**FÜRÜZAN MELİS BAĞATIR, Makale İncelemesi**

# AĞIZLIKLI VE AĞIZLIKSIZ 66 ATTA AĞRININ DAVRANIŞSAL DEĞERLENDİRMESİ

**W. R. Cook ve M. Kibler**

Bu incelemede, W.R. Cook ve M. Kibler'in araştırma makalesi analiz edilerek, güçlü ve zayıf yönleri ile bulguların genel sunumu tartışılacaktır. Bu amaçla çalışmada kullanılan metodoloji incelenmiş ve araştırma sorularını ele almak için uygun ve sağlam olup olmadığı değerlendirilmiştir. Ayrıca veri kaynaklarının güvenilirliği gözden geçirilmiş ve sonuçları etkileyebilecek olası önyargılar sorgulanmıştır.

Binicilik topluluğunda atlarda ağızlık (bit) kullanımı ile ağızlıksız (bitless) gemler arasındaki tartışma uzun süredir devam etmektedir. Tartışma, ağızlıkların neden olabileceği ağrı ve rahatsızlık ile ağızlıksız seçeneklerin potansiyel faydaları ile ilgilidir. Ağızlık kullanımı yaygın bir uygulama olmasına rağmen, atlarda oluşturduğu ağrı üzerine yapılan araştırmalar sınırlıdır. Cook ve Kibler (2018) tarafından yapılan **"Ağızlıklı ve Ağızlıksız 66 Atın Davranışsal Ağrı Değerlendirmesi"** başlıklı çalışmada, atların büyük çoğunluğunun ağızlıktan rahatsızlık duyduğu ve 66 attan en az 65'inde huzursuzluk belirtileri görüldüğü tespit edilmiştir.

Bu makale, bireylerin zaman içinde izlendiği ve koşulları değiştikçe haklarında veri toplandığı **epidemiyolojik ve prospektif bir çalışma** örneğidir (Cook & Kibler, 2018). Bu çalışmada koşul, atların ağızlıkla veya ağızlıksız binilmesidir. Araştırma süresince atlar değişken geri bildirim veremez, çünkü atlar sözlü olarak geri bildirim sağlayamaz. İnsan hastalar ağrılarını ifade edebilirken, bu atlar için mümkün değildir. Dolayısıyla araştırmacılar, at ağızlıkla biniyorken ağrı göstergelerini belirlemişlerdir (Cook & Kibler, 2018).

Çalışmanın metodolojisi ile ilgili bazı noktalar tartışmaya açıktır. Öncelikle, deney öncesi standart bir muayene belirtilmemiştir. Atların dişleri bir veteriner tarafından kontrol edilmiş miydi? Uygun olmayan bir gem, atın elmacık kemiklerini tahriş edebilir; kötü ayarlanmış bir altlık zinciri de çene oluğunda ağrıya neden olabilir (Esterson, 2019a).

Ayrıca atların alt ve üst çenelerinin genişlik ve uzunlukları farklıdır; ağızlık boyutu ağrının belirlenmesinde önemli bir faktördür (Esterson, 2019b). Bu nedenle, binicilerin doğru boyutta ağızlık kullandığını doğrulayan bir kontrol mekanizması olup olmadığı kritik bir sorudur. Deney öncesinde atlarda mevcut başka ağrıların olup olmadığı belirsizdir ve bu eksiklik çalışmanın sağlamlığını azaltmaktadır.

Atakan Tepebaşı (kişisel iletişim, 21 Haziran 2023), binicinin deneyim seviyesinin ve el hassasiyetinin, ağızlığın atın ağzına uyguladığı kuvveti etkilediğini belirtmiştir. Pelham ve snaffle ağızlıklar arasında fark olduğunu ve pelham'ın daha sert bir bit olduğunu, bu nedenle yalnızca tecrübeli binicilere önerildiğini ifade etmiştir. Bu durum atın ağız sertleşmesine ve biniciden gelen sinyalleri almakta zorlanmasına neden olabilir. Dolayısıyla, binici seviyesi bu çalışmada önemli bir değişken olabilir.

Cook ve Kibler (2018), deneyin farklı cinsiyet, yaş, ırk ve disiplinlerden 66 at üzerinde yürütüldüğünü belirtmiş ve çalışmanın homojen olmadığını kabul etmişlerdir. Çalışma grubunun homojen olmaması, araştırmacılar tarafından makalenin "Sınırlılıklar" bölümünde açıkça tartışılmıştır (Cook & Kibler, 2018). Araştırmada **uygunluk örneklemesi**kullanılmıştır ve değişkenler (yaş, yükseklik, disiplin, ırk, cinsiyet) oldukça farklıdır. Ayrıca davranış listesi (etogram) görsel davranışsal belirtileri içermektedir, ancak 69 'ağrı göstergesinden' bazıları doğrudan ağrı ile ilişkili değildir. Örneğin, "yavaş öğrenen" bir davranışsal belirti değildir; "ağızlıktan nefret eder" bir yorumdur (Cook & Kibler, 2018).

Strunks (2017), **"Binici Deneyim Düzeyinin At Kinematiği ve Davranışı Üzerindeki Etkileri"** başlıklı tezinde, farklı deneyim seviyelerine sahip binicilerin atın eklem kinematiği üzerindeki etkilerini incelemiştir. Strunks (2017), küçük bir grup ile çalıştığını ve parametrelerin kontrolünün sınırlı olduğunu belirtmiştir. Cook ve Kibler'in (2018) makalesi, daha büyük bir grup ve daha geniş parametreler ile çalıştığından daha fazla veri sunmaktadır. Ancak kontrollü değişkenlerin yeterliliği hâlâ tartışmaya açıktır.

Araştırma sonuçları makalede açıkça sunulmuştur. Çalışmanın zayıf ve güçlü yönleri detaylı bir şekilde belirtilmiş, grafik ve tablolar ile veriler desteklenmiştir (Cook & Kibler, 2018).

Cook'un (2003) önceki çalışması, ağızlıktan ağızlıksıza geçen binicilerin raporlarını inceleyen etnolojik bir araştırmadır. Bu makale ile karşılaştırıldığında, 2018 makalesi veri ve görsel materyal açısından daha zengindir. Büyük gruplar daha fazla bilgi sağlasa da, değişken sayısını artırabilir; Cook & Kibler (2018) bu konuda açıklık getirmiştir.

Makale hipotezinin bağlamı, araştırma sorusunun hangi arka plan ve koşullarda formüle edildiğini ifade eder. Özet, çalışmanın neden yapıldığını ve metodolojiyi net bir şekilde sıralamamakta; at refahının nasıl artacağına dair ölçüm, istatistiksel test ve hipotezi destekleyen net bir sonuç sunmamaktadır (Cook & Kibler, 2018).

## KAYNAKÇA

**Cook, W. R., & Kibler, M. (2018).** Behavioural assessment of pain in 66 horses, with and without a bit. *Equine Veterinary Education, 30*(9), 551-560. https://doi.org/10.1111/eve.12792

**Cook, W. R. (2003).** Bit-induced pain: a cause of fear, flight, fight and facial neuralgia in the horse. *Pferdeheilkunde, 19*, 1–6.

**Esterson, E. (2019a).** *The ultimate book of horse bits* (pp. 30–314). Skyhorse Publishing.

**Esterson, E. (2019b).** *The ultimate book of horse bits* (pp. 28–29). Skyhorse Publishing.

**Strunks, R. (2017).** *Effects of rider experience level on horse kinematics and behaviour* (Master's thesis, Clemson University). Clemson University Digital Repository.

