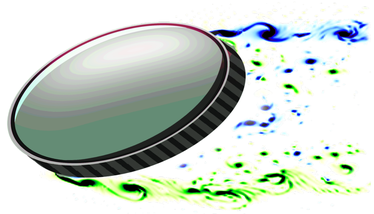

Naïve concepts of aerodynamic lift
– data lessons from different (learning) cultures

ZUKUNFTSSTRATEGIE LEHRER*INNENBILDUNG

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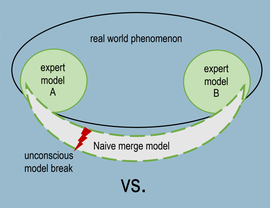
▶ Introduction

For reducing unconsciously exclusionary practices we try to elicit different "schools of thought" in the context of flight physics. For decades aerodynamic lift explanations have been a highly controversial topic in PER – and they are still. However, the discussion has been mainly driven by disjunct models and hermeneutical arguments. Here, we carve out empirically different "schools of thoughts" by asking 400+ university students at three different institutions about their agreement to various explanations for aero-dynamic lift. Results revealed that – within ONE mind – naïve concepts can coexist with expert concepts and that this phenomenon is especially prevalent among high scoring individuals of the Flight Physics Concept Inventory (FliP-CoIn). This motivated a new theory model which we call "PvsME": The Phenomena vs. Merge Effect

▶ New Theory Model

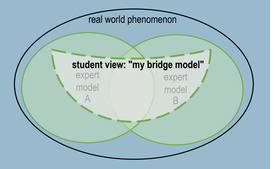
"Phenomena vs. Merge Effect" (PvsME) we define as the difference between the following two:

Model merging phenomena (MMP): If the limitations of two coexisting models remain obscure, students try to merge them into one. The gap is often filled by naïve model aspects outside the real world phenomenon.



VS.

Mental model merge effect (MMME): Same bridge model from a student perspective. Learners are often unaware of model limitations and overrate their applicability. Therefore, they overestimate the overlap of expert models and their own - actually naïve - merge models.



