining Hamilton, Braun or Dixon doing that. Go ahead, close your eyes and imagine them doing it, again and again. Now, substitute yourself for them. Imagine yourself approaching and entering that favorite 2nd-gear corner, managing the brake release to nail the perfect corner entry speed, while getting your car to rotate – controlling any amount of understeer there is – so you can fully commit back to full throttle early in the corner.

Next, spend a few days at the track solely focused on noticing how your car responds from turn-in to apex. Play with the timing and rate of release of the brakes, and you will improve your ability to know whether to release the brakes more, or continue to trail brake more.

Driver Causes of Oversteer

- Corner entry with excessive brake force
  - e.g. Turn 5, turn 9
- Lifting off the throttle may result in “trailing throttle” oversteer
  - Weight transfers forward off rear tires
- Aggressive braking mid-turn
- Excessive steering input in downhill turn
- Power oversteer – throttle application too aggressive (high powered vehicles)



How to Fix Oversteer

PREVENT

- Less trail braking (probably)
- Smoother transition off the brakes
- More progressive steering input
- Less and/or later gas (smooth!)

COMPENSATE

- Countersteer
  - Requires practice!
- CPR

Develop “Seat of the Pants”

- Autocross
- Skid Pad
- Car Control Clinic
- Winter driving
- Etc.

Car Control Summary

- Must first know ("feel") what the car is doing!
  - Sensory input sessions: kinesthetics
  - Key part of "advanced driving"
- Think about balance & grip; not just "responsive"
  - Concerned about handling?
    - Get organized: do handling debriefs
- In modern Porsches, most "handling issues" are caused by the driver, not the car
  - Can you induce understeer? Oversteer?
- No substitute for skid pad, AX, etc.

NNJR Q&A

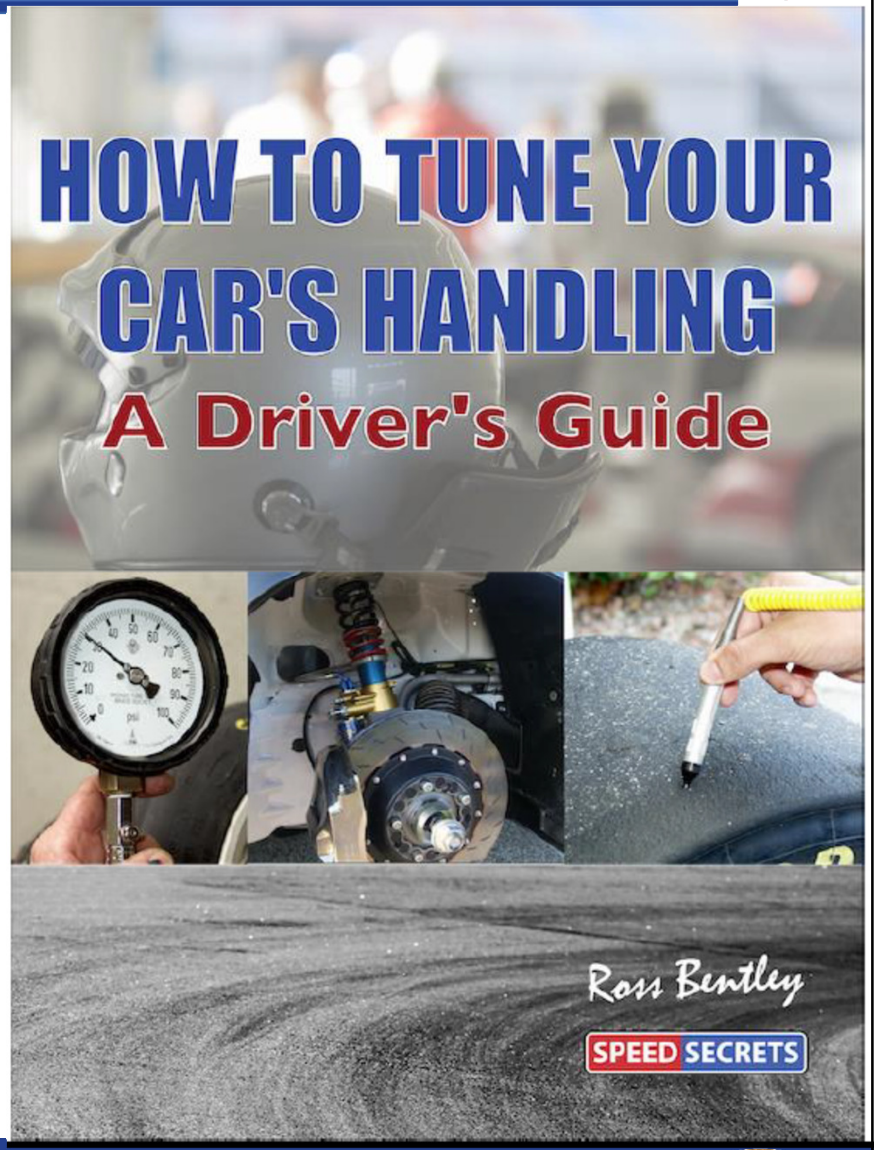
APPENDIX

HANDLING

Understeer, Oversteer and More

Fact Check

- Many opinions on car setup
- Know/trust your source(s)
- Ask and understand
  - Why?



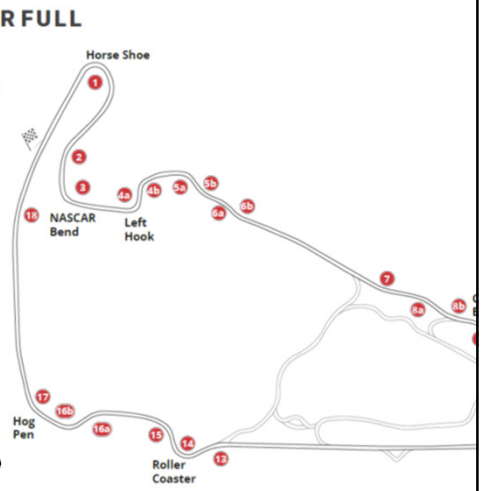
Handling Debrief

- Quick Debrief
  1. Better or worse? Was car's handling better or worse than before the change?
  2. If I could have the car do just one thing better, what would it be?

Ross Bentley: How to Turn Your Car's Handling

Handling Debrief

- Detailed debrief (with track map)
  1. What is the car doing? Understeering or oversteering? Slow to respond?
  2. Where is the car doing it? Which corner(s)?
  3. Where in the corner(s)? Entry, mid or exit?
  4. What am I doing when the car does this?
     - Braking?
     - Turning in?
     - Trail braking?
     - Coasting?
     - Maintenance throttle?
     - Maximum cornering?
     - Beginning to apply throttle?
     - On power?
     - Unwinding the steering?
  5. How bad is it on a scale of 1 to 5 (1 = slight; 5 = serious)?
  6. Is it the car or me? Am I inducing the handling problem, or is it the car?



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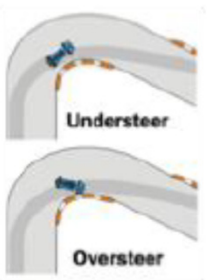
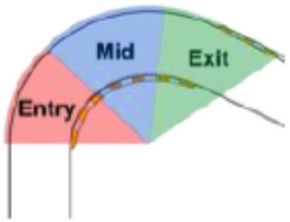
Handling Debrief



What's the car doing?
Understeer? Oversteer?

Where on the track?
Which turns have the problem?



Where in the turn(s)?
Entry? Mid? Exit?

What am I doing?

Braking?
Turning in
Trail braking?
Coasting?

Maintenance throttle?
Maximum cornering?
Beginning to apply throttle?
On power?
Unwinding steering?

Is it the car, or me causing the problem?

Better or worse?

If I could have the car do just one thing better, what would it be?

Ross Bentley: How to Turn Your Car's Handling

Want to Learn More?

What Are You Sensing?

- Yaw (Body Slip Angle, Rotation)
- G-loads
- Weight (Load) transfer
- Steering effort/vibrations (steering is output & input device)
- Visual picture
- Tire/wind/engine sound

Improving Sensing (Learned skills)

- Personal sense of balance
- Exercises:
  - Centering
  - Sports/training (cycling, balance board/ball, etc.)
- Deliberate Practice sensing the car
  - Street practice
  - Light hands
  - Sensory Input Sessions
  - G-load sessions
  - Setup sweeps
  - Skid pad
  - Test the limits – steering, braking, accelerating
  - Make car show its weakness

Ross Bentley: How to Turn Your Car's Handling

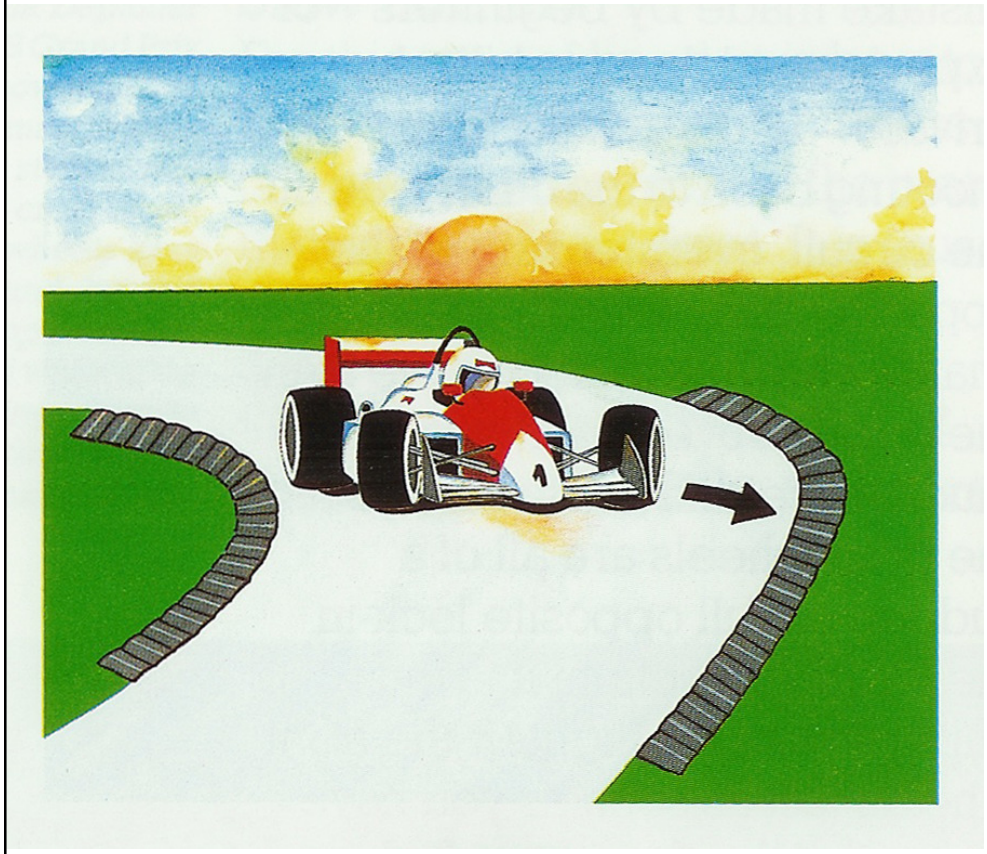
Understeer

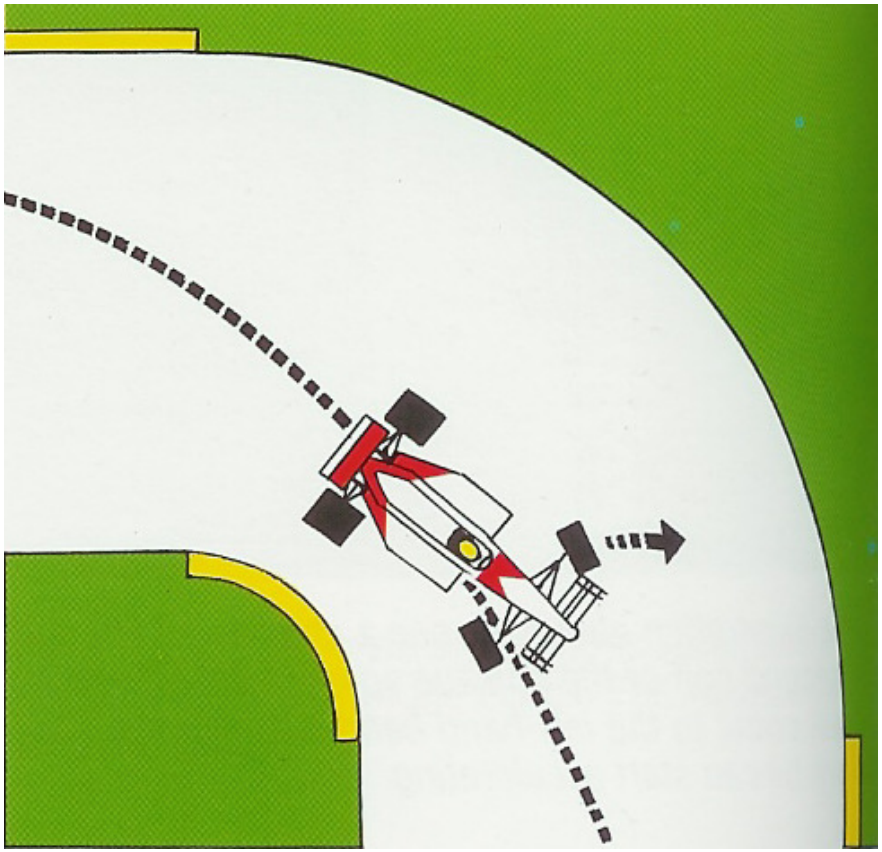
- Front tires have less traction than the rears
  - Car is not turning as much as you want
  - Increases radius of the turn

- Often referred to as “pushing”, “tight” or “plowing”
- The car is turning ***less*** than you had hoped and ***less*** than the steering input would normally dictate

Understeer / Push

- "The car won't turn!"
- Front slip angle > rear slip angle





Alain Prost: *Competition Driving*

Oversteer

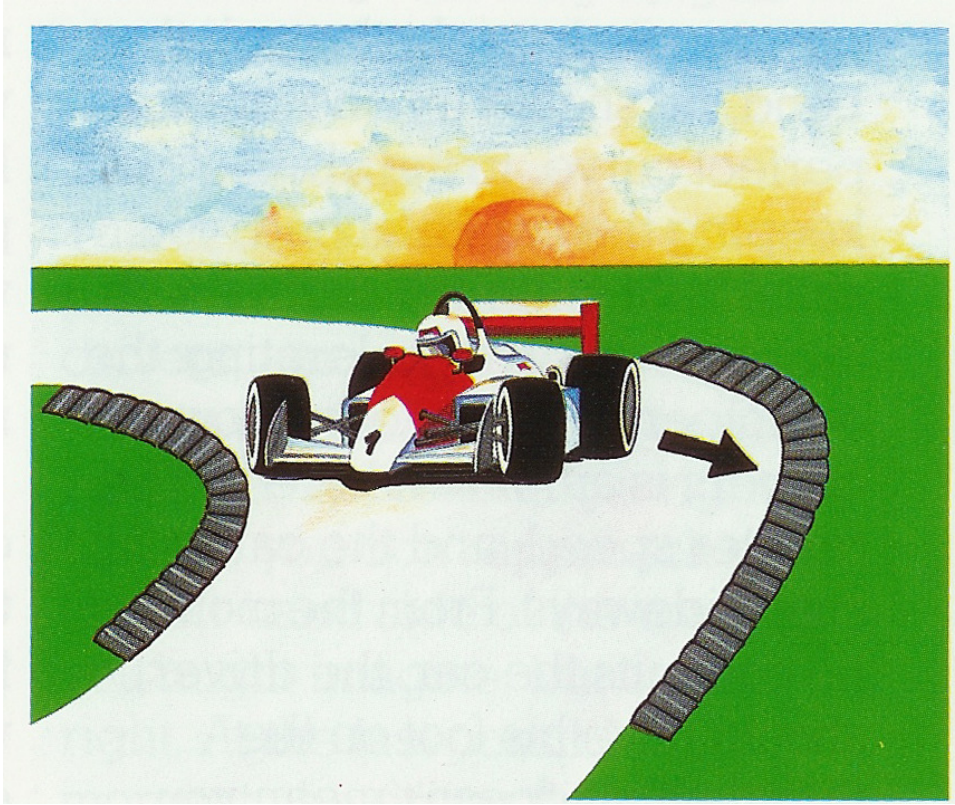
- Rear tires have less traction than front tires
- Commonly referred to as “loose”, “fishtailing” or “hanging out the tail”
- Car is turning ***more*** than you had hoped and ***more*** than steering input would normally dictate
- Car rotates so front points to inside of the turn rather than track out

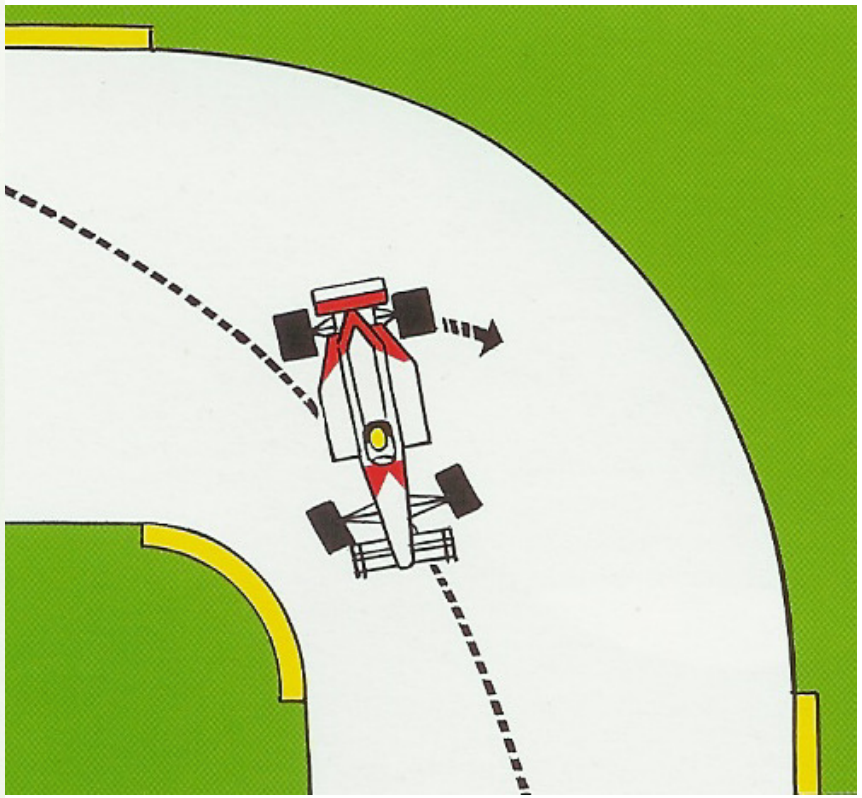
Randy Pobst

- Understeer is slow
- Oversteer is scary!

Oversteer / Loose

- "The car is turning too much!"
- "The car wants to spin!"
- Rear slip angle > front slip angle

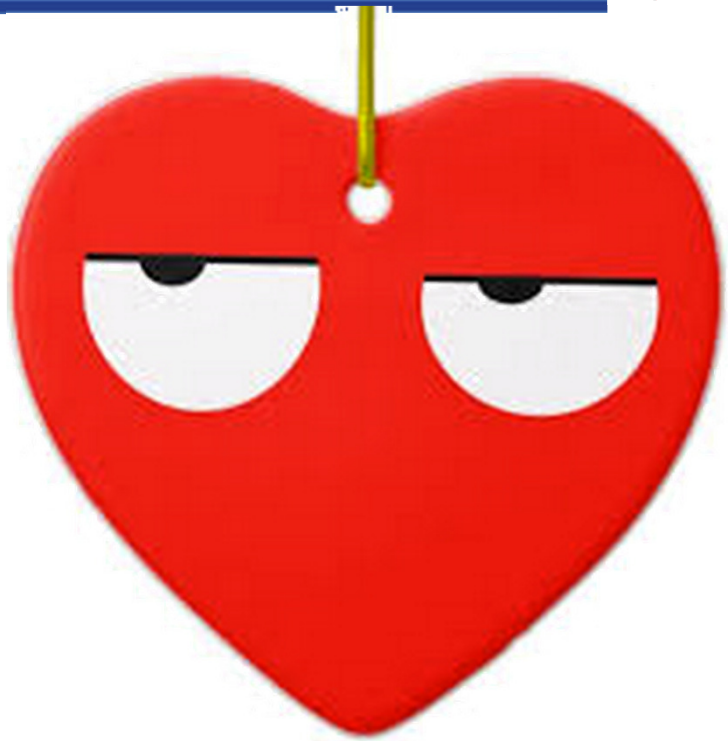




Alain Prost: *Competition Driving*

NNJR CPR

- **Correct** (steering input)
  - Do it NOW
- **Pause**
  - Allow the car to settle
- **Recover**
  - Bring the car under control
  - Use all the track you need
  - Sacrifice your line if you need more pavement to slow down



Look where you want to go!

Handling Tradeoffs

- Whenever you're tuning the handling of your car, think in terms of
  - Balance,
  - Responsiveness, and
  - Overall grip

Ross Bentley: Speed Secrets Weekly 378

Tuning your car's handling

- What do I want?
  - More front grip (car is understeering)
  - More rear grip (car is oversteering)
  - More responsiveness to steering wheel
  - More overall grip

- Where do I want it?
  - Specific corner(s)
  - Brake zone
  - Turn in
  - Brake release
  - Mid corner
  - Off throttle
  - Maintenance throttle
  - On power
  - Corner exit

Ross Bentley: How to Turn Your Car's Handling

How to Make Adjustments

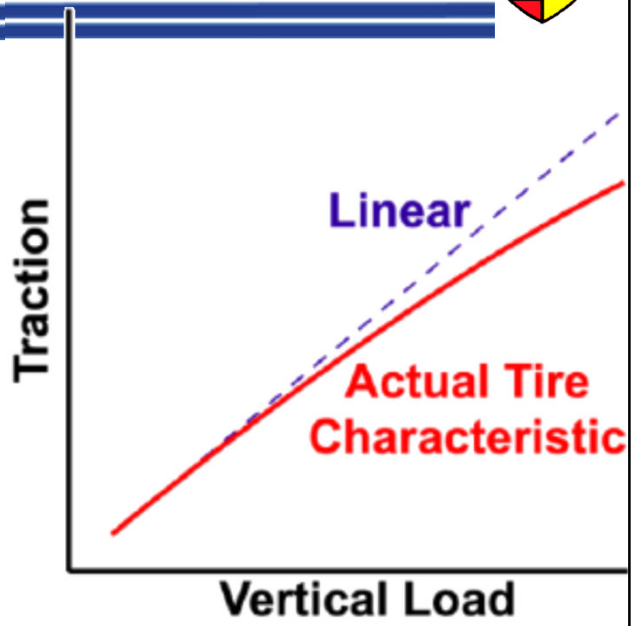
- One change at a time
- Big enough you are sure to feel
- Take notes (on track map)
- Learning what doesn't work is important
- Understand why?

- Work on end of car that needs improvement
- Work with what you have
- Easiest adjustment to get direction from
- A-B-A tests

Ross Bentley: How to Turn Your Car's Handling

Vehicle Dynamics

- Lateral loads (cornering) cause roll
  - With weight transfer
- More weight transfer = less grip
- Front vs rear roll stiffness is critical



- General rule: soften the end of the car that needs more grip
  - Anti-roll bars, springs, shocks
- Exception: too much roll (common) requires the opposite!

Ross Bentley: How to Turn Your Car's Handling

Setup Changes to Reduce Understeer

- Adjust tire pressures Front vs. Rear
  - e.g. +4 lbs in front
- Softer front sway bar or stiffer rear bar
- Larger front tires
- Increase front downforce (e.g. splitter)
- Softer or stiffer front (too much roll or not?)
  - Opposite for rear springs
- Shocks: reduce front low-speed bump (maybe)

Notes: Factory settings tend toward understeer
Assumes car setup within "normal" parameters

Setup Changes to Reduce Oversteer

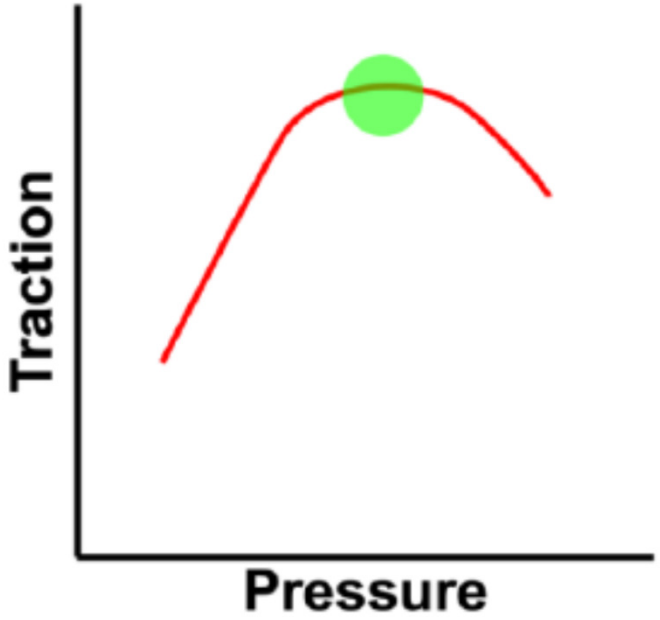
- Adjust tire pressures Front vs. Rear
  - e.g. +4 lbs in rear
- Softer rear sway bar or stiffer front bar
- Smaller front tires
- Increase rear downforce (e.g. wing)
- Softer or stiffer rear springs (too much roll or not?)
  - Opposite for front springs
- Shocks: reduce rear low-speed bump (maybe)

Notes: Factory settings tend toward understeer
Assumes car setup within "normal" parameters

Tire Pressures

- Increase or decrease for more grip?
  - It depends!

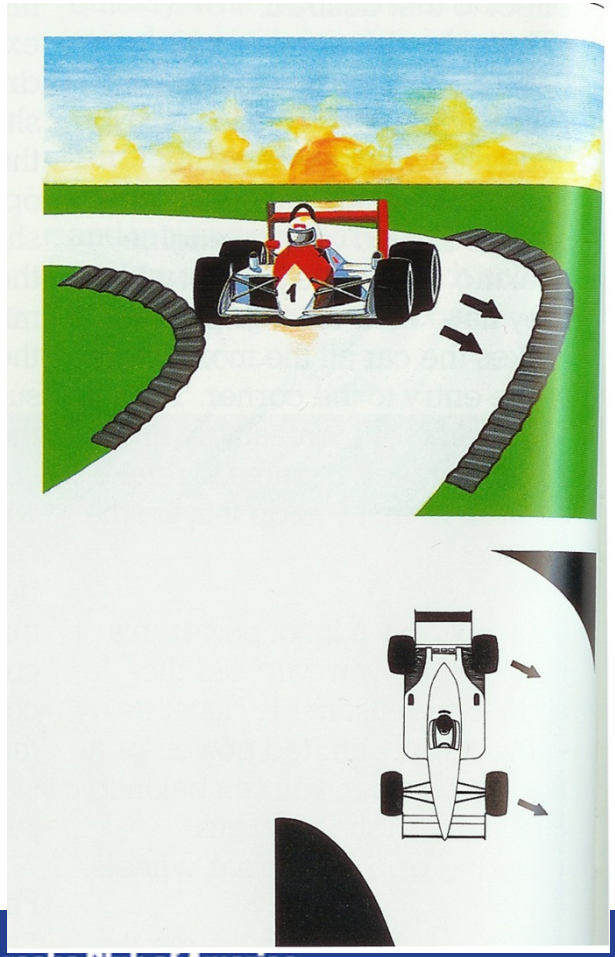
- Not sure? Do a “sweep”
  - One run with baseline
  - Second run + 4 lbs
  - Third run - 4 lbs (vs baseline)
  - Refine

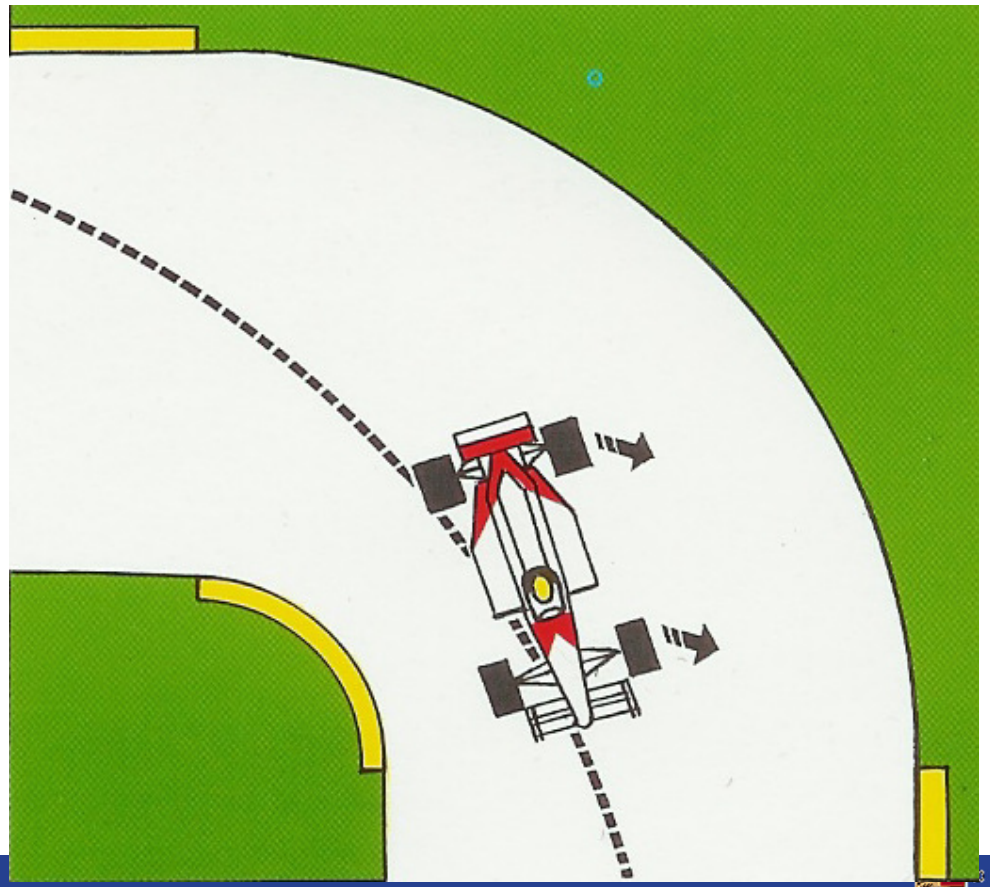


Ross Bentley: *How to Tune Your Car’s Handling*

The Objective: Neutral

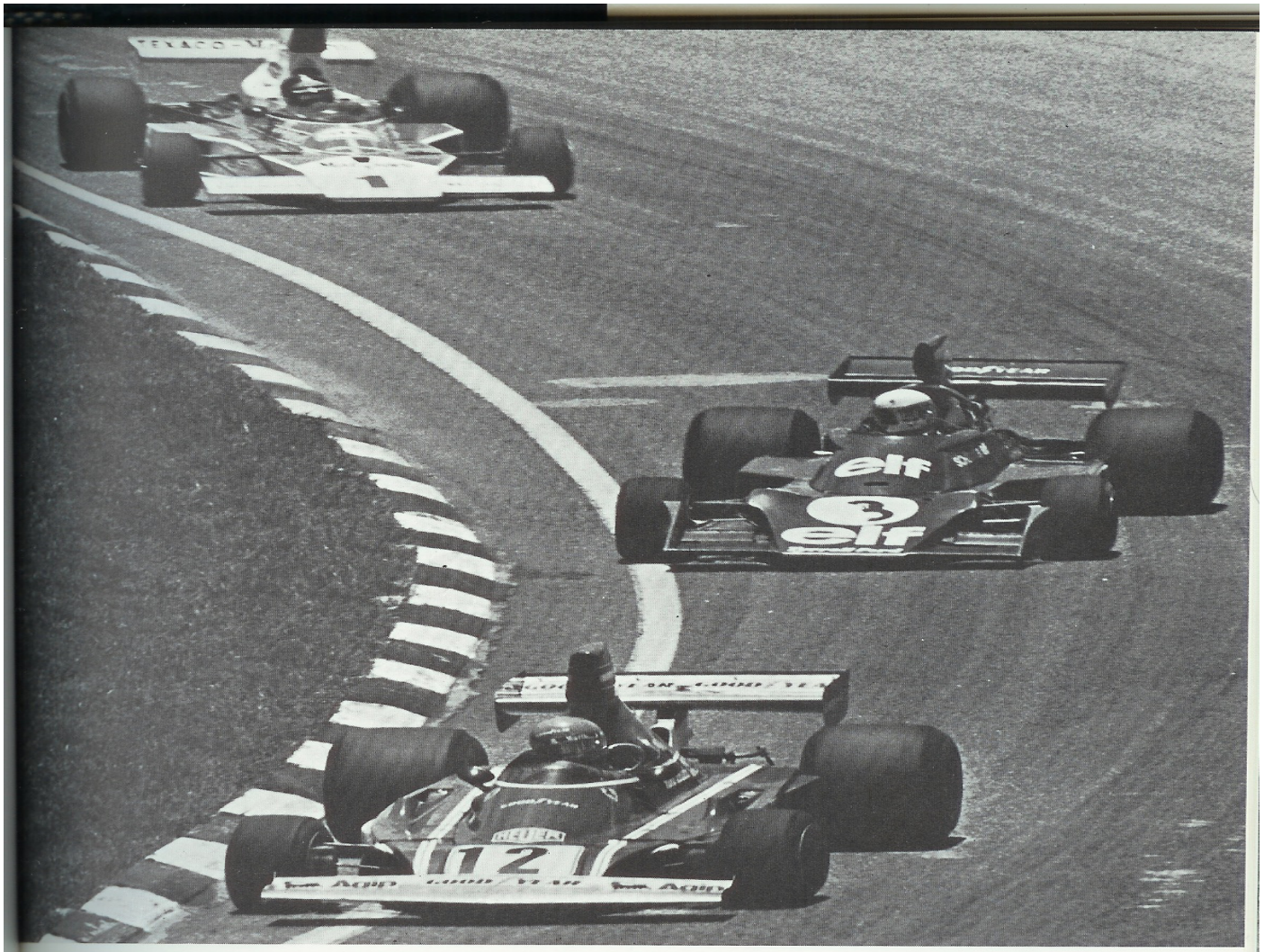
- Front slip angle = rear slip angle
- Steer with throttle and/or fingertips





Niki Lauda: *The Art and Science of Grand Prix Driving*

Under, Over, Neutral



A remarkable photograph from the 1975 season showing three cars, each handling completely differently. My Ferrari (Number 12) is absolutely neutral; Jody Scheckter's Tyrrell (Number 3) is slightly oversteering, and Fittipaldi's Mclaren (Number 1) is heavily understeering.

Understeer

- Understeer is not always bad !