**Tepebaşı, A. (2023, June 21).** Personal communication.

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*Original Article*

# Behavioural assessment of pain in 66 horses, with and without a bit

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## Summary

**Horses can be ridden with or without a bit. Comparing the behaviour of the same horse in different modes constituted a 'natural experiment'. Sixty-nine behaviours in 66 bitted horses were identified as induced by bit-related pain and recognised as forms of stereotypic behaviour. A prototype questionnaire for the ridden horse was based on 6 years of feedback from riders who had switched from a bitted to a bit-free bridle. From a template of 69 behavioural signs of pain derived from answers to the questionnaire, the number of pain signals shown by each horse, first when bitted and then bit-free, was counted and compared. After mostly multiple years of bit usage, the time horses had been bit-free ranged from 1 to 1095 days (median 35). The number of pain signals exhibited by each horse when bitted ranged from 5 to 51 (median 23); when bit-free from 0 to 16 (median 2). The number of pain signals for the total population when bitted was 1575 and bit-free 208; an 87% reduction. Percentage reduction of each of 69 pain signals when bit-free, ranged from 43 to 100 (median 87). The term 'bit lameness' was proposed to describe a syndrome of lameness caused by the bit. Bit pain had a negative effect on proprioception, i.e. balance, posture, coordination and movement. Only one horse showed no reduction in pain signals when bit-free. The welfare of 65 of 66 horses was enhanced by removing the bit; reducing negative emotions (pain) and increasing the potential to experience positive emotions (pleasure). Grading welfare on the Five Domains Model, it was judged that – when bitted – the population exhibited 'marked to severe welfare compromise and no enhancement' and – when bit-free – 'low welfare compromise and mid-level enhancement.' The bit-free data were consistent with the 'one-welfare' criteria of minimising risk and preventing avoidable suffering.**

## Introduction

Pain in animals is defined as an aversive sensation caused by actual or threatened tissue damage; a negative mental state. Pleasure is defined as fulfilment of a biological drive for comfort and safety; a positive mental state. Current animal welfare thinking (Mellor 2015a) refers to 'pleasure' as a 'positive affective experience' (**Table 1**). The term 'affect' describes emotion (feeling), either positive or negative. It encompasses 'motivation'; an animal's urge to move towards or away from a stimulus, i.e. stereotaxis.

Used since the Bronze Age, metal bits have been accepted as part of the furniture of horsemanship and not subjected to scrutiny until quite recently (Cook 1999). In a review of equine pain assessment, the absence of data on 'abnormal bit behaviour' [sic] was noted by Ashley *et al.* (2005). Since then, three studies have compared ridden horse behaviour, with and without a bit. First, two unschooled 2-year-old horses in a 10-day period of foundational training performed "at least as well, if not better" without bits as two matched horses in snaffle bridles (Quick and Warren-Smith 2009). Second, four mature horses, in their maiden bit-free test, exhibited statistically improved ridden behaviour (Cook and Mills 2009). In two concurrent four-minute tests, first bitted then bit-free, riders' scores increased from a mean of 37 ('fairly bad') to 64 ('satisfactory'). Finally, a study of 16 therapeutic riding horses showed significantly more negative behaviours when bitted and positive behaviours when bit-free (Carey *et al.* 2016).

Pain studies in animals have not generally included removal of the pain's source. The arrow of direction in assessing most management interventions (e.g. castration) is from painless to painful. In the current study, the direction was reversed. Bit usage is an elective and almost daily intervention during many horses' working lives. Assessment of its effect on welfare is overdue.

As bits have been standard equipment for millennia, they are widely assumed to be indispensable and ethically justified. This being so, an opinion by welfare researchers is cited … "Most horses exhibit clear behavioural evidence of aversion to a bit in their mouths, varying from the bit being a mild irritant to very painful" (Mellor and Beausoleil 2017). The same authors observe that evidence of aversion is available to all who seek by comparing the open mouth, head tossing and restricted jaw angle of many bitted horses – clearly apparent on YouTube videos – with the absence of these behaviours in videos of wild horses and of domestic horses when ridden bit-free or bridleless. The need for a list of ridden horse behaviours to be developed was noted by Hall *et al.* (2013).

The study objective was to start answering six questions:

- What behaviours are caused by the bit?
- How prevalent are they?
- How many bit-induced behaviours might one horse exhibit?
- Are they reversible when the bit is removed?
- Is a horse's welfare improved by removal of the bit?
- Can a horse be controlled without a bit?

The null hypothesis was that removal of the bit would cause no behavioural change.

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**TABLE 1: Prevalence of 69 pain indices in 66 horses, when bitted and bit-free. The mean reduction when bit-free was 85% (range 43–100) with a median of 87%. Many of the bit-induced pain indices jeopardised the safety of both horse and rider**

| Order when bitted | PAIN INDICES | Number of horses affected BITTED | number of horses affected BIT-FREE | Reduction when bit-free (%) | Inferred likelihood of horse having POSITIVE AFFECTIVE EXPERIENCES e.g., pleasures of safety, confidence, comfort, compliance, enthusiasm, motivation following removal of the bit and cessation or easement of pain |
|---|---|---|---|---|---|
| 1 | Hates the bit | 53 | 0 | 100 | The relief, pleasure and comfort of being without pain |
| 2 | **FRIGHT:** | 46 | 4 | 87 | One of the five major categories of fear (the five 'F's), replaced by calmness, ease and comfort |
| 3 | Stiff-necked | 45 | 7 | 84 | Freedom of the head: Ability to balance; smoothness and fluidity in the 'way of going' |
| 4 | Lack of control | 43 | 6 | 86 | Horse/rider high accident hazard replaced by willing cooperation, harmony and partnership |
| 5= | Resents bridling | 41 | 3 | 93 | Drops head eagerly into bridle; exhibits enthusiasm for work |
| 5= | Above the bit | 41 | 3 | 93 | Able to select the physiologically most comfortable (optimally balanced) head position |
| 6 | Muzzle rubbing | 40 | 9 | 77 | Relief from the persistent irritation and distraction of facial neuralgia |
| 7= | Head shaking | 37 | 8 | 78 | As above for 'muzzle rubbing' - the relief from nerve ache |
| 7= | Unfocused | 37 | 1 | 97 | Focused; not distracted; 'listens' to and complies with rider's signals |
| 8 | **FLIGHT** | 35 | 1 | 97 | Contentment; energy conservation; no propensity to bolt, rush or run away |
| 9= | **FIGHT** | 34 | 2 | 94 | Calm, quiet, cooperative and willingly offers compliance |
| 9= | Pig-rooting | 34 | 2 | 94 | See 'fight' above: Does not grab the bit and snatch reins from rider's hands |
| 10 | Difficult to steer | 33 | 8 | 76 | Ability to balance; steers straight and turns comfortably (also see 'lack of control' above) |
| 11= | Stiff or choppy stride | 32 | 2 | 94 | Enjoys the natural rhythm of motion (also see 'stiff-necked' above) |
| 11= | Reluctant to rein-back | 32 | 10 | 69 | Return of normal agility; one of many signs of reduced 'bit lameness' |
| 12 | Tail swishing | 31 | 1 | 97 | Removal of discomfort; tail movement in synchrony with spinal movement |
| 13= | Hair-trigger response to bit | 29 | 0 | 100 | Calm and confident as opposed to 'highly strung,' anxious and apprehensive |
| 13= | Sneezing & snorting | 29 | 13 | 55 | Restoration of normal breathing pattern; reduction of nasal irritation (facial neuralgia) |
| 14 | Yawning | 28 | 4 | 86 | Absence of yawning suggestive of reduced need to ease/interrupt pain signals (see facial neuralgia above) |
| 15 | Slow learner | 27 | 1 | 96 | Return of ability to learn - a vital survival strategy (see unfocussed above) |
| 15 | Uncooperative | 27 | 3 | 89 | See 'fight' above |
| 15 | Heavy on the forehand | 27 | 6 | 78 | Unhampered ability to balance, return of normal agility, elimination of stress and pain |
| 16 | Fails to stand still | 26 | 0 | 100 | Return of species specific default behaviour of calmness and contentedness |
| 17 | Pulling on bit | 26 | 0 | 100 | No need to defend itself from the bit and become unbalanced in the process |
| 18= | Grazing on the fly at exercise | 25 | 11 | 56 | Less need to 'interrupt' pain signals (see 'yawning' above) |
| 18= | Inverted frame | 25 | 5 | 80 | No pain - no high head carriage - return of ability to balance |
| 19= | Dislikes wind/rain/sunlight | 24 | 10 | 58 | Relief from trigeminal hypersensitivity |
| 19= | Tilts head at exercise | 24 | 5 | 79 | Proper balance with no need to try and avoid bit pain |
| 19= | Fails to maintain trot or canter | 24 | 4 | 83 | Engaged, lively, energised, exhibits vitality of fitness |
| 20= | Difficult to mount | 23 | 3 | 87 | Reduced anxiety and apprehension |
| 20= | Grabs the bit | 23 | 0 | 100 | No need for defensive behaviour at exercise |
| 20= | Lacks courage | 23 | 5 | 78 | Confident, engaged and curious about its environment |
| 21= | Napping | 22 | 4 | 82 | Reduction of fear; reduced pain increases comfort (see 'Freeze') |
| 21= | Stumbling | 22 | 7 | 68 | Reduction of 'bit lameness' with unfettered proprioception enabling a horse to keep itself upright and safe |
| 22= | **FREEZE** | 21 | 4 | 81 | Keen to explore. Relief from the 'frozen' state of a prey animal when attacked by a predator |
| 22= | Resents unbridling | 21 | 1 | 95 | Optimism rather than pessimism (see 'hates the bit' above) |

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**TABLE 1: Continued**

| Order when bitted | PAIN INDICES | Number of horses affected BITTED | number of horses affected BIT-FREE | Reduction when bit-free (%) | Inferred likelihood of horse having POSITIVE AFFECTIVE EXPERIENCES e.g., pleasures of safety, confidence, comfort, compliance, enthusiasm, motivation following removal of the bit and cessation or easement of pain |
|---|---|---|---|---|---|
| 22= | Behind the bit | 21 | 1 | 95 | Adopts head position based on proprioceptive signals (see 'above the bit') |
| 22= | Head shyness | 21 | 12 | 43 | Abatement of trigeminal hypersensitivity, hyperalgesia or neuralgia |
| 22= | Salivates excessively | 21 | 2 | 90 | A relatively dry mouth betokens contentedness at exercise |
| 23= | Bucking or bounding | 20 | 3 | 85 | Less pain, more comfort |
| 23= | Lazy or dull | 20 | 4 | 80 | Engaged aliveness |
| 23= | Heads for the stable | 20 | 6 | 70 | Relishes exercise, fulfils biological drive and need for movement |
| 23= | Jigging | 20 | 1 | 95 | Walks quietly and contentedly |
| 24= | Unfriendly in stable | 18 | 2 | 89 | Return of normal (social) behaviour |
| 24= | Anxious eye | 18 | 2 | 89 | 'Soft' (rounded) eye - an indicator of comfort |
| 25= | Ear pinning at exercise | 17 | 4 | 76 | Non-aggression equates with the default social behaviour of the species |
| 25= | Open mouth (gaping) | 17 | 2 | 88 | Closed mouth and sealed lips; oral vacuum restored; default condition for unobstructed airway at exercise |
| 25= | Lolling tongue | 17 | 0 | 100 | Another return to physiological and behavioural norm |
| 25= | Reluctant to change lead | 17 | 5 | 71 | Return of normal agility with correction of 'bit lameness' |
| 26 | Bites at tack or other horses | 16 | 0 | 100 | Reduced facial neuralgia enables disposition to move beyond neutral to a more positive emotional state |
| 27 | Scuffs hind hooves | 15 | 7 | 53 | Soundness of limb returns with correction of 'bit lameness' |
| 28 | Backing-up | 14 | 1 | 93 | See 'fails to stand still' |
| 29 | Multiple wrinkles around muzzle | 13 | 2 | 85 | Relaxation of tension with elimination of pain |
| 30 | Crossing the jaw | 13 | 1 | 92 | As above - return to 'normal' behaviour when on the move |
| 31= | Evades capture in paddock | 12 | 2 | 83 | Accepts rider as a member of its 'herd' or 'band' |
| 31= | Sweats excessively | 12 | 1 | 92 | No stress, less sweat |
| 31= | Over bends | 12 | 0 | 100 | Proprioceptively and physiologically comfortable head position |
| 31= | Tongue over bit | 12 | 0 | 100 | No need for defensive behaviour following removal of the bit, unobstructed breathing |
| 31= | Interfering | 12 | 4 | 67 | Another aspect of 'bit lameness' corrected |
| 32 | Rears | 11 | 2 | 82 | Reductionof bit-escape behaviour |
| 33= | Runs wild on bitted lunge | 10 | 1 | 90 | More comfortable |
| 33= | Lower lip slapping | 10 | 3 | 70 | More comfortable |
| 33= | Incoordination. | 10 | 1 | 90 | Unhampered proprioception corrects 'bit lameness' |
| 34= | Eyes water | 9 | 2 | 78 | Reduction of corneal pain (facial neuralgia) |
| 34= | Exercise triggers cough | 9 | 2 | 78 | Reduction of pharyngeal angina (trigeminal neuralgia) and/or inflammatory airway disease |
| 34= | Back problems | 9 | 2 | 78 | Relief of 'bit-lameness' |
| 35 | Retracts tongue behind bit | 7 | 0 | 100 | Return of default tongue position at exercise, oral vacuum, soft palate stability, unobstructed airway |
| 36 | Drops food | 6 | 0 | 100 | Elimination of 'sore mouth' (mandibular gingivitis) |
| 37 | Reluctant to drink during 'endurance' test | 4 | 0 | 100 | Ability to create an oral vacuum and relief of 'sore mouth' prevents dehydration |

Upper case letters mark the five major categories of fear-induced behaviour (the five 'F's) in the questionnaire; i.e. fright, flight, fight, freeze and facial (trigeminal) neuralgia. Pain indices specific to the bit are shaded grey.

## Method

### *Study design*

Owner/rider assessment of horse behaviour, with and without a bit; a longitudinal, retrospective, questionnaire-based study. The number of behavioural signs of pain in each of 66 horses when bitted was compared with the number of signs when bit-free.

### *Questionnaire*

The questionnaire (**Supplementary Item 1**) was based on 6 years' feedback from 605 riders who had switched from a bitted to a bit-free bridle (Cook 2003). As recommended, questions were posed using vernacular terms (Wemelsfelder *et al.* 2001). At the end of an 8-page manual for a bit-free bridle, riders were informed that a questionnaire was available for documenting behavioural changes. The questionnaire was mailed on request or, more commonly, downloaded online. The 6-page questionnaire comprised signalment; 106 'yes/no' questions about horse behaviour and signs of disease; and 10 questions describing a rider's feelings about riding. It was completed twice; once when bitted and again when bit-free. From the answers, the change in prevalence of 69 behaviours, occurring in not less than 4 of 66 horses when bitted, was assessed (**Table 1**).

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### *Population selection*

Owner/riders volunteered their participation in the study. Each horse served as its own control, inasmuch as its behaviour was compared before and after removing the bit. Between 2002 and 2016, 96 questionnaires were received. Sixty-six were completed correctly; a 'usable' rate of 69%. The inclusion criterion was that for each of the 69 behaviours selected for analysis, a yes/no answer must have been entered for both bitted and bit-free periods.

### *Statistical analysis*

A matched pairs *t*-test was used to determine if there was change in the number of pain signals (pain indices) when bit-free. An alpha level of 0.05 was set for significance.

### *Welfare assessment*

A numerical grading of behaviour was eschewed in favour of the Five Domains Model (Mellor and Beausoleil 2015; Mellor 2017). Welfare compromise was graded on a five-tier scale from A (no compromise) to E (very severe compromise). Welfare enhancement was graded on a four-tier scale from zero (no enhancement) to +++ (high-level enhancement).

## Results

The age of the population ranged from 3 to 24 years, with a mean of 10 years and a median of 8 (**Table 2**). Including half-breds, the breeds comprised Thoroughbreds (n = 21), Arabians (n = 11), Warmbloods (n = 7), Tennessee Walking Horses (n = 5), Appaloosas (n = 4), Clydesdales (n = 3) and others (n = 15). Gender distribution was male (n = 40; 39 geldings and one stallion) and female (n = 25). Categories by predominant use were dressage (n = 22), pleasure (n = 21), trail (n = 13), eventing (n = 5) and jumping (n = 5). All owners rode 'English' style. Twenty-eight horses had been bitted for five or more years. The time a horse had been bit-free before the second assessment ranged from 1 to 1095 days (median 35; mean 108). Questionnaires were returned from North America (n = 46), UK (n = 14), Australasia (n = 3), Austria (n = 1), France (n = 1) and Holland (n = 1).

Bits used were snaffles, Pelhams and double bridles. The bit-free bridle used throughout was a crossunder (Dr.Cook®)[1]

Results are displayed in **Tables 1–3** and **Figure 1**. Answers to the six questions are summarised as follows:

- All 69 behaviours were caused by the bit, as judged by their significant reduction in prevalence when the bit was removed. Excessive salivation was the only behaviour not caused solely by bit-induced pain, being also a reflex response to an oral foreign body.
- Bit-induced behaviours, as a group, were highly prevalent. The total number of pain signals for the population when bitted was 1575 and, when bit-free, 208; an 87% reduction. From 66 horses, the number of horses exhibiting each behaviour ranged from 53 (80% of the population) to 4 (6%) (**Table 1**).
- The median number of behaviours per horse when bitted was 23 (range 5–51); when bit-free 2 (range 0–16).
- Most bit-induced behaviours were eminently reversible and the change was statistically significant (**Table 2**). The matched pairs *t*-test gave a P-value of less than 0.005, supporting a causal link between the bit and pain-induced behaviour (**Table 3**).
- The welfare grade for the population when bitted was judged to be D/0 (marked to severe compromise and no enhancement) and, when bit-free B/++ (low compromise and mid-level enhancement).
- None of the riders experienced loss of control when bit-free, quite the opposite. In only one horse was control unchanged.

The null hypothesis was refuted: 65 out of 66 horses showed a change in behaviour following removal of the bit.

## Discussion

The data support previous observations based on anecdotal evidence (Cook 2003).

Horses exhibit stereotaxis; a word derived from the Greek *stereo,* 'hard, solid'. This fundamental property of (even) primitive life forms, also known as thigmotaxis, is defined as 'the positive (or negative) response of a freely moving organism to cling to (or avoid) a solid object'. Indisputably, a bit is a 'solid' object. A horse is innately programmed to (try and) move away from (evade) the bit, i.e. to display negative stereotaxis. A definition for thigmotaxis (Greek: *thigmo,*'touch') emphasises the point – "the motion or orientation of an organism in response to a touch stimulus". When the touch is painful, stereotaxic stimuli are stronger. It follows that the equitation mantra requiring a horse to 'accept the bit' is misconceived. Expecting a horse to accept an oral foreign body is a biologically unrealistic expectation.

Mason (2006) proposed a definition of stereotypical behaviour based on three causal mechanisms, i.e. 'repetitive behaviours induced by frustration, repeated attempts to cope and/or CNS dysfunction'. The reversibility of 69 behaviours in 65 of the bitted horses indicates that 'CNS dysfunction' was not their cause but 'frustration' and 'attempts to cope' are mechanisms consistent with the data. In Mason's words again, stereotypical behaviours are generally 'responses of normal animals to abnormal environments'. In captive animals, they stem from 'a deficit in housing or husbandry, where a deficit means something that the animal would change if it could (e.g. a motivational deficit linked with frustration; a health deficit linked with nausea or pain; or a safety deficit causing fear)'.

Observational evidence constitutes the foundation for animal welfare assessment and this evidence – carefully observed – is objective, not subjective. "Contemporary animal welfare science understanding" accepts the need to "focus on subjective experiences, known as affects, which collectively contribute to an animal's overall welfare status" (Mellor 2017). Inferences based on such observational evidence derive credibility from the underlying affective neuroscience in a process that "involves cautiously exercising scientifically informed best judgement" (Mellor and Beausoleil 2017). Thus, it is asserted that improvements in behaviour following removal of the bit enable inferences to be made about the aversive experience of bit-induced pain. The improvements cannot be dismissed as 'merely subjective'.

Collectively, the behaviours were predominantly manifestations of pain experience, expressed by aberrant movements of the head, spine and limbs. They ranged from too little movement (e.g. stiffening, freezing) to too much

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**TABLE 2: Results for 66 horses switched from bit to bit-free, sorted on number of days bit-free. The number of pain indices when bit-free was significantly (P<0.005) reduced in 65 of the 66 horses**

| Case # | Age (yrs) | BREED | Gender | USE | # of pain indices bitted | Time bit-free (days) | % reduction in pain indices bit-free |
|---|---|---|---|---|---|---|---|
| 39 | 4 | TWH | G | Trail | 7 | 1 | 86 |
| 24 | 5 | Arab/TB | F | Dressage | 23 | 1 | 100 |
| 15 | 6 | TB | G | Pleasure | 5 | 1 | 60 |
| 22 | 6 | Arab | F | Trail | 30 | 1 | 83 |
| 29 | 23 | 3/4 TB | G | Dressage/trail | 22 | 1 | 100 |
| 3 | 8 | WB | G | Dressage | 16 | 4 | 62 |
| 7 | 9 | TB | F | Equitation/jumper | 39 | 5 | 53 |
| 32 | 5 | Welsh | G | Trail/Pony Club | 24 | 7 | 96 |
| 57 | 8 | QH/App | G | Trail | 24 | 7 | 96 |
| 9 | 12 | WB | G | Dressage/eventing | 6 | 7 | 100 |
| 44 | 19 | Arab | F | Trail | 32 | 7 | 84 |
| 35 | 6 | TB | F | Pleasure/endurance | 23 | 8 | 87 |
| 1 | 5 | TB | G | Trail | 34 | 14 | 100 |
| 10 | 7 | TB/QH | F | Pleasure | 17 | 14 | 35 |
| 51 | 7 | cob | F | Trail | 13 | 14 | 100 |
| 55 | 8 | TB | G | Pleasure | 24 | 14 | 96 |
| 50 | 4 | App | G | Jumping/hunter trials | 26 | 19 | 88 |
| 48 | 4 | WB | F | Dressage | 37 | 20 | 100 |
| 12 | 6 | QH | G | Western pleasure | 24 | 21 | 83 |
| 27 | 3 | WB | F | Dressage/eventing | 19 | 30 | 100 |
| 42 | 7 | TB/Trotter | G | Pleasure | 12 | 30 | 100 |
| 45 | 7 | Arab/Pinto | G | Dressage/trail | 39 | 30 | 100 |
| 60 | 9 | Paint | G | Trail | 23 | 30 | 57 |
| 26 | 10 | Gaited | G | Pleasure | 5 | 30 | 80 |
| 43 | 10 | Arab/QH | F | Pleasure/dressage | 42 | 30 | 98 |
| 64 | 12 | Arab | G | Endurance | 23 | 30 | 100 |
| 23 | 13 | QH | G | Hunter | 16 | 30 | 0 |
| 52 | 22 | TB | G | Pleasure | 23 | 30 | 78 |
| 5 | ? | TWH | ? | Pleasure | 21 | 30 | 76 |
| 56 | ? | Andalusian | G | Classical riding | 27 | 30 | 67 |
| 40 | 6 | TB | F | Pleasure | 15 | 35 | 100 |
| 25 | 16 | App | F | Pleasure/trail | 27 | 35 | 100 |
| 47 | 11 | Morgan/WB | F | Dressage | 29 | 40 | 100 |
| 49 | 12 | cob | G | Jumping, dressage | 21 | 42 | 90 |
| 13 | 14 | TB | G | Dressage/pleasure | 23 | 42 | 33 |
| 59 | 3 | Draft/X | F | School horse | 7 | 60 | 71 |
| 58 | 6 | Draft | F | Trail | 21 | 60 | 62 |
| 4 | 8 | TWH | G | Trail | 11 | 60 | 100 |
| 53 | 8 | TB | G | Dressage/jumper | 42 | 60 | 100 |
| 16 | 15 | App | G | Dressage | 43 | 60 | 93 |
| 31 | ? | TB | F | Dressage/trail | 13 | 60 | 54 |
| 8 | 4 | TB | G | Dressage/eventing | 34 | 64 | 97 |
| 11 | 11 | SDB | G | Pleasure/trail | 24 | 64 | 77 |
| 2 | 11 | Arab | G | Dressage/trail | 31 | 72 | 94 |
| 28 | 5 | TB | F | Dressage/eventing | 10 | 90 | 70 |
| 18 | 7 | WB | F | Dressage | 29 | 90 | 100 |
| 17 | 8 | WB | G | Dressage | 29 | 90 | 100 |
| 19 | 9 | WB | G | Dressage | 27 | 90 | 100 |
| 62 | 11 | Draft | G | Mounted patrol | 9 | 90 | 35 |
| 63 | 18 | WB | F | Dressage/jumping | 34 | 90 | 97 |
| 34 | 8 | TB/Paint | G | Eventing/pleasure | 23 | 120 | 74 |
| 46 | 8 | Arab | F | Pleasure/endurance | 28 | 120 | 100 |
| 54 | 11 | TB | G | Trail/ dressage | 23 | 120 | 69 |
| 41 | 14 | Saddlebred | G | Dressage/jumping | 42 | 150 | 90 |
| 20 | 12 | Arab/Pinto | G | Trail | 18 | 180 | 83 |
| 65 | 14 | TWH | M | Dressage/pleasure | 28 | 180 | 89 |
| 6 | 22 | Arab | F | Trail | 12 | 180 | 83 |
| 61 | 3 | Draft | G | Mounted patrol | 17 | 240 | 87 |
| 14 | 13 | TB/WB | F | Dressage/eventing | 9 | 240 | 100 |
| 37 | 6 | TB (OTTB) | F | Dressage | 32 | 300 | 75 |
| 30 | 11 | WB | G | Pleasure/trail | 7 | 300 | 86 |
| 38 | 24 | Arab/Welsh | G | Eventing/trail | 43 | 330 | 93 |

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**TABLE 2: Continued**

| Case # | Age (yrs) | BREED | Gender | USE | # of pain indices bitted | Time bit-free (days) | % reduction in pain indices bit-free |
|---|---|---|---|---|---|---|---|
| 21 | 10 | Arab | G | Dressage/pleasure | 21 | 365 | 67 |
| 36 | 10 | TB/Conn | F | Dressage/eventing | 51 | 720 | 85 |
| 33 | 8 | TB/Paint | G | Dressage/jumping/trail | 42 | 730 | 93 |
| | 23 | TWH | F | Trail | 24 | 1095 | 100 |

App = Appaloosa; Conn = Connemara; QH = Quarter Horse; STB = Standardbred; TWH = Tennessee Walking Horse; TB = Thoroughbred; WB = Warmblood.

**TABLE 3: Results of the matched pairs *t*-test for means**

| | Bitted | Bitless |
|---|---|---|
| Mean | 23.86 | 3.15 |
| Standard deviation | 10.88 | 3.99 |
| Observations | 66 | 66 |
| Actual mean difference | 20.71 | |
| Hypothesised mean difference | 0 | |
| Degrees of freedom | 65 | |
| *t* Stat | 14.50144 | |
| Two-tailed P-value | 4.75E-22 | |
| *t* critical two-tail | 1.997138 | |

The test was significant (P<0.005).

movement (e.g. bucking, bolting). That some horses may exhibit a few aversions to the bit is widely acknowledged. That every horse is programmed to be averse to the bit and that aversions are numerous is not. The current study showed that at least 65 of 66 horses exhibited aversion to the bit and that horses have not less than 69 ways of exhibiting frustration, attempts to cope and efforts to avoid bit contact. In a review of poor performance, 48 (72%) of these same behaviours were recognisable among 67 behavioural signs of pain compiled by Dyson (2016). Clearly, even though both lists are incomplete, the mandible and tongue (a sense organ in its own right) figure prominently as the seat of musculoskeletal manifestations of pain experience in the bitted horse. To this must be added pain from the lips, a particularly sensitive area of another sense organ – skin.

A bit stimulates nociceptors mediated by the trigeminal nerve in lips, tongue, teeth and bone. Gingiva is periosteum, the most sensitive part of bone. A principle of saddle-fitting is that saddles should not press on bone. A bit breaches this principle. In the male horse, the peridontium of the canine tooth roots lies immediately ventral to the dorsal edge of the so-called 'interdental' space. In the female, unerupted, vestigial canine teeth are common (Sisson and Grossman 1938). In both sexes, 'wolf' teeth (erupted and unerupted) may be present in this space. In cross-section, bits are circular and make point contact with the 'knife edge' of bone at the 'bars'. This can be assumed to cause a horse pain, just as it causes us pain if we press the barrel of a pencil sideways into our gums. When the edges of the tongue are pinched between bit and bone, this too is likely to be painful. Pain is also likely when lips are stretched longitudinally to twice their normal length by the bit's retractor effect. Finally, cuts at the commissures will cause pain.

In common with other mammals, the vestibular labyrinths and receptors in skin, muscle, tendon and temperomandibular joints of the horse's head mediate perception of orientation and motion in three planes; i.e. proprioception. Head proprioception controls not only movement and posture of the head but also dominates that of the trunk and limbs (Sherrington 1907). In the ridden horse, imbalance can result in a fall with potentially fatal consequences. Head proprioception constitutes a central balancing mechanism and is key to a horse's agility and athleticism. Painful restraint of the head by a bitted rein interferes with a horse's ability to balance. As a horse's head movement is synchronised with limb movement for energy economy in the work of breathing and locomotion, proprioception unfettered by nociception is crucial. A bit also obstructs breathing and probably triggers the negative affective experiences of breathlessness, i.e. respiratory effort, air hunger and chest tightness (Mellor and Beausoleil 2017). These unpleasant physical and emotional consequences of bit pain are also antithetical to athleticism. Thus, the bit represents an impediment to welfare, safety and performance. Noxious stimuli from the bit are proposed to be incompatible with the unimpeded function of at least four systems critical to performance: the nervous, musculoskeletal, proprioceptive and respiratory systems.

Dyson *et al.* (2018) observe that, since 2013 "there is an increasing awareness that horses can exhibit lameness when ridden, while appearing sound when trotted in hand". In common usage, the word 'lame' denotes a gait abnormality caused by pain in a limb. Another sense of the word is not limited to limbs and carries the wider meaning of 'disabled, imperfect and lacking in smoothness' (Webster). In this sense, at least 65 of the 66 horses when bitted were shown to be 'disabled'. When trotted-up in a halter, they were not limb-lame, but when bitted and ridden they developed an abundance of gait abnormalities. The term 'bit lame' is proposed to describe a syndrome of bit-induced disability, i.e. the 69 pain indices here studied. As bit usage is the norm in 'English' equitation and still frequent in 'Western' equitation, it seems likely that bit lameness will be found to be common in the ridden horse.

A provisional diagnosis of 'bit lameness' is testable. If, by removing the bit, a gait abnormality is corrected this confirms a diagnosis of bit lameness and differentiates it from primary limb and thoraco-lumbar-sacral lameness or the incoordination of equine protozoal myeloencephalitis (EPM). As the definitive diagnosis of EPM and other subtle gait abnormalities can be difficult, removal of the bit is recommended as an early step in the differential diagnosis of lameness and the evaluation of poor performance. Such a step is especially indicated to help interpret the findings of computerised gait analysis, a diagnostic methodology that has introduced a dilemma over defining the term 'lameness' (Van Weeren *et al.* 2017).

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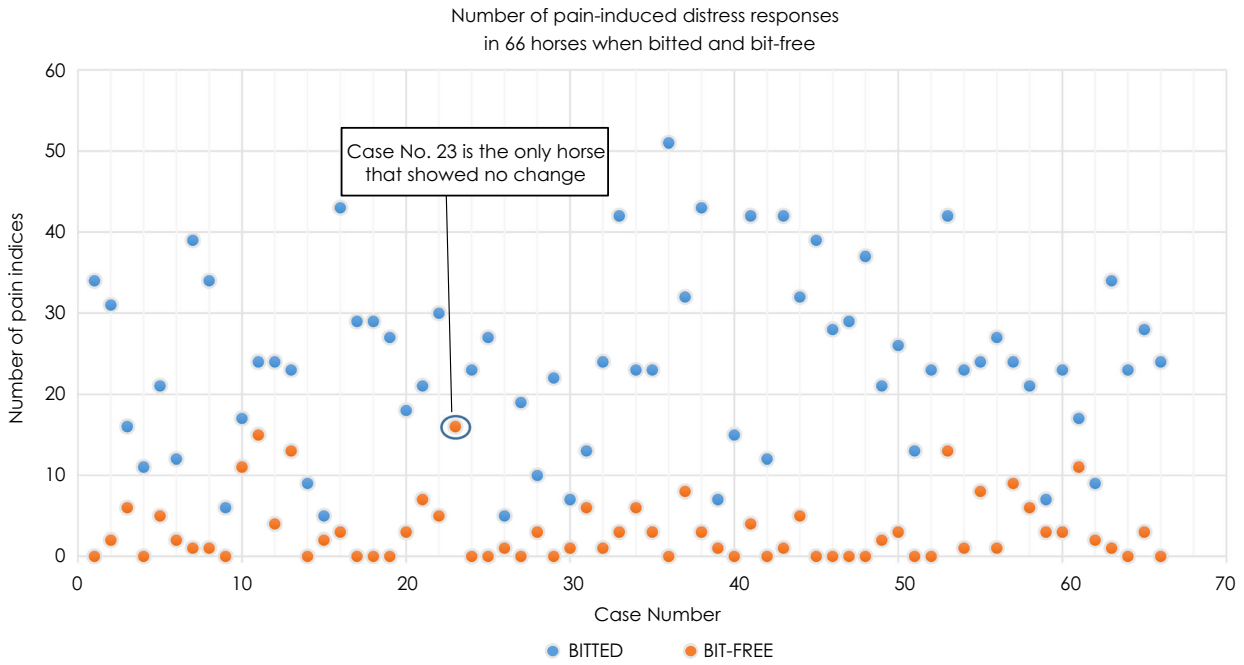


***Fig 1: Individual value plot of pain index numbers in 66 horses when bitted and bit-free. When bitted, all 66 horses (100%) exhibited pain, with a range of indices from 5 to 51 (median 23). When bit-free, for a median time of 35 days, 66% still exhibited some pain but the range of indices was from zero to 16 (median 2).***

After owning a horse for years, riders discovered that many 'unwanted' behaviours they had assumed to be immutable character traits were corrected by removing the bit. They were sometimes aware that their horse was exhibiting signs of pain but, until they removed the bit, did not recognise the source. Often, the signs themselves were not even noticed until, following bit removal, they disappeared. Norm theory explains how signs of bit lameness, being so familiar, fail to elicit surprise and are assumed to be 'normal'. What ultimately did surprise owners was the unexpectedly large number of pain indices each discovered. It follows that riders need to carry out a bit-free test before asserting that their horse shows no sign of bit pain.

The most prevalent pain index was 'hates the bit', a family of behaviours shown by 53 horses (80% of the population) (**Table 1**). The full line in the questionnaire read, "Hates the bit, chomping, chewing or clenching the bit, grinding the teeth (bruxism), constant fussing with the bit, 'busy mouth,' evading contact" (**Supplementary Item 1**).

The second most prevalent index was 'fright', shown by 46 horses (70% of the population). In the questionnaire, the line read "Fright: Anxious, unpredictable, 'hot,' nervous, painful, shy, spooky, panicky, tense, stressed". It seems reasonable to assume that at least a quarter of the 69 pain indices imperil the safety of horse and rider (**Table 1**). The data support the opinion that bit-induced fear is the cause of many horse-related accidents (Jahiel 2014). Removal of the bit in 65 horses appeared to 'minimise risk and prevent avoidable suffering,' in accord with the concept of 'one-welfare' (Campbell 2013; Pinillos *et al.* 2016). In the feral horse, pain or the anticipation of pain (fear) is adaptive and promotes survival. In the ridden horse, pain is inimical to performance. A bolting horse can be in such fear and panic that it behaves as though blind and can run straight into standing objects. Case No. 36, with 51 pain indices when bitted, was described as dangerous to ride (**Table 2**, **Fig 1**).

A 'stiff neck' was the third most prevalent behaviour and shown by 45 horses (68% of the population). Its 84% reduction when bit-free is important for reasons over and above the relief of pain. Bitted-rein tension restricts movement of the head and neck, handicapping a horse's ability to breathe, stride and balance. Bedouin horsemen apparently understood this long ago. When their very lives depended on their horse's peak performance, Bedouins rode bit-free (Hanson and Cook 2015). Over half of the 69 pain indices when bitted were expressed by abnormal positions of the head and neck at exercise. Unfettered movement of the head-and-neck pendulum is a vital locomotory mechanism. Freedom of the neck is key to freedom of gait. Except when ridden by a master horseman (someone who rides with a loose rein and does not apply rein tension) a bitted horse can be unbalanced by rein tension and is likely to stumble.

The fourth most prevalent sign of pain when bitted was 'lack of control' (65% of the population). Its reduction by 86% when bit-free questions the rationale of competition rules which mandate bit usage on the grounds that bits control horses.

Twelve horses were assessed for the second time after having been bit-free for 14 days or less. Five riders completed the second assessment on day one (**Table 2**). Because of this and the persistent nature of neuropathic pain compared with nociceptive pain, the number of horses documented as having recovered from facial (trigeminal) neuralgia may not reflect the population's full potential for recovery from what

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was listed in the questionnaire as 'Facial neuralgia (the headshaking syndrome)'. The percentage reduction in the prevalence of this syndrome in the population was the lowest of the five major categories of fear (**Supplementary Item 2**). Yet the reduction was still encouraging compared with results from other treatments for headshaking (Mills *et al.* 2002). The 'headshaking syndrome' line item was checked for 37 of the 66 horses when bitted; eight when bit-free – a 78% reduction (**Table 1**). The word 'bit' derives from the word 'bite.' Clearly, bits bite. It is considered no coincidence that the headshaking syndrome includes many of the same behaviours caused by biting flies.

Space does not permit a paragraph on every one of 69 pain indices but the 'positive affective experiences' column of **Table 1** provides a précis.

Cognitive bias was recognised in the population. Mellor (2015c) describes the bias as follows – "negative emotional states may be accompanied by greater attention to threatening stimuli and more pessimistic interpretations of ambiguous information, whereas positive states may be accompanied by more optimistic judgments". The behavioural changes matched such a description; for example, the greater frequency with which bitted horses shied and spooked compared with their calmness when bit-free (see 'Fright' **Table 1**).

The 69 pain indices assessed in this study represent only a fraction of possible bit aversions. If, for example, a study was done on racehorses, it is predicted that many more bit-induced, pain-related indices (diseases and disabilities) would be identified. From a performance perspective, the most critical years in the working life of a Thoroughbred racehorse are those between the ages of one and four. These are the years in which canine teeth are developing in the interdental space. Bit-induced mandibular periostitis ('sore mouth') is the aetiological equivalent of metacarpal periostitis ('sore shins'). Both sides of the mouth are traumatised on a daily basis. The mouth is even more sensitive than the shin. Bit pain can trigger a cascade of locomotor and respiratory consequences; separation of the jaws – open lips – loss of the intraoral vacuum – instability of the soft palate – asphyxia – followed by fatigue, sprains, dislocations, fractures and falls – and/or negative pressure pulmonary oedema ('bleeding') and sudden death (Cook 2002, 2014, 2016; Mellor and Beausoleil 2017).

A horse learns to defend itself from the bit by gripping it between the premolars ('grabbing the bit'); trapping it under the tongue ('tongue over bit'); or placing it against the rostral edge of the first mandibular cheek teeth. Horses that try to disarm the bit in these ways are unfairly blamed for being 'hard-mouthed' or 'pullers'. The strategies result in bone spur development at the interdental space and/or dental erosion. Both defects are highly prevalent (Van Lancker *et al.* 2007; Cook 2011; Mata *et al.* 2015).

Ödberg and Bouissou (1999) reported that many horses are slaughtered at a young age, perhaps because of 'unresolved behavioural problems'. McGreevy and McLean (2005) stressed the need for physical causes of undesirable behaviour to be ruled-out before behavioural therapy was adopted. They noted that bits are '…a potential source of tremendous discomfort'.

The horse is motivated to avoid pain and seek comfort. Mankind has an obligation to promote positive emotions for the horse – the neuroscience-supported concept (see **Table 1**) of 'positive affective engagement' (Mellor 2015a). Contingent on the absence of pain a horse can probably derive pleasure from being ridden, similar to that derived from 'play' with conspecifics (Mellor 2015b). Bonding between horse and rider seems optimal when rein cues are devoid of pressure, painless and proprioceptively supportive (Hanson and Cook 2015).

## Limitations of the study

### *Study design*

The case-study population was not a random population.

### *Questionnaire*

The prototype questionnaire does not meet recently developed standards for questionnaire-based research (Hall *et al.* 2013; Muir 2013; Reid *et al.* 2013). A future questionnaire could be based on the Five Domains Model (Mellor and Stafford 2001; Jones and McGreevy 2010; Mellor and Beausoleil 2015; Mellor 2017). Future questionnaires might also include input from the work of Mullard *et al.* (2017) and Dyson *et al.* (2017) who have developed a ridden horse ethogram based on facial expression. Most recently, Dyson *et al.* (2018) have developed a pain scoring ethogram for the ridden horse with the objective of differentiating lame from nonlame horses.

### *Assessors were not 'blinded'*

Nevertheless, as recommended by current welfare science, the assessors were the people most familiar with the animals studied, having triple credentials as owners, caretakers and riders.

### *Data grading*

A simple count of pain indices represents the most basic of welfare grading systems. As a result, the homocentric 'lack of control' carried no more weight than, for example, 'yawning'. Absence of relative weighting will have underestimated the harm of the bit. That said, current welfare science thinking recommends non-numerical grading (Mellor and Beausoleil 2015; Mellor 2017).

### *Standardisation*

Lack of standardisation prevents this study from being compared with others, e.g. Hockenhull and Creighton (2013). To permit comparisons, a standard glossary (McGreevy *et al.* 2005), ethogram and protocol is needed. None of the 24 behavioural markers of pain in the ridden horse ethogram developed by Dyson *et al.* (2018) were identical in wording to the 69 markers of pain in the current study. However, many were clearly descriptions of the same behaviours. Comparisons cannot be made because of the terminology differences and because none of Dysons' 37 horses were assessed when bit-free. The authors concluded "None of the horses … had evidence of oral pain".

### *Crib-biting, wind-sucking and other stereotypic behaviours in stabled horses*

A footnote to the questionnaire read: "To date there is no evidence to link wind-sucking or crib-biting as problems that might be caused by the bit but it would be worth noting the occurrence of such items in case a pattern of correlation could be demonstrated". Six out of 66 horses (9%) were

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reported as showing stable-based stereotypic behaviour when bitted; four windsuckers, one wood-chewer and one self-mutilator. Information was not collected on whether this behaviour changed when the bit was removed. In a survey of stereotypic behaviour in a randomly selected population of 650 riding-school horses, 46 exhibited stereotypies (Normando *et al.* 2002). A statistically significant difference was recognised in the prevalence of stereotypies between stabled horses ridden Western style (9 out of 348 horses – 3%) and 'English' (37 out of 302 horses – 12%). The authors noted that "the latter employs more hand to bit contact".

## Conclusions

When bitted, the median number of behavioural signs of pain per horse was 23. After being bit-free for a median period of 35 days, the median was 2. Removal of the bit reduced the prevalence of pain signals by 87%; showing the bit to be a predominant cause of pain in the population. The null hypothesis was refuted. Following the criteria proposed by Campbell (2013) for distinguishing use from abuse, removal of the bit in 65 horses minimised risk (for the rider) and prevented avoidable suffering (for the horse). In sum, 65 horses out of 66 benefitted from removal of a foreign body.

## Authors' declaration of interests

No current conflict of interests have been declared.

## Ethical animal research

No ethical review was required.

## Source of funding

There was no formal funding for this research. The data were collected by W.R. Cook during a period of years when he was the CEO of a small company, Bitless Bridle Inc. The costs, small as they were, were part of the general running costs of the company and did not figure in any line item for research in the annual accounts.

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## Authorship

The study design was conceived by W. R. Cook, as was the execution, data entry and preparation of the manuscript. The statistical data analysis was carried out by M. Kibler. Both authors approved the final manuscript.

## Manufacturer's address

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## References

Ashley, F.H., Waterman-Pearson, A.E. and Whay, H.R. (2005) Behavioural assessment of pain in horses and donkeys: application to clinical practice and future studies. *Equine Vet. J.* **37**, 565-575.

Campbell, M.L.H. (2013) When does use become abuse in equestrian sport?. *Equine Vet. Educ.* **25**, 489-492.

Carey, C., Moriarty, S.H. and Brennan, R. (2016) A study of the impact of bitted and bitless bridles on the therapeutic riding horse. Proceedings of the 12th International Society for Equitation Science Conference, p 99.

Cook, W.R. (1999) Pathophysiology of bit control in the horse. *J. Equine. Vet. Sci.* **19**, 196-204.

Cook, W.R. (2002) Bit-induced asphyxia in the horse: elevation and dorsal displacement of the soft palate at exercise. *J. Equine. Vet. Sci.* **22**, 7-14.

Cook, W.R. (2003) Bit-induced pain: a cause of fear, flight, and facial neuralgia in the horse. *Pferdeheilkunde* **19**, 75-82.

Cook, W.R. (2011) Damage by the bit to the equine interdental space and second lower premolar. *Equine Vet. Educ.* **23**, 355-360.

Cook, W.R. (2014) A hypothetical etiological relationship between the horse's bit, nasopharyngeal asphyxia and negative pressure pulmonary edema (bleeding). *Equine Vet. Educ.* **26**, 381-389.

Cook, W.R. (2016) Bit-induced asphyxia in the racehorse as a cause of sudden death: a hypothesis. *Equine Vet. Educ.* **28**, 405-409.

Cook, W.R. and Mills, D.S. (2009) Preliminary study of jointed snaffle vs. crossunder bitless bridles: Quantified comparison of behaviour in four horses. *Equine Vet. J.* **41**, 827-830.

Dyson, S. (2016) Evaluation of poor performance in competition horses: a musculoskeletal perspective. Part 1: clinical assessment. *Equine Vet. Educ.* **28**, 284-293.

Dyson, S.J., Berger, J.M., Ellis, A. and Mullard, J. (2017) Can the presence of musculoskeletal pain be determined from the facial expressions of ridden horses (FEReq)? *J. Vet. Behav.* **19**, 78-89.

Dyson, S.J., Berger, J., Ellis, A.D. and Mullard, J. (2018) Development of an ethogram for a pain scoring system in ridden horses and its application to determine the presence of musculoskeletal pain. *J. Vet. Behav.* **23**, 47-57.

Hall, C., Huws, N., White, C., Taylor, E., Owen, H. and McGreevy, P.D. (2013) Assessment of ridden horse behaviour. *J. Vet. Behav.* **8**, 62-73.

Hanson, F.J. and Cook, W.R. (2015) The Bedouin bridle rediscovered: a welfare, safety and performance enhancer. *The horseshoof.com*, **60**, 8.

Hockenhull, J. and Creighton, E. (2013) The use of equipment and training practices and the prevalence of owner-reported ridden behaviour problems in UK leisure horses. *Equine Vet. J.* **45**, 15-19.

Jahiel, J. (2014) Increase comfort, reduce risk: The Bit-free Bridle. Fall Newsletter, pp 5-12 of the Equestrian Medical Safety Association http://emsaonline.net/wp-content/uploads/gravity_forms/1-5f7def01e62df8eee656c247c514b181/2015/01/emsa-news-fall-2014.pdf Accessed 27th June, 2017

Jones, B. and McGreevy, P.D. (2010) Ethical equitation: applying a cost-benefit approach. *J. Vet. Behav.* **5**, 196-202.

Mason, G. (2006) Stereotypic behaviour in captive animals: fundamentals and implications for welfare and beyond. Chapter 11. In: *Stereotypic Animal Behavior; Fundamentals and Applications to Welfare*, 2nd edn. Eds: G. Mason and J. Rushen. CAB International, North America

Mata, F., Johnson, C. and Bishop, C. (2015) A cross-sectional epidemiological study of prevalence and severity of bit-induced oral trauma in polo ponies and racehorses. *J. Appl. Anim. Welf. Sci.* **18**, 259-268.

McGreevy, P.D. and McLean, A.N. (2005) Behavioural problems with the ridden horse. Chapter 14. In: *The Domestic Horse: The Origins, Development And Management Of Its Behavior*, Eds. D.S. Mills, S.M. McDonnell, Cambridge University Press, Cambridge.

McGreevy, P.D., McLean, A.N., Warren-Smith, A.K., Waran, N. and Goodwin, D. (2005) Defining the terms and processes associated with equitation. Proceedings of the 1st International Equitation Science Symposium. http://www.equitationscience.com/proceedings Accessed 16th January, 2017

Mellor, D.J. (2015a) Enhancing animal welfare by creating opportunities for 'positive affective engagement'. *N. Z. Vet. J.* **63**, 3-8.

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Mellor, D.J. (2015b) Positive animal welfare states and encouraging environment focused and animal-to-animal interactive behaviours. *N. Z. Vet. J.* **63**, 9-16.

Mellor, D.J. (2015c) Positive animal welfare states and reference standards for welfare assessment. *N. Z. Vet. J.* **63**, 17-23.

Mellor, D.J. (2017) Operational details of the five domains model and its key applications to the assessment and management of animal welfare. *Animals* **7**, 60.

Mellor, D.J. and Beausoleil, N.J. (2015) Extending the 'Five Domains' model for animal welfare assessment to incorporate positive welfare states. *Anim. Welfare* **24**, 241-253.

Mellor, D.J. and Beausoleil, N.J. (2017) Equine welfare during exercise: an evaluation of breathing, breathlessness and bridles. *Animals* **7**, 41.

Mellor, D.J. and Stafford, K.J. (2001) Integrating practical, regulatory and ethical strategies for enhancing farm animal welfare. *Aust. Vet. J.* **79**, 762-768.

Mills, D.S., Cook, S. and Jones, B. (2002) Reported response to treatment amongst 245 cases of equine headshaking. *Vet. Rec.* **150**, 311-313.

Muir, W.W. (2013) Stress and Pain: their relationship to health-related quality of life in horses. *Equine Vet. J.* **45**, 653-655.

Mullard, J., Berger, J.M., Ellis, A.D. and Dyson, S. (2017) Development of an ethogram to describe facial expressions in ridden horses (FEReq). *J. Vet. Behav.* **18**, 7-12.

Normando, S., Canali, E., Ferrante, V. and Verga, M. (2002) Behavioural problems in Italian saddle horses. *J. Equine. Vet. Sci.* **22**, 117-120.

Ödberg, F.O. and Bouissou, M.F. (1999) The development of equestrianism from the baroque period to the present day and its consequences for the welfare of horses. The role of the horse in Europe. *Equine Vet. J.* **31**, *Suppl.* **28**, 26-30.

Pinillos, R.G., Appleby, M., Manteca, X., Scott-Park, F., Smith, C. and Velarde, A. (2016) One welfare – a platform for improving human and animal welfare. *Vet. Rec.* **179**, 412-413.

Quick, J.S. and Warren-Smith, A.K. (2009) Preliminary investigations of horses' (*Equus caballus*) indices to different bridles during foundation training. *J. Vet. Behav.* **4**, 169-176.

Reid, J., Scott, M., Nolan, A. and Wiseman-Orr, L. (2013) Pain assessment in animals. *In Practice* **35**, 51-56.

Sherrington, C.S. (1907) On the proprio-ceptive system, especially in its reflex aspect. *Brain* **29**, 467-482.

Sisson, S. and Grossman, J.D. (1938) *The Anatomy of the Domestic Animals*, 3rd edn., revised. W.B. Saunders, Philadelphia.

Van Lancker, S., Van der Broeck, W. and Simoens, P. (2007) Incidence and morphology of bone irregularities of the equine interdental space (bars of the mouth). *Equine Vet. Educ.* **19**, 103-106.

Van Weeren, P.R., Pfau, T., Rhodin, M., Roepstorff, L., Serra Braganca, F. and Weishaupt, M.A. (2017) Do we have to redefine lameness in the era of quantitative gait analysis? *Equine Vet. J.* **49**, 567-569.

Wemelsfelder, F., Hunter, T.E.A., Mendl, M.T. and Lawrence, A.B. (2001) Assessing the whole animal: a free choice profiling approach. *Anim. Behav.* **62**, 209-220.

## Supporting information

Additional Supporting Information may be found in the online version of this article at the publisher's website:

**Supplementary Item 1:** Questionnaire.

**Supplementary Item 2:** Prevalence of five major categories of fear in 66 horses compared by their order when bitted.

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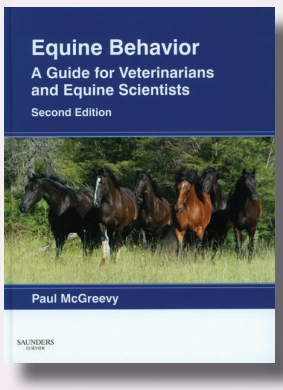


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