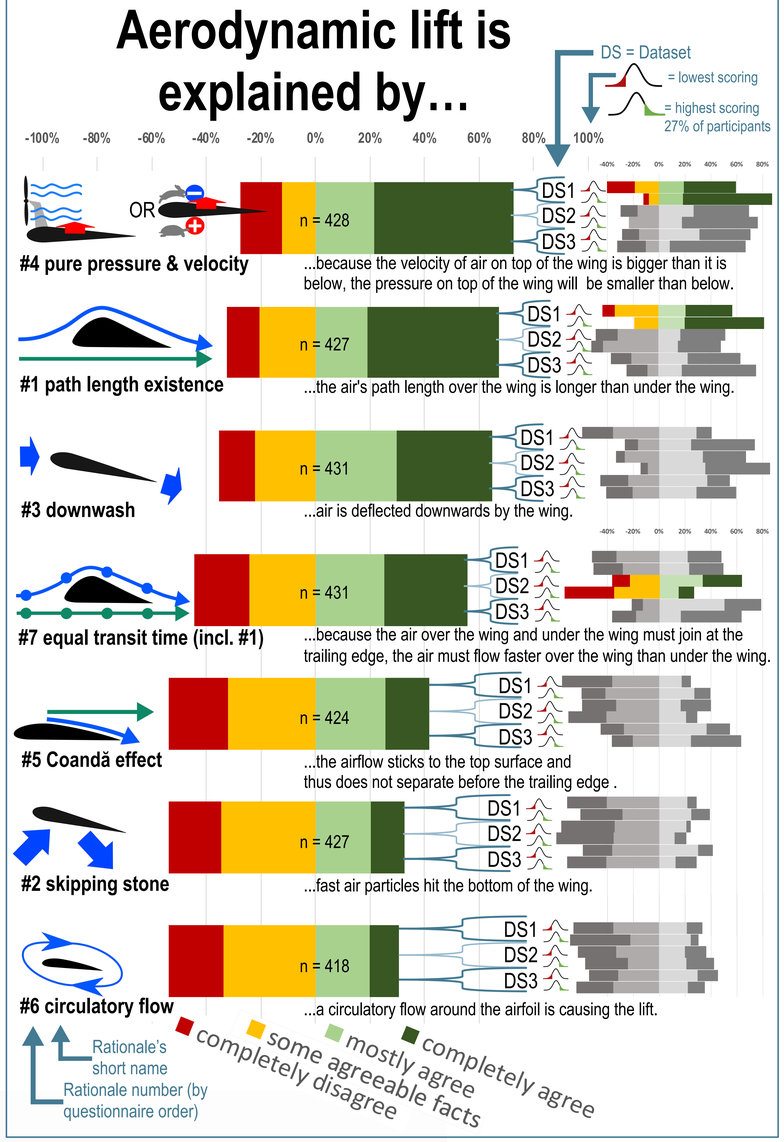
▶ Methods

Agreement to different explanations for aerodynamic lift was collected on a 4-point Likert scale for seven rationales. The study was accompanied by the FliP-CoIn instrument [1].

For further analyses, all 3 datasets were divided into high ( ) and low ( ) scorers with help of the FliP-CoIn total score. Following Kelley [2], the top-scoring 27% of each dataset (DS) were considered high scorers and the bottom 27% low scorers.

Dataset		DS1	DS2	DS3
Age in years	AV	28	22	23
	SD	7.9	3.5	4.3
gender of finishers (in %)	female	7	14	18
	male	90	75	78
	other/divers	2	11	4
response rate		.24	.72/>.10	.90
completion rate		.50	NA	.81
n (finishers)		136	107	167
Country		USA	Germany	Germany
institution type & focus		University of applied science		
		Aviation	Engineering	Engineering
survey format		online	on-site/online	on-site

▶ Results



▶ Conclusions & Educational Practice

Concepts continue to coexist or stay merged: Rationale #7 focuses on a different aspect of the naïve pathlength reasoning (rejoining of air packages and equal transit time). Compared to rationale #1 (path length existence), the overall agreement scores are only slightly lower! Furthermore, what *stunned* us was that only in DS2 the *high* scorers showed a much higher disagreement to rationale #7 (73% of high scorers in DS2 answered with "completely disagree" or "some agreeable facts" but only 36% of low scorers in DS2 marked one of these two options), whereas DS1 shows little differences between low scorers and high scorers, and DS3 even shows an ambiguous trend towards complete agreement *and* disagreement. This gives rise to the idea, that only at DS2 institution the "air packets rejoining" aspect of the pathlength misconception is well contrasted and debunked.

Debunking one aspect is not enough: However, naïve rationale #1 seems still seductive in all datasets – and even more for high scorers (complete disagreement is always lower). Therefore, we argue that debunking one aspect of a misconception (rejoining of air packages) might not be enough for learners to drop it completely (=path length). The data suggests that they can exist independently from each other. A recent fMRI study seems to back this concept coexistences hypothesis [3]. However, it might also be the case that the model merge phenomena (MMP, see. "New Theory Model" box) might become a more practical approach for relating what happens during conceptual learning. Further studies should be able to differentiate that.

Meaning for educational practice: Especially in high scorer minds, different naïve concepts can continue to coexist next to expert concepts [4]. Therefore, we recommend to shift educational effort away from replacing naïve concepts by expert concepts (usually by readings, lecture, contrasting misconceptions in theory,…) but rather let students *actively* find the limitations and strengths of their current concepts. This may be best facilitated by the help of simulations, experiments, concept mapping [5], real world observations and authentic, practical problems, as well as participation in scientific discussion.

For further conclusions, a fruitful discussion and for adding your own thoughts feel free to visit (within 60 days): https://pad.riseup.net/p/flip-coin or scan this QRcode:

▶ Literature